

# **AI in Medical Diagnosis: Balancing Promise, Trust, and Clinical Reality**

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**Abstract:**

Artificial Intelligence (AI) is swiftly changing the field of medical diagnosis, providing an unparalleled opportunity to improve accuracy, efficiency, and accessibility in clinical decision-making. AI systems are demonstrating their worth as aids for healthcare professionals, from deciphering intricate imaging data to forecasting disease probabilities and tailoring treatment regimens. Nonetheless, this assurance comes with a variety of difficulties that highlight the need for equilibrium between technological advancement and the practicalities of clinical work. Concerns about the trustworthiness and ethical use of AI in healthcare arise from issues related to algorithmic transparency, data bias, and interpretability. Moreover, incorporating AI into clinical workflows requires careful contemplation of aspects such as human-machine collaboration, regulatory oversight, and the continuous training of healthcare professionals. This research investigates AI's dual role in diagnostics, its promise to transform healthcare delivery, and the complex obstacles that need to be overcome for its safe, equitable, and trustworthy application. The aim of the research is to offer a thorough perspective on the responsible and effective incorporation of AI into diagnostic medicine by examining current progress, constraints, and future paths.

# Chapter 1

## Introduction:

Artificial Intelligence (AI) is quickly becoming a transformative power in medical diagnosis, altering clinicians' methods for detecting diseases, predicting outcomes, and planning treatments. AI systems, especially those driven by machine learning and deep learning, are showcasing extraordinary abilities in fields like medical imaging analysis, pathology, genomics, and predictive analytics. This is due to their capacity to handle enormous volumes of intricate medical data at speeds never seen before. By picking up on subtle data patterns that even seasoned clinicians may miss, these technologies facilitate earlier diagnoses that are potentially more accurate. As an illustration, AI algorithms have demonstrated performance that is comparable to or exceeds that of humans in the interpretation of radiological scans for ailments like lung cancer, diabetic retinopathy, and breast cancer. Likewise, tools powered by AI can scrutinize electronic health records (EHRs) to identify patients at high risk, propose differential diagnoses, or suggest treatments grounded in evidence. AI holds promise for diagnosis not just in enhancing clinical outcomes and minimizing human error, but also in expanding access to quality care in underserved regions by bolstering the capabilities of healthcare systems under heavy strain (Bajwa, 2021).

Even with these improvements, incorporating AI into clinical practice is not simple. Trust continues to be a crucial challenge, as it is essential for both healthcare professionals and patients to have confidence in the accuracy, fairness, and reliability of decisions made by AI. A key issue is the "black box" characteristic of numerous AI models, especially deep learning systems, which frequently yield outcomes without transparent elucidations. This absence of transparency complicates clinicians' efforts to comprehend, validate, or challenge AI-generated

recommendations, which may jeopardize their clinical judgment and accountability. Moreover, the performance of AI models depends on the quality of their training data; should the training data exhibit bias or lack representation, the algorithms produced may sustain or even exacerbate current inequalities in healthcare provision. To illustrate, if certain demographic groups are underrepresented in training datasets, this can result in misdiagnoses or worse outcomes for those populations. To establish trust in AI systems, it is essential to guarantee data diversity, model explainability, and ethical oversight (Kuwaiti, 2023).

AI technologies' implementation in the real world adds another layer of complexity. Although pilot projects and proof-of-concept studies frequently yield encouraging outcomes, the implementation of AI tools across a variety of clinical settings involves considerable logistical, regulatory, and cultural difficulties. Due to worries about job displacement, insufficient training, or fears of legal liability, healthcare professionals may be reluctant to embrace AI tools. Moreover, the current healthcare infrastructure may lack the necessary support for a smooth integration of AI systems, necessitating considerable investment in areas such as interoperability, data governance, and cybersecurity. As regulatory bodies continue to create frameworks for assessing the safety and effectiveness of AI in medicine, the speed of innovation frequently surpasses the development of these guidelines. Therefore, the clinical reality of implementing AI encompasses not just technical feasibility but also involves stakeholder engagement, collaboration across disciplines, and continuous education (Uren, 2023).

The objective of this study is to offer a thorough investigation of the intricate interactions among the potential of AI in medical diagnosis, the necessity of trust among stakeholders, and the actualities of clinical integration. Our aim is to provide a balanced perspective that transcends hype and skepticism by conducting a critical analysis of current technologies, ethical concerns, and systemic barriers. Ultimately,

our capacity to align innovation with human-centered care will determine how responsibly and effectively AI can be deployed in diagnostics. This alignment is essential to ensure that technological advancements yield significant benefits for patients and healthcare systems alike (Olawade, 2024).

### **Background:**

The application of artificial intelligence in medical diagnosis has transformed from a theoretical idea into a field that is progressing quickly and has practical applications. AI's roots in healthcare can be found in the early expert systems of the 1970s and 1980s, like MYCIN and INTERNIST-I, which aimed to help doctors diagnose infections and internal medicine conditions using logical rules and clinical guidelines. Although these initial systems were groundbreaking, they were constrained by the inflexibility of rule-based logic and the scarcity of computational resources and extensive medical data. However, over the last twenty years, the rapid increase in data availability, computing power, and the complexity of algorithms has led to the development of robust machine learning (ML) and deep learning (DL) models capable of learning from vast datasets and enhancing their performance over time. These AI systems are currently being utilized for a diverse range of diagnostic tasks, including the analysis of radiological images and pathology slides, as well as the interpretation of EHRs and genomic data (Hirani, 2024).

Medical imaging is now one of the leading fields for AI applications, with deep learning models—particularly convolutional neural networks (CNNs)—showing high precision in tasks such as identifying tumors, fractures, or hemorrhages in X-rays, CT scans, and MRIs. In numerous situations, AI has equaled or exceeded the diagnostic capabilities of seasoned radiologists. For instance, in the realm of breast cancer screening, AI algorithms have demonstrated their ability to lower false

positive rates and enhance early detection, which could result in improved patient outcomes. There have been comparable developments in dermatology, ophthalmology, and cardiology, fields where diagnostics based on images are crucial. In addition to imaging, natural language processing (NLP) aids in extracting clinically pertinent information from the unstructured text of medical records. At the same time, predictive models evaluate patients' risk for conditions like sepsis, heart failure, and diabetes by recognizing patterns within physiological data. These advancements have spurred hope regarding AI's potential to diminish diagnostic errors, simplify clinical workflows, and provide high-quality care in resource-limited environments (Jia, 2024).

Nonetheless, the increasing dependence on AI for diagnosis brings forth numerous technical, ethical, and operational challenges that need to be tackled in order to fully harness its potential. A key issue is the quality and representativeness of the data. AI models learn from existing datasets that may include biases connected to race, gender, socioeconomic status, or geographic location. Due to these biases, diagnostic performance may vary across different patient populations. This raises concerns regarding fairness and health equity. Moreover, the proprietary nature of numerous commercial AI systems complicates the evaluation of their internal mechanisms, which hampers transparency and trust. If clinicians do not comprehend the process behind recommendation generation or if the system's logic cannot be examined when an error occurs, they may hesitate to embrace AI tools. Additionally, the “black box” nature of deep learning models—whereby decisions arise from complex calculations that are hard to decipher—represents a considerable obstacle to clinical validation and accountability (Mennella, 2024).

The interaction between AI systems and the existing healthcare ecosystem adds another layer of complexity. To integrate AI into routine practice, substantial adjustments to infrastructure, workflows, and professional roles are necessary. As an

illustration, hospitals need to put resources into systems that are interoperable and facilitate smooth data exchange between AI tools and electronic health records. Clinicians should be trained not just in using these technologies, but also in comprehending their limitations and the suitable contexts for their application. With this shift, clinical responsibility needs to be redefined: AI should be viewed as a support tool rather than a replacement for human judgment. It requires strong regulatory frameworks that can guarantee safety, efficacy, and ethical compliance while keeping up with technological progress. Regulatory agencies such as the U.S. Food and Drug Administration (FDA) and the European Medicines Agency (EMA) have started formulating guidelines for AI-based medical devices, but numerous uncertainties persist regarding long-term oversight, algorithm updates, and liability management in the event of harm (Olawade D. B., 2024).

Given these complexities, the development of AI in medical diagnosis involves not only a narrative of technological advancement but also one of social, institutional, and ethical negotiation. Although the field has advanced remarkably, moving ahead necessitates more than ongoing innovation; it requires a dedicated effort to reconcile the advantages of AI with the tenets of transparency, inclusivity, and patient-centered care. AI can only bring about a transformation in diagnosis that is trustworthy, equitable, and clinically meaningful by addressing the complex background issues involved (Williamson, 2024).

**Problem statement:**

Although there have been swift developments in and increasing uptake of AI for medical diagnostics, incorporating these technologies into actual clinical practice is a complicated issue that involves more than just technological feasibility. Although AI systems have shown remarkable performance in controlled settings—such as accurately diagnosing diseases from images, forecasting health outcomes, and simplifying data interpretation—their effectiveness, reliability, and fairness in various clinical environments are still uncertain. It is not just a matter of guaranteeing technical precision: it is also necessary to tackle vital problems relating to ethical accountability, transparency, and trust. Numerous AI models function as “black boxes,” providing minimal understanding of the decision-making process. This lack of transparency erodes clinician confidence and complicates regulatory examination. Moreover, the use of training data that is biased or lacking in completeness can result in differences in diagnosis, which may worsen current inequalities in healthcare provision. Healthcare professionals might not have sufficient training to assess or question AI suggestions. Additionally, healthcare systems could face difficulties due to infrastructural constraints, interruptions in workflow, and ambiguity regarding liability in instances of mistakes or damage. These challenges underscore a basic discrepancy between the theoretical potential of AI and its practical, reliable, and fair use in real-world healthcare. The main issue this research tackles, then, is how to incorporate AI into medical diagnostics in a way that is responsible and effective while maintaining clinical integrity, gaining the confidence of stakeholders, and improving patient care rather than undermining it (Varnosfaderani, 2024).

## **Research objective:**

### **- Main Goal**

This study aims primarily to assess the incorporation of artificial intelligence into medical diagnosis, emphasizing a balance between its technological promise and the key factors of trust, clinical applicability, and ethical responsibility in healthcare practice.

### **- Sub-Objectives**

1. To evaluate the present strengths and weaknesses of AI diagnostic tools in different medical specialties, emphasizing domains of AI excellence and inadequacy.
2. To explore the elements that affect trust in AI among healthcare professionals and patients, encompassing matters of transparency, interpretability, accountability, and perceived reliability.
3. To evaluate the ethical and societal ramifications of AI-driven diagnostics, especially in relation to data bias, inequalities in healthcare accessibility, and the consequences of decisions made without sufficient human supervision.
4. To investigate the difficulties of incorporating AI systems into clinical workflows, looking at infrastructural, operational, and regulatory obstacles to adoption in actual healthcare environments.
5. To suggest a framework for the responsible and effective use of AI in diagnostics, highlighting strategies to promote collaboration between human clinicians and AI, enhance system transparency, and guarantee fair patient outcomes.

## **Research scope:**

### **1. Subject Scope**

This research concentrates on the function of Artificial Intelligence in medical diagnosis, particularly:

- The application of AI in the analysis of medical data (such as imaging, laboratory results, and patient records).
- The advantages and assurances of AI, including rapidity, precision, and early identification.
- The difficulties associated with trust issues, ethical dilemmas, and the doctor-patient dynamic.
- The practical clinical constraints, including regulatory challenges, data privacy concerns, and the need for integration into hospital workflows.

### **2. Spatial Scope**

This specifies the context in which the study is applied. As an illustration:

- Hospitals or healthcare centers chosen for employing AI diagnostic tools.
- A particular country or area (e.g., hospitals in Saudi Arabia, the UK, or a worldwide review based on your research).
- Healthcare facilities of different tiers (primary, secondary, or tertiary care centers).

### **3. Temporal Scope**

This denotes the time span that the study encompasses, such as:

- A defined research period (e.g., January to June 2025).
- The timeframe during which AI technology was implemented or assessed in medical diagnostics (e.g., advancements from 2020 to 2025).

- Period of data gathering and examination in the research project.

#### **4. Human Scope**

This specifies who is involved or impacted in the study:

- Further experts from the medical field (e.g., radiologists, general practitioners, AI specialists).
- Patients with AI-backed diagnoses.
- Healthcare policymakers and administrators engaged in the adoption of AI tools.
- Producers and suppliers of AI medical diagnostic systems.

## Chapter 2

### **Literature review:**

Patients respond in various ways—both negative and positive—to the introduction of Artificial Intelligence (AI) in healthcare. Although AI has the potential to transform healthcare by enhancing, speeding up, and increasing the accuracy of care services, we have a limited understanding of how patients will respond to these fundamental changes. Especially, there is little knowledge about how open patients are to using AI-supported diagnostic applications on their own. This research (Hajiheydari, 2025) seeks to develop a holistic, context-specific model capturing both the negative and positive cognitive responses of patients utilising AI-powered diagnostic services. The study utilizes Behavioural Reasoning Theory to analyze patients' cognitive responses, including their reasons for and against using such applications, employing a sequential mixed-methods approach. The study starts with a qualitative investigation, examining user reviews to pinpoint context-specific barriers and motivators. With these qualitative insights as a foundation, the model's empirical validity is assessed in a quantitative phase that involves survey data analysis. The results of our research offer a detailed comprehension of the contextual factors that influence patients' cognitive reactions to AI-enabled diagnostic services, providing useful perspectives for creating and executing patient-centred AI solutions in healthcare.

AI (artificial intelligence) has given rise to the new “big thing” in contemporary medicine. It promises to result in safer, improved care that benefits patients and serves as a valuable tool for skilled physicians. However, even with the anticipation surrounding it, AI's implementation and use remain at a rudimentary stage, especially because of legal and ethical concerns related to "data." These challenges ought to be acknowledged and addressed rather than ignored, so that all relevant

stakeholders can accept them without bias. When it becomes possible to surmount these challenges, AI will genuinely transform the medical field through better diagnostic precision, alleviation of physician burnout, and advancement of treatment methods. It is thus essential for physicians to accept AI and for it to be incorporated into medical education so that we can be adequately prepared for our future roles in medicine (Akinrinmade, 2023).

The purpose of this literature review (Karalis, 2024) is to provide a fundamental synopsis of current research pertaining to artificial intelligence (AI) within the domain of clinical practice. Through the provision of innovative solutions to complex problems, artificial intelligence has transformed medicine and healthcare. A key advantage of AI in clinical practice is its capacity to explore large datasets efficiently and accurately. This has resulted in the creation of multiple applications that have enhanced patient outcomes and alleviated healthcare professionals' workloads. AI can assist physicians in creating personalized treatment plans and making diagnoses that are more precise. Illustrative instances of successful AI applications are detailed across a range of medical specialties, including cardiology, surgery, gastroenterology, pneumology, nephrology, urology, dermatology, orthopedics, neurology, gynecology, ophthalmology, pediatrics, hematology, care for critically ill patients, and various diagnostic methods. There is a particular emphasis on legal and ethical aspects such as accuracy, informed consent, privacy concerns, data security, regulatory framework, product liability, explainability, and transparency. To conclude, this review critically assesses the use of AI in clinical practice and its future outlook. Nonetheless, it is crucial to proceed with caution when developing and implementing it in order to satisfy ethical requirements.

Artificial intelligence (AI) is more than just a tool for the future of clinical medicine; it is already transforming the landscape, questioning conventional models, and broadening the scope of what can be accomplished in healthcare. AI-driven

solutions could transform disease diagnostics and simplify patient education, with the potential to improve accuracy, efficiency, and fairness in healthcare delivery. These developments are more than just tools; they act as vital links for a world confronting health challenge of growing complexity. Nonetheless, notwithstanding their promise, these innovations face considerable challenges that could compromise their transformative potential if not addressed. The main challenge is clear: as AI tools develop greater sophistication, our ability to incorporate them into clinical practice in an ethical, equitable, and effective manner must advance alongside this development. This editorial examines the extraordinary advancements in AI-driven medicine, pinpoints crucial deficiencies that impede its complete realization, and underscores the cooperative endeavors required to establish a patient-centered future. AI-driven medicine has made particularly significant strides in the fields of diagnosis and predictive analytics, which are transforming clinical precision and decision-making. High-quality diagnostics are becoming more scalable and accessible thanks to deep convolutional neural networks (DCNNs), which have reached dermatologist-level accuracy in skin lesion classification. In the field of oncology, artificial intelligence has proven to be on par with expert radiologists in the diagnosis of thyroid cancer through ultrasound, and it provides improved specificity.

Machine learning models are revolutionizing predictive analytics beyond diagnosis, offering personalized insights like prognostic predictions for colorectal cancer that exceed the abilities of conventional methods. Moreover, LLMs like ChatGPT showcase the adaptability of AI by providing essential assistance in emergency medical situations, including the creation of differential diagnoses and the suggestion of management approaches. These innovations demonstrate that AI not only enhances clinical practice, but also tackles some of the most complex issues in contemporary healthcare. In addition to diagnostic and predictive uses, AI is

facilitating enhancements in clinical workflows, alleviating administrative burdens, and fostering patient involvement, all of which contribute to greater operational efficiency. Generative AI, which encompasses natural language processing and automatic speech recognition, can help reduce the workload of clinicians by automating the creation of SOAP and BIRP notes, all while ensuring that documentation quality is upheld. Google Translate, an AI-driven translation tool, has demonstrated effectiveness in bilingual patient-provider interactions, with 90% of Spanish-speaking patients able to convey pain and nausea through neural machine translation. Automated machine learning (autoML) is also proving to be a beneficial tool for the management of electronic health records, improving efficiency in data processing and clinical decision support. In surgical environments, instrument recognition powered by ChatGPT-4o has shown an accuracy rate of almost 90% for broad classifications, indicating its potential to enhance workflow efficiency and procedural safety. All these developments contribute to a healthcare system that is more centered around patients by allowing clinicians to spend more time on direct patient care and using AI to enhance the efficiency of standard procedures (Genovese, 2025).

The growing incorporation of artificial intelligence (AI) into medical applications could transform healthcare by enhancing the precision of diagnoses, the quality of treatment recommendations, and patient outcomes. Nonetheless, the extensive implementation of medical AI systems is obstructed by problems relating to trust and transparency. It is challenging for patients and healthcare workers to comprehend the reasoning behind decisions made by AI models, especially deep learning systems, due to their intrinsic complexity. Explainable AI (XAI) has developed into an essential area focused on making AI systems more interpretable and transparent, which in turn boosts confidence in the use of AI in medicine. This study (Cakes, 2025) explores the role of XAI in fostering trust among stakeholders

in medical AI systems. The study investigates the current literature regarding trust in AI, reviews the existing methods in XAI, and examines how effective they are in medical settings. The findings suggest that integrating explainability mechanisms into medical AI can bolster user confidence, aid in meeting regulatory requirements, and improve clinical decision-making. Nonetheless, difficulties persist in achieving a balance between explainability and model performance. This article addresses these challenges, reviews cutting-edge XAI methods in medical AI, and offers suggestions for further research aimed at reconciling the efficiency and interpretability of AI.

Over the last ten years, there have been considerable developments in Artificial Intelligence (AI), and it has found applications across a wide range of fields. Among these, healthcare has surfaced as a vital domain where AI can bring about transformative effects, especially in the realm of medical diagnosis. The promising abilities of AI models to diagnose diseases with high accuracy notwithstanding, the opacity and lack of interpretability of these systems raise issues regarding trust, accountability, and ethical deployment. Explainable AI (XAI) aims to tackle these issues by offering explanations for AI decisions that humans can comprehend. This article examines the idea of explainable AI in the context of medical diagnosis, covering its necessity, current progress, challenges, and potential future developments. The goal is to emphasize how crucial interpretability and trustworthiness are in creating AI models for medical diagnosis, so that these models can be integrated into clinical environments safely and effectively (Paul, 2024).

Utilizing artificial intelligence (AI) in the field of medical imaging offers great potential for enhancing diagnostic precision and efficiency, as well as improving patient outcomes. However, it also brings forth considerable ethical and regulatory challenges that need to be tackled in order to guarantee a safe and fair implementation. Major ethical issues encompass bias in AI algorithms, stemming

from training datasets that are unrepresentative or imbalanced. This can result in unequal diagnosis and treatment among various demographic groups. It is also essential for AI systems to be transparent and explainable, as clinicians and patients must comprehend the decision-making process to foster trust and guarantee accountability. Furthermore, due to the sensitive nature of medical imaging data and the potential risks of breaches or misuse, data privacy and security are of utmost importance. From a regulatory standpoint, the absence of standardized frameworks for validating, certifying, and monitoring AI tools presents a challenge. It is crucial for regulatory bodies to reconcile the necessity of innovation with the obligation to safeguard patient safety, which entails thorough testing of AI systems and ongoing observation after their implementation. Moreover, the incorporation of AI into clinical workflows brings up concerns regarding liability in instances of mistakes or negative outcomes, as well as its potential effects on the duties and roles of healthcare professionals. To tackle these challenges, it is essential for developers, clinicians, regulators, and ethicists to work together to create strong guidelines, foster fairness, and guarantee responsible implementation of AI technologies. Through careful navigation of these ethical and regulatory challenges, the medical community can fully leverage AI's potential in medical imaging, all while protecting patient rights and nurturing confidence in these groundbreaking technologies (Alabi, 2025).

## Chapter 3

### **Research methodology:**

#### **- Research Design and Approach**

This study adopts a quantitative research design (Ghanad, 2023), aiming to objectively measure perceptions, challenges, and expectations surrounding the use of artificial intelligence in medical diagnosis. Using a quantitative approach makes it possible to gather numerical data that can be subjected to statistical analysis in order to uncover patterns, connections, and trends associated with healthcare professionals' adoption of and trust in AI. The study aims to evaluate the current knowledge, attitudes, and practices regarding AI diagnostic tools, and to explore the relationships between variables such as perceived trustworthiness, ease of use, ethical concerns, and readiness for implementation. This will be done using a descriptive and correlational research design. This design is suitable for hypothesis testing, assumption validation, and making generalizable conclusions across various demographic and professional groups in the healthcare sector. It allows the researcher to systematically collect data from a larger population, which improves the reliability and validity of the findings.

#### **- Data Collection Tool and Measurement Scale**

For this study, a closed-ended questionnaire was employed as the main data collection tool. It was designed to gather quantitative data from medical professionals such as doctors, radiologists, and healthcare administrators. The questionnaire comprises thematic sections that correspond to the study's sub-objectives, addressing areas such as familiarity with AI tools, perceived advantages and risks, trust factors, ethical issues, and institutional readiness. To guarantee

uniformity and ease statistical analysis, each question comes with a selection of predefined response options. The measurement scale used predominantly consists of Likert-type scales (Koo, 2025), ranging from 1 (strongly disagree) to 5 (strongly agree), allowing respondents to express the intensity of their opinions and attitudes. Alongside Likert scales, there are multiple-choice and dichotomous (yes/no) questions included to gather factual data and categorical variables. The closed-ended format guarantees clear and consistent answers, diminishes ambiguity, and facilitates efficient data coding and analysis. The questionnaire is pilot-tested before deployment to confirm its clarity, reliability, and internal consistency. Modifications based on feedback are made to improve its effectiveness in capturing the intended quantitative data.

### **Expected outcomes:**

Alongside Likert scales, there are multiple-choice and dichotomous (yes/no) questions included to gather factual data and categorical variables. The closed-ended format guarantees clear and consistent answers, diminishes ambiguity, and facilitates efficient data coding and analysis. The questionnaire is pilot-tested before deployment to confirm its clarity, reliability, and internal consistency. Modifications based on feedback are made to improve its effectiveness in capturing the intended quantitative data. Third, the study seeks to identify particular obstacles to incorporating AI into diagnostic workflows, including infrastructural limitations, regulatory uncertainties, and insufficient training or support for clinicians. Fourth, the study will probably produce data that show correlations between demographic or professional factors (such as years of experience, specialty, or institutional setting) and attitudes toward AI adoption. Ultimately, the study aims to provide practical recommendations for the responsible use of AI in medical diagnostics, based on an analysis of these findings. The goal is to promote a balanced approach that takes

advantage of technological innovation while protecting patient trust, clinical judgment, and ethical standards.

### Gantt chart:

| Task / Month                                            | Month<br>1 | Month<br>2 | Month<br>3 | Month<br>4 |
|---------------------------------------------------------|------------|------------|------------|------------|
| 1. Title Selection and Research Proposal                | ✓          |            |            |            |
| 2. Literature Review (AI in diagnosis, trust, ethics)   | ✓          |            |            |            |
| 3. Defining Research Problem, Objectives, and Questions | ✓          |            |            |            |
| 4. Designing Research Methodology                       | ✓          | ✓          |            |            |
| 5. Tool Design (e.g., questionnaire or checklist)       |            | ✓          |            |            |
| 6. Data Collection (interviews, surveys, documents)     |            | ✓          |            |            |
| 7. Data Analysis and Interpretation                     |            | ✓          | ✓          |            |
| 8. Writing Draft Chapters (Findings & Discussion)       |            |            | ✓          | ✓          |
| 9. Final Editing, Proofreading, and Formatting          |            |            |            | ✓          |
| 10. Submission and Presentation Preparation             |            |            |            | ✓          |

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