IMPACT OF TECHNOLOGY-BASED CLINICAL DOCUMENTATION IMPROVEMENT PROGRAM - MEDICAL CODER PERSPECTIVE

by

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DISSERTATION

Presented to the Swiss School of Business and Management Geneva

In Partial Fulfillment

Of the Requirements

For the Degree

DOCTOR OF BUSINESS ADMINISTRATION

SWISS SCHOOL OF BUSINESS AND MANAGEMENT GENEVA

FEBUARY, 2026

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Dedication

This thesis is dedicated to the professionals driving digital transformation in U.S. healthcare coding those who navigate complexity, ambiguity, and constant change in pursuit of accuracy, compliance, and better patient outcomes. Challenges are inevitable, but progress is built through reflection, adaptation, and sustained effort.

Acknowledgements

This dissertation represents the culmination of a long academic and professional journey, shaped by the guidance, support, and encouragement of many individuals. While numerous people have crossed my path over the years, a few have remained constant through both challenges and achievements. This work would not have been possible without their belief, support, and influence.

I am deeply grateful to my mentor, Prof. David Annan, whose guidance, insight, and encouragement have been invaluable throughout this journey. I also extend my sincere thanks to my friends, whose consistent support and thoughtful conversations have helped me navigate both professional and academic challenges. My appreciation also goes to my professional role model, Ashish Aggarwal, whose leadership, integrity, and vision have been a constant source of inspiration.

I would like to acknowledge the many coders, coding managers, and healthcare leaders who have worked with me or interacted with me during my career. Their real-world experiences, perspectives, and collaboration have significantly influenced my understanding of U.S. healthcare coding and digital transformation and have shaped the foundation of this research.

My family has been my greatest source of strength. I am profoundly thankful to my wife, Lavanya, for her unwavering patience, understanding, and support throughout this demanding journey. To my son, Jai Pranav Shankar, and my daughter, Jai Kaarthiga, thank you for being my constant motivation and for reminding me of the importance of perseverance, balance, and purpose.

ABSTRACT

IMPACT OF TECHNOLOGY-BASED CLINICAL DOCUMENTATION IMPROVEMENT PROGRAM - MEDICAL CODER PERSPECTIVE

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2024

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The rising use of tech-based clinical documentation improvement programs has changed how healthcare coding works, but not much research has looked at their effects from the point of view of medical coders. This study looks at how technology-enabled CDI platforms affect documentation quality, coding accuracy, workflow efficiency, and adoption behavior in outpatient healthcare settings. Grounded in the Technology Acceptance Model and Diffusion of Innovation theory, the research explores the relationships among perceived usefulness, ease of use, organizational support, and behavioral intention and how these factors contribute to measurable coding and documentation outcomes. A quantitative cross-sectional design was used based on data collected through a structured questionnaire administered to 372 medical coding professionals working in physician practices and outpatient environments. The instrument included validated TAM and DOI constructs adapted to the CDI context. Data was analyzed using descriptive statistics, reliability testing, exploratory factor analysis, correlation, and multiple regression techniques. Reliability and validity assessments confirmed the robustness of the measurement model. Results show strong positive perceptions of technology-based CDI programs across all major constructs. Perceived usefulness was found to be the strongest predictor for documentation quality and coding accuracy while ease of use had a significant influence on workflow efficiency. Organizational support in terms of training and managerial backing plays an important role in sustaining adoption as well as improving performance outcomes. Regression analysis results indicated that CDI technology significantly enhances identification of gaps in documentation and reduces operational inefficiencies. Correlation results further confirmed strong relationships among technology acceptance variables which support the theoretical framework. Most respondents were early-career coders who had limited exposure to CDI technology but reported real improvements in workflow and documentation processes, meaning that well-designed CDI platforms can give quick benefits even during early adoption stages. Diffusion of Innovation attributes overlapped with TAM constructs but were treated as contextual antecedents reinforcing their indirect influence on perceived usefulness and ease of use. The research ends with the idea that CDI programs using technology can improve coding and documentation practices if there are a strong organizational system and user-friendly ways to put them into action. These results offer real proof that CDI technology makes work easier for professionals and helps keep healthcare data correct. Practical results suggest focusing on training, ease of use, and fitting into current work processes to increase acceptance. Future studies should look at long-term effects and use real performance measures to confirm these results more thoroughly.

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CHAPTER I:

INTRODUCTION

1.1 Introduction

Clinical documentation improvement (CDI) denotes an organized program promoting complete, thorough, and precise documentation in the medical record. The main motivations for analytical clinical documentation improvement (CDI) systems are better healthcare quality measures, greater reimbursement, decreased denials, and avoidance of claims retrieval. The systems allow for timely issuance of up-to-date rules but can also generate evidence of noncompliance, save time if the necessary documentation is absent, and automatically decide which data to display. Analysis of trending data enables identification of frequently overlooked queries, specific specialties requiring extra support, and auditors avoiding tedious tasks to increase focus on more strategic analysis.

Hence, clinical documentation is the process of developing patient's medical record by capturing all the necessary medical conditions, clinical assessment that are performed on the patient and treatment option provided to patient during patient's visit to a hospital or a clinic. The purpose of clinical documentation is not only to record patient's care but also to plan, monitor and refer the same in future to ensure better quality of care (Aina et al., 2020). It lowers the chance of mistakes in treatment and makes it more probable that a patient will have a good result even when there is no treating doctor in the future. Multiple studies show that clinical documentation could be improved on average in over half of medical charts (Myrick, 2019).

This is an issue since complete and accurate documentation can eliminate any doubt regarding diagnoses and treatments; inadequate documentation may result in several readmissions, increased use of services, affect after-care follow-up increased costs as well as medication errors. In turn affects the quality of care and claims reimbursement and may also lead to compliance issues and regulatory audits. The medical record is the single source of truth for clinical coding which is used for claims reimbursement in the USA and also for statistical research and analysis of diseases and treatment options. So accurate, clinical documentation aid patients, healthcare workers and healthcare facilities. To ensure the quality of clinical documentation it is important to implement an effective clinical documentation improvement program (CDIP) (Arrowood et al., 2016).

In conventional approach an effective clinical documentation improvement program involves review of multiples clinical chart or records, manually, to identify the areas for improvement, then provide education to the providers (physicians, nurses, therapist etc.,) who are involved. Followed by continuous monitoring and performing random checks on clinical charts at regular intervals, manually, to ensure the effectiveness of the documentation improvement program.

This paper aims to identify the effectiveness of technology-based clinical documentation improvement program that involves the same steps as of conventional approach but with proper workflow management system and process driven sampling along with intuitive dashboards and data insights. With technological support we can improve the effectiveness by identifying the pattern of documentation mistakes, trending documentation mistakes by physicians, by practice and provide appropriate provider outreach which will be again through a defined workflow and examine the accuracy and effectiveness in upcoming documents.

1.2 Research Problem

The topic of clinical documentation improvement (CDI) has become widely discussed in health care and among professional organizations due to the ongoing transition to ICD-10 for coding diagnoses and procedures. This change creates a need for greater specificity in documentation. Consequently, in some institutions, the job responsibility for medical coders has expanded to include documentation auditing for completeness and to provide formal education for improvements (DeAlmeida, 2012).

Various technologies are being introduced in several hospitals to assist both the CDI process and the coding process (Ozurigbo, 2018). Computer-assisted coding programs extract textual information from health records and suggest codes for further review by medical record coding personnel. Computer-assisted documentation programs recommend additions to the initial clinical documentation to capture the medical record accurately. In hospitals that have implemented a technology-based CDI program, coders comment that the quality of clinical documentation has declined.

Clinical documentation is at the center of every patient visit, whether that visit takes place in a hospital or outside of one. Since their creation, clinical documentation improvement programs have concentrated on hospital visits and stays. Even though there are basic differences between inpatient and outpatient CDI because of briefer meetings, patient groups, and ways to get paid, the same rules for good writing hold true. Physician practices can benefit from CDI programs. It has been largely up to coding specialists or office managers to improve documentation in physician practices in the past. They usually work directly with providers on a case-by-case basis by asking for more detail in clinical documentation that will support accurate CPT codes. With quality programs and reimbursement methods now emerging that focus on ICD-10-CM diagnoses to show risk, there is much more incentive for practices to get started with outpatient CDI programs using a formal query process (Lunt 2018).

Providers should adopt CDI for the right reasons. The American Health Information Management Association has developed guidance by defining purposes, goals and roles as well as policies and procedures that further describe the benefits of thorough documentation. Though this content is provided in the form of guidelines more as professional opinion, the point is clear: Most CDI programs are primarily concerned with enhancing clinical documentation quality without regard to its effect on revenue. This can be seen as one of the most important functions of a CDI program—an accurate reflection of healthcare service provision through complete and correct reporting of diagnoses and procedures... The improvement in accuracy of clinical documentation would reduce compliance risks, lessen vulnerability during external audits for a healthcare facility, and shed light on legal quality of care issues (Optum White Paper, 2016).

It is therefore of importance to help ensuring a high success rate of any CDI program. To do this, there requires to be information around what specifically helps them succeed. While numerous studies have been performed on importance of effectiveness of CDI program, there is not enough research available specifically about how technology impacts the CDI program.

1.3 Purpose of Research

Hiring a medical coder for assistance with records review and assignment of coding required implementation of a dual documentation strategy: (1) detailed notes within the

EHR supportive of coding that remained attached to the record visible only to coders and auditors and (2) a shorter version for clinicians. Coder suggestions across specialties remained consistent; while restrictions were expected, full satisfaction and interest remained high. No sudden jump in requirements or breakdown of information exchange occurred.

The purpose of this research is to gather and collate existing knowledge from the life experiences of key stakeholders from US health care industry to evaluate how technological interventions enhance the quality, efficiency, and accuracy of clinical documentation. Here are specific aims such research might pursue:

Assess technology's role in enhancing documentation quality: Explore how tools like Electronic Health Records (EHRs) and Natural Language Processing (NLP) can improve the completeness, clarity, and structure of clinical documentation (Ebbers et. al., 2022)

Evaluate impact on physician efficiency: Study how automation and computer-assisted documentation reduce the administrative burden on healthcare providers, allowing them to focus more on patient care (Koh, 2021).

Measure compliance healthcare regulations: Investigate whether technology facilitates better compliance with healthcare coding standards (e.g., ICD-10, CMS guidelines), improving both clinical and financial outcomes (Carr 2021, ACDIS white paper)

Assess how improvements in documentation lead to fewer denied claims, better reimbursement rates, and a positive return on investment (ROI) for healthcare institutions (Cullen 2022).

By improving the accuracy of documentation, healthcare providers can create more precise and personalized treatment plans. This leads to quicker detection of medical issues and faster interventions, significantly enhancing the overall quality of care. For example, CDI programs have shown to improve coding accuracy, which directly impacts patient care quality by ensuring correct documentation of conditions like sepsis or heart failure (Myrick 2019).

The overall goal would be to quantify the benefits of technological integration in CDI programs while identifying any challenges or limitations, ultimately offering recommendations for optimized clinical workflows and documentation processes

1.4 Significance of the Study

Accurate clinical documentation that reflects the reality of patient care is crucial for multiple reasons, such as payment of claims, proper care for patients, quality reporting, and safety analyses. A clinical documentation improvement (CDI) initiative aims to increase documentation quality by correcting gaps, errors, or weaknesses in clinical documentation or records.

The quantity and quality of documentation, however, are under the control of drafters, such as clinicians, rather than the organization operating the CDI program. Clinicians support organizations when checking undisclosed conditions or diagnosis through clinical consultation but can also resent the process. A Medical Coding professional must make the best out of the documentation he/she is presented with, using what is there, while caring for a potential audit in case the documentation is questionable or incorrect

Technology-based CDI programs focus on the improvement of documentation quality by providing education and feedback to draft of documents, such as clinicians. The leading cause for a non-optimized use of these programs is user adoption and support for process changes, although several change management and governance structures can address that concern. Adoption of technology-based CDI programs can support and optimize medical coder activities by increasing the quality of documentation, ensuring compliance with medical coding regulations, supporting financial and operational performance, and improving clinical outcomes ensuring that CDI approaches deliver benefits for all stakeholders starting from the draft of clinical documents.

The significance of research on how technology improves clinical documentation and patient care quality is multi-faceted, encompassing critical improvements in healthcare outcomes, financial efficiency, and compliance with medical standards.

Enhancing Patient Safety and Reducing Errors: Accurate documentation ensures that all clinical information is correctly recorded, reducing the likelihood of medical errors like misdiagnosis or incorrect treatment plans. Technologies such as EHRs and CDI programs help streamline the capture of crucial patient data, which is essential for making accurate diagnoses and decisions about treatments. Studies have shown that accurate documentation directly reduces adverse medical events, thereby enhancing patient safety (Myrick 2019).

Improving Communication Among Healthcare Providers: Clear and complete documentation facilitates better communication among multidisciplinary healthcare teams. EHRs and CDI programs ensure that all members of a patient's care team are working with the same accurate and up-to-date information, which improves care coordination, especially in complex cases that involve multiple specialists Research on improving communication among healthcare providers through Electronic Health Records (EHRs) and Clinical Documentation Improvement (CDI) programs shows that these technologies play a critical role in enhancing interdisciplinary collaboration.

EHRs centralize patient information, allowing all members of a healthcare team to access and update real-time data, improving coordination and reducing miscommunications. This is particularly important for complex cases involving multiple specialists, as it ensures that every provider has access to consistent, up-to-date information, leading to more accurate diagnoses and treatments. For example, studies have demonstrated that EHRs enable seamless communication among doctors, nurses, and allied healthcare providers by facilitating access to shared medical records, which enhances decision-making and care coordination.

The immediate availability of data, such as lab results or medication histories, improves efficiency and reduces delays in treatment (Vos et al., 2020). These improvements in communication directly contribute to better patient outcomes by ensuring that care is cohesive and well-coordinated across the healthcare continuum. This collaborative approach also helps minimize fragmented care, leading to a more holistic treatment process for patients (Kadaei, 2024).

Saves time for the healthcare providers: Healthcare providers are under increasing pressure to document clinical encounters in electronic health records (EHRs). A 2020 study in the Annals of Internal Medicine (Overhage, 2020) found that physicians take an average of 16 minutes and 14 seconds per patient encounter using EHR, with administrative tasks such as chart review (33%), documentation (24%), and ordering (17%) taking most of that time—leaving less than 5 minutes for direct interaction with the patient. Providers need better solutions to help them with encounter documentation so they can accurately capture clinical care, stay compliant with coding requirements, and support the financial goals of their organizations without compromising meaningful interactions with patients.

Ensuring Compliance with Standards: With healthcare regulations (e.g., ICD-10 coding and CMS guidelines) becoming increasingly stringent, technologies that enhance documentation accuracy ensure compliance with these standards. Accurate documentation prevents errors in coding, reduces claim denials, and ensures that healthcare providers meet regulatory and billing requirements. Technologies like EHRs and Clinical Documentation Improvement (CDI) programs significantly enhance compliance with healthcare regulations, such as ICD-10 coding and CMS guidelines.

Accurate documentation through these systems ensures that healthcare providers meet stringent regulatory standards, reducing the risk of errors that can lead to claim denials. This is critical for compliance and also aids in avoiding penalties and securing appropriate reimbursements from payers. Regular auditing of clinical documentation, as part of a compliance strategy, helps in identifying gaps and ensuring that codes are appropriately applied, further reducing discrepancies and errors that might arise during external audits (Bryant, 2020).

Improving Financial Outcomes: By improving documentation accuracy, healthcare organizations experience fewer denied claims and better reimbursement rates. This has a significant financial impact, as proper documentation ensures that all services are billed correctly and promptly, leading to improved cash flow and a reduction in revenue loss due to denied claims (Overhage, 2020).

Supporting Quality of Care and Decision-Making: Accurate documentation helps healthcare providers make better-informed decisions, leading to more effective treatment plans. This proactive approach leads to improved patient outcomes by allowing clinicians to tailor treatments to individual patients' needs more accurately, improving recovery times and reducing the risk of complications (Myrick 2019)

The research on the impact of technology on clinical documentation improvement is significant for its potential to transform healthcare by increasing accuracy, improving compliance, reducing costs, and enhancing the quality of patient care. By adopting technology in clinical documentation, healthcare organizations can not only meet regulatory demands but also improve clinical and financial outcomes.

1.5 Research Purpose and Hypothesis

Technology-based Clinical Documentation Improvement (CDI) Programs have emerged to address the inadequacies and clinical ambiguities related to documentation required for coding. Current research does not sufficiently examine specific technologies adopted within these programs and their associated implementation, workflow, and productivity effects. Medical coders bridge care delivery and payment, validating clinical documentation compliance with coding conventions and reimbursement policies. Their role is impacted by the adoption of coding and documentation technologies. Four objectives guide this examination of technology-based CDI programs, contributing to practice and theory:

i. Investigate the extent to which these programs alter documentation processes, coder workflows, and overall productivity across various healthcare settings, including acute, post-acute, and outpatient.

ii. Evaluate their effects on documentation quality, coding accuracy, and revenue.

iii. Identify the challenges and facilitators influencing the adoption and sustainability of these programs from a coding perspective.

iv. How does the implementation of technology-based CDI platforms affect query turnaround time, rework rates, and documentation clarification cycles for medical coders?

Research Hypothesis

Hypothesis 1: The implementation of technology-based CDI programs significantly alters documentation processes and coder workflows and leads to measurable improvements in overall productivity across acute, post-acute, and outpatient healthcare settings.

Hypothesis 2: Technology-enabled CDI programs improve documentation quality and coding accuracy and contribute to increased revenue performance in healthcare organizations.

Hypothesis 3: The adoption and long-term sustainability of CDI programs are positively influenced by organizational support, coder training, and system usability, while resistance to change, workflow disruption, and technical limitations act as significant barriers.

Hypothesis 4: The implementation of technology-based CDI platforms reduces query turnaround time, lowers rework rates, and shortens documentation clarification cycles for medical coders.

CHAPTER II:
REVIEW OF LITERATURE

2.1 Introduction

Clinical documentation improvement (CDI) has undergone an evolution shaped by health information technology, the emergence of electronic health records (EHRs), and the increasing adoption of natural language processing (NLP). Technology-based CDI programs automate documentation workflows and use NLP to validate findings, integrating concurrent coding validation and quality auditing. Medical coders remain essential for high-quality documentation, and the deployment of AI-assisted coding tools enhances coder productivity. A conceptual framework outlines how technology-based CDI programs influence coding accuracy and revenue. Evidence from two hospital systems indicates that technology-based CDI programs improve coder performance, support ROI-based business cases, and lessen the burden on coding and CDI teams.

Technology has enabled the automation of clinical documentation workflows and the use of NLP to validate clinical findings, resulting in programs that integrate these functions with concurrent coding validation and quality auditing. AI-assisted coding technology and tools support medical coders by increasing productivity and providing additional decision-making support. Nevertheless, these tools do not replace the need for skilled medical coding professionals. Guidance from associations such as the American Academy of Professional Coders stresses the need to maintain the human touch in coding despite increased reliance on technology to support coders in interpreting descriptions and identifying billing requirements.

A clinical documentation program will address the quality of patient's care, quality and outcome metrics, statistics, and research. Understanding the deficiencies in documentation and/or coding within a healthcare organization is the first step in identifying the need and requirements for clinical documentation improvement.

All health care organizations aim for complete and accurate documentation; however, research suggests that this is difficult to achieve and that facilities often struggle to maintain a consistent level of high-quality documentation (Arrowood et al., 2016). Building on the dimensions identified above, this study moves beyond merely listing the potential benefits of clinical documentation improvement programs and empirically examines how a technology-based CDIP influences these areas in physician practices. Specifically, the research evaluates the extent to which technology-enabled CDI workflows support medical coders in improving documentation completeness, enhancing coding accuracy, strengthening compliance with regulatory requirements, and optimizing workflow efficiency.

By examining these outcomes through the medical coder perspective, the study seeks to assess not only whether improvements occur, but also how technology facilitates sustainable documentation quality, effective query management, and measurable operational and financial impact. This approach allows for a structured evaluation of technology-based CDIP effectiveness across clinical, compliance, and revenue-related domains.

The main message to physicians should be that CDI is a quality initiative. Physicians understand the need to make documentation legible, timely, complete, precise, and clear. They understand that the documentation is the legal health record. They understand the common phrase "If you didn't write it, it did not happen" (Adele 2013).

A computerized system for care planning and documentation of patient care was initiated at a western teaching hospital, using the framework of Nursing Interventions Classification and Nursing Outcomes Classification standardized languages (Kathy et al., 2005). The software integrates care planning and documentation and includes both order entry as well as a charting application. Prior to initiating the project, a study was conducted by (Kathy et al., 2005), to evaluate staff attitude toward computerization, time needed for documentation, and comprehensiveness of charting entries. Data from staff surveys, observations, and chart audits conducted pre- and post–computer project implementation demonstrated that the staff attitudes toward computers were less positive, the time required for charting was unchanged, and there were improvements in how completely the nurses documented charting elements (Kathy et al., 2005).

The implementation of a Clinical Documentation Improvement Program (CDIP) is a decision that should not be made hastily. There are various types of programs that can be chosen. Each one of them has the potential to become a success. The facility that was utilized for this study chose a physician led program. The facility felt that it was important for their physicians to hear the message from a physician and that they would be well received with this approach (Wilson, 2009). Surgery department delinquent documentation decreased by 85% after CDI implementation. Compliance with SCIP measures improved from 85% to 97%. Significant increases in surgical SOI, ROM, CMI, and APR-DRG (all $p < 0.01$) were found after CDI/ICD-10 training implementation. Provider responses to CDI queries resulted in an estimated $4,672,786 increase in charges (Reyes et al., 2017)

2.2. Evolution of Clinical Documentation

The concept of clinical documentation improvement (CDI) has transitioned from an arduous undertaking focused predominantly on accuracy and completeness to an increasingly more automated process that extends beyond a single health record to a broader enterprise-wide focus. Over time, the implementation of electronic health records (EHRs) and the proliferation of technology-assisted coding tools—in particular the deployment of natural language processing (NLP) tools has led to an evolution within the field. Beyond the traditional focus on documentation accuracy, quality measures reflecting documentation clarity, consistency, and completeness have gained prominence. At the same time, technology-assisted coding tools have substantially reduced the time and skill level required to complete the coding process.

Recently, however, the benefits of implementing CDI technology systems on an enterprise level are coming into focus. Rather than only looking at individual patient coders' decisions, systems are being integrated in ways that introduce feedback loops for both the clinical and coding populations. These feedback loops usually start with a dual-encoder process, in which two coders work together to generate a single report for a physician to sign off. Discrepancies and suggestions made between the two coders then create a learning opportunity for both members of the process. Additionally, identified documentation improvements created during this process are being communicated back to the clinicians, with the aim of educating them to close these gaps for future encounters.

2.3 Technology in Documentation: EHRs, NLP, and Coding Tools

Electronic health record (EHR) systems are ubiquitous in modern healthcare and represent an important precursor to advanced documentation technologies. EHRs allow for the acquisition, storage, and sharing of clinical information across distributed settings and timeframes (Dong et al., 2022). They can serve multiple functions through embedded software modules, and integrate various health-record formats, including text documents and numerical data. Initial character-based encoder-decoder models developed for EHR text were unfamiliar with clinical concepts, and subsequent models specialized in concept extraction within clinical contexts have been adopted (Avendano et al., 2022).

Natural language processing (NLP) technologies automate and semiautomated certain data entry tasks within EHRs, easing the cognitive burden of clinicians and making documentation less time-consuming. NLP can also analyze large amounts of unstructured data and generate useful summary statistics, while machine learning offers the potential for accurate unmet clinical need detection. Automated translation from a clinician's spoken or typed words to an EHR text format constitutes the first NLP-related technological development to gain widespread adoption in healthcare. AI-based virtual scribes transcribe discussions between clinicians and patients and post-edit the resulting text, automatically generating completed documentation. As per the above literature, clinical documentation improvement (CDI) is an essential aspect of healthcare, as it ensures that patient care is accurately and comprehensively documented. Technological advancements have made it possible to improve CDI by automating certain aspects of the process, such as coding and documentation review.

The Role of technology in clinical documentation improvement is vast and diversified. Technology has the potential to improve the accuracy and completeness of clinical documentation. The areas where technology could enhance CDI, are as natural language processing (NLP) and machine learning, generative Ai, speech recognition etc.,

The study tracks the amount of time spent creating and reviewing documentation to examine usage patterns in healthcare settings. Rates were determined using an electronic health record's audit record, and usage patterns were discovered using social network analysis. All healthcare professionals who created or read electronic documentation at an urban academic medical facility were included as subjects. Care providers devote a lot of time to reading and writing notes. The rates of utilization vary greatly by author and viewer, and many notes are never read. Even after two years, inpatient notes are still examined, even though the rate of viewing declines rapidly with age. Documentation workload, team structure, and degrees of communication among team members were all disclosed by a thorough log of authors and viewers of clinical notes in an electronic health record. (Hripcsak, et al., 2011).

Interactions between humans and computer programs that allow structured entry of healthcare data are supported by clinically oriented interface terminology. This article details efforts made over the past ten years at the Vanderbilt University Medical Center to integrate the CHISL (Categorical Health Information Structured Lexicon) interface terminology into clinical practice. Vanderbilt offers a variety of electronic documentation methods, from strictly structured data capture to partially templated free-form notes and transcription of spoken words. Vanderbilt University encourages doctors to enter clinical notes in whichever way they feel is best for the particular clinical circumstance at hand. In this context, CHISL fills a significant void in clinical documentation (Rosenbloom et al., 2013).

To evaluate the effects of speech recognition (SR) technology on document correctness, provider efficiency, institutional cost, and other factors, the study set out to review recent literature on the topic. Despite the extensive use of SR for clinical recording, research on the subject is still very diverse, frequently utilizing several evaluation metrics and yielding contradictory results. Further research into the use and efficacy of SR-assisted documentation in clinical settings outside of radiology is warranted given that these settings are becoming more prevalent (Blackley et al., 2019).

Processing notes for research can be done using natural language processing (NLP) tools like the clinical Text Analysis and Knowledge Extraction System but maximizing their efficiency for a clinical data warehouse is still difficult. The objective is to provide a use case for a predictive model while developing a high throughput NLP architecture utilizing the clinical Text Analysis and Knowledge Extraction System. Unified Medical Language System concept unique identifier (CUI)-based approaches for large-scale clinical research may use the high throughput NLP architecture of health systems as a standard. This helps create a warehouse for clinical documentation (Afshar, 2019).

The methods the authors built to automatically extract medical ideas, annotate assertions on concepts, and relate concepts to one another are described in this work to improve information access in clinical documentation. Both rule-based and machine learning techniques are used in the author's approaches. The authors' machine-learning algorithms leverage the features they extract from the input texts through natural language processing. For idea extraction, the authors used Conditional Random Fields, and for assertion and relation annotation, they used Support Vector Machines. The authors experimented with various combinations of rule-based and machine-learning techniques depending on the assignment. The authors affirm that the employment of just machine-learning techniques is heavily reliant on the annotated training data, and as a result, superior results were obtained for classes that were well-represented. Good results were obtained when hybrid approaches integrating machine learning and rule-based approaches were used, that helps in improving information access in clinical documentation (Minard, 2011).

Design, develop, and evaluate a scalable clinical data normalization pipeline using the HL7 Fast Healthcare Interoperability Resources (FHIR) specification to standardize unstructured electronic health record (EHR) data. It is possible to model unstructured EHR data and incorporate structured components into the model using the NLP2FHIR pipeline. The results of this work offer standards-based clinical data normalization tools that are essential for enabling portable EHR-driven phenotyping and large-scale data analytics, as well as insightful information for future FHIR specifications developments with regard to handling unstructured clinical data to enhance clinical improvement program (Hong et al., 2019).

The development and validate a standards-based phenotyping tool to author electronic health record (EHR)-based phenotype definitions and demonstrate execution of the definitions against heterogeneous clinical documentation data platforms. The author developed an open-source, standards-compliant phenotyping tool known as the PhEMA Workbench that enables a phenotype representation using the Fast Healthcare Interoperability Resources (FHIR) and Clinical Quality Language (CQL) standards. Then demonstrated how this tool can be used to conduct EHR-based phenotyping, including phenotype authoring, execution, and validation. A phenotype definition that integrates with existing standards-compliant systems, and the use of a formal representation facilitates automation and can decrease potential for human error in clinical documentation (Brandt et al., 2022).

Coders are central actors in CDI programs. They not only assign accurate codes but also detect omissions and ambiguities in documentation. Watzlaf and Sheridan (2012) emphasize that coders must possess both technical knowledge and communication skills to deliver effective feedback. However, multiple studies (Eberhardt, 2019) note that coders often face barriers, including lack of physician responsiveness, insufficient training in query development, and workflow complexity.

The integration of electronic query systems, automated alerts, and dashboards has been shown to improve query response rates and reduce turnaround times (AHIMA, 2017). Nevertheless, research indicates that coder satisfaction with these tools depends heavily on usability and perceived effectiveness. Fenton et al., (2018) found that coders prefer workflows that are intuitive, integrated into their daily routines, and supported by clear policies and training.

2.4: Medical Coder Roles and Professional Standards

With the widespread adoption of electronic health records (EHRs), numerous digital tools supported by natural language processing (NLP), artificial intelligence (AI), and machine learning have emerged to enhance the creation and quality of clinical documentation. At the same time, a new generation of technology-based clinical documentation improvement (CDI) programs is being deployed to address deficiencies in the clinical documentation, coding, and billing processes that directly affect the quality of care in hospitals and health systems. This suite of documentation, coding, and analytics tools is intended to automate, streamline, and optimize clinical documentation processes to boost coder and clinician productivity, reduce fraud and abuse risk, improve reimbursement, and optimize regulatory compliance.

A medical coder is primarily responsible for categorizing health records into numerical and alphanumeric codes based on regulations and recognized coding classification standards. Coding completion is often time constrained, with facilities recommending 24 to 48 hours to complete the coding of a discharge record. In a CDI program within a health information management department, a coder who identifies an uncompensated diagnosis at the time of coding insertion may provide feedback directly to clinicians, a process sometimes called reverse CDI. Some organizations allow coders to serve in documentation workflow oversight roles and utilize predictive analytics to establish feedback loops that signal to clinical staff which types of documentation are likely to be requested by the coding team (Lucyk et al., 2017; Richardson et al., 2024).

2.4.1. Importance of Clinical Documentation

An effective clinical documentation program plays a vital role in the quality of patient's care, utilization management and accurate reimbursement. Physician practices are not afforded to wait for an OIG or CMS audit to identify noncompliance, which could put a practice at risk and may be out of business. Collaboration among key staff members in the provider practice will help providers document better and more efficiently.

Documentation quality begins in the outpatient setting. Physicians who document well in their practices help establish a baseline for patient severity and justify medical necessity for inpatient services. Quality documentation enhances outcomes and ensures accurate revenue. Quality CDI programs can help practice streamline processes and procedures that currently create extra work for office staff and providers (Bonner 2016).

Healthcare reform, electronic health records (EHRs), pay for performance, and ICD-10-CM/PCS are just some of the influences changing the landscape of health information management (HIM) quality and finance. Administrative data is used to measure patient care and clinical performance for hospitals and providers. In order for the administrative and coded data to be valid, the care provided to the patient needs to be documented with accuracy and completeness which can be achieved by clinical documentation program (Kathy et al., 2012)

In the current era of healthcare transformation, the continuing importance of documentation and coding cannot be overstated. With the multitude of acronyms being added to the healthcare vocabulary, one may wonder where documentation and coding fits in. It is important to remember that accurate documentation and complete and compliant coding impacts almost all areas of quality reporting and, ultimately, provider reimbursement (DeVault et al., 2017).

Clinical documentation improvement (CDI) is an increasing part of health system quality and patient care with clinical documentation integrity specialists (CDIS) expanding into daily physician workflow. CDIS–physician integration into resident teams can occur through a collaborative focus on specific aspects of physician workflow and improving understanding of the impact of CDI on patient safety and quality of care. (Rouse et al., 2022).

There is increasing emphasis on multidimensional risk assessments during hospital admission. However, little is known about how nurses use multidimensional assessment documentation in clinical practice to address preventable harms and optimize person-centered care. Efficient and streamlined documentation systems should herald feedback from nurses to address their clinical workflow needs and can support, and capture, their decision-making that enables partnership with patients to improve the individualization of care provision (Paterson et al., 2023).

Accurate clinical documentation (CD) is necessary for many aspects of modern health care, including excellent communication, quality metrics reporting, and legal documentation. The hospital identified CD deficiencies that could have resulted in a profound reduction in revenues with the national implementation of ICD-10. An intra-professional team was established to create a multi-media CDIP training curriculum for our academic surgery department that resulted in more accurate CD, improved quality assessment, and higher surgery hospital charges. Clinical documentation improvement program training in an academic surgery department is an effective method to improve documentation rates, increase the hospital estimated reimbursement based on more accurate CD, and provide better compliance with surgical quality measures (Reyes et al., 2017).

Clinical documentation could play a major role in raising a hospitalist's value. In the authors' experience, the average hospitalist with a typical patient volume and acuity represents $150,000 to $250,000 per year in losses to the hospital because of inadequate documentation. In comparison with more commonly recognized value drivers, fifty-one improving documentations could offer a far greater rate of return. The value of hospitalists could be even larger in the future as hospitalists take on bigger roles in co-management, so it's important to have a CDI program in place to manage it (Asakura et al., 2014).

Electronic health records (EHRs) are important tools for the proper documentation and administration of clinical care. When combined with quality improvement capabilities such as clinical decision support, population health management analytics, and quality measurement, EHRs can enhance the quality of care delivered. As with any tool, EHRs can be used to improve the efficiency and completeness of documentation in support of good care and good billing practices or for less laudable aims (Daniel et al., 2013)

Clinical documentation improvement (CDI). Each word carries its own meaning for health care providers. Together, they mean improved quality of patient care and more accurate reimbursements. Complete and accurate documentation in the medical record has a direct impact on the assignment of codes and ultimately leads to higher, more accurate levels of reimbursement (Courtright et al., 2004).

2.5 Theoretical Framework

Technology Acceptance Model (TAM) and Diffusion of Innovations (DOI) theory are applied to understand the acceptance, diffusion, and implementation of technology in Clinical Documentation Improvement (CDI). TAM identifies perceived usefulness and ease of use as the primary factors determining user acceptance and intention to use technologies. Perceived usefulness is defined as the degree to which the user thinks that using a particular system would enhance job performance. Perceived ease of use is defined as the degree to which the user believes that using a system is free of effort. The intention to use predicts actual use, which determines system usage. Systems used frequently can be expected to affect the user's work and performance.

DOI theory examines how, why, and at what rate new ideas and technology spread among the community. It offers a framework for understanding the adoption and diffusion of technological innovations, including technology-enabled innovations that leverage technology extensively for clinical documentation or Clinical Documentation Improvement by automating tedious and repetitive tasks within an integrated workflow.

The DOI framework focuses on understanding the attributes of a technology-enabled clinical documentation innovation and how these attributes impact processes and ultimately, the outcomes achieved in different settings and clinical specialties. It examines the stage at which medical coders, Clinical Documentation Improvement specialists and health system leadership become participants in the process. Research also explores how factors in the internal and external environment of the adopter facilitate or impede adoption. It is concerned with adoption within an organization, with reference to the use of technology for conducting clinical audits and providing feedback to clinical teams.

2.5.1 Technology Acceptance Model (TAM)

TAM provides a useful perspective on the acceptance of technology-based CDI programs from a coder viewpoint. Originally developed by Davis, TAM explains user behavior and perceived performance of information-and-communication technologies based on the Theory of Reasoned Action and the Theory of Expectations. The model posits that perceived usefulness and perceived ease of use determine technology usage, while external variables such as experience, motivation, and subjective norms influence the two main factors (Moukoumbi Lipenguet et al., 2022).

In the healthcare domain, TAM has been applied widely to assess acceptance of electronic medical records. The model predicts the intention to adopt such systems according to (1) perceived usefulness, the extent to which users believe the system improves their performance and (2) perceived ease of use to which they consider using the system effortless. Subjective norms, including the influence of colleagues, and perceptions concerning image, ethics, experience, and motivation also affect acceptance (van der Ham et al., 2020).

Within the healthcare sector, the diffusion of new technologies hinges on user acceptance of and initial engagement with the tools. The perceived usefulness and perceived ease of use of CI technology, accordingly, shape not only acceptance of the technology itself but also the subsequent deployment of documentation, auditing, and feedback processes that constitute technology-enabled CDI. Therefore, retrospective analyses of previously deployed CDI technologies featuring a strong emphasis on human-computer interaction and user-centered design principles and analyses documenting subsequent changes in the underlying technology that triggered re-engagement with the equipment or software are particularly Connected to understanding medical coder interactions with technology-enabled CDI.

In the context of this research:

Perceived Usefulness (PU): The degree to which physicians believe coder-initiated documentation improvement notifications and recommendations enhance their work (e.g., improving clinical accuracy, reducing claims denials, supporting compliance). Physicians are more likely to engage when they see that addressing deficiencies results in measurable benefits (e.g., reduced queries, improved coding accuracy, higher reimbursement).

Perceived Ease of Use (PEOU): The degree to which physicians perceive the feedback workflow (e.g., electronic notifications, dashboards, query templates) as simple, accessible, and minimally disruptive. If feedback processes are complicated or time-consuming, physicians may resist participation.

In this study, coders' ability to present clear, actionable, and concise recommendations through an intuitive workflow is critical to shaping positive perceptions. The Technology Acceptance Model further posits that external variables play a critical indirect role in shaping users' perceptions of both usefulness and ease of use. In the context of technology-enabled clinical documentation improvement workflows, factors such as structured training, organizational support, and leadership endorsement influence how medical coders perceive and engage with CDI technology. Adequate training enhances coders’ confidence and competence in using CDI tools, thereby strengthening perceived ease of use. Organizational support and visible leadership commitment reinforce the perceived value of documentation quality initiatives, positively influencing perceived usefulness. Collectively, these external variables create an enabling environment that facilitates technology acceptance, sustained engagement, and effective utilization of CDI workflows.

In alignment with the Technology Acceptance Model, positive attitudes toward technology-enabled CDI workflows shape medical coders’ behavioral intentions to engage with documentation improvement recommendations. These intentions, in turn, translate into actual behavioral outcomes, such as timely query initiation, effective communication with providers, and consistent application of documentation improvement practices. As engagement becomes sustained, these behaviors contribute to measurable improvements in documentation quality, coding accuracy, and compliance outcomes.

2.5.2 Diffusion of Innovation Theory (DOI)

Diffusion of Innovation Theory (DOI), formulated by Rogers (2003), provides an additional perspective on how the workflow process itself viewed as an innovation spreads and gains acceptance among physicians. Health care organizations are under increasing pressure to improve the quality of the documentation that supports their clinical services. Clinical Documentation Improvement (CDI) programs are one of the strategies that organizations have put in place to accomplish this objective. A growing number of health care organizations are implementing technology-based programs. While the key elements in technology-based technology CDI programs are being studied, the factors affecting the acceptance and diffusion of technology-based CDI programs remain underexplored. This study examines these factors through the lens of theory acceptance model (TAM) and diffusion of innovation (DOI), two technology-related theories.

Diffusion of innovation theory explains how new ideas, processes, or technologies spread within and among organizations. This process can be divided into four stages of knowledge, persuasion, decision, and confirmation. Organizations tend to follow a stage-by-stage pathway that involves different groups of individuals clustered in five adopter categories: innovators, early adopters, early majority, late majority, and laggards.

Innovators possess the technical expertise to evaluate and implement innovations; thus, they may adopt early, even without considering the consequences. Early adopters are opinion leaders who are selectively exposed to information about new ideas and enjoy higher social status. Early majority individuals prefer to deliberate with peers before adopting; late majority individuals adopt only after most of their colleagues do. Laggards are the last to adopt; they are typically older members who are greatly influenced by peers. The prior decision to adopt may create a favorable or unfavorable environment for further exploration. Communication through various channels enhances the diffusion process, enabling messages to reach broader audiences (Weagraff, 2016; Hudson, 2011).

Hnece, innovation attributes applied to this study:

Relative Advantage: Physicians' perception that engaging with coder-driven feedback provides clear improvements over the prior status quo (e.g., fewer denials, faster charge capture).

Compatibility: Alignment of the workflow with physicians' routines and professional expectations. For example, workflows that integrate into the Electronic Health Record (EHR) and do not require multiple logins are more compatible.

Complexity: If feedback tools are perceived as cumbersome or require extensive training, adoption is hindered.

Trialability: Opportunities to pilot the workflow on a small scale or with select departments build confidence before broader rollout.

Observability: Physicians see tangible results (e.g., improvements in audit scores, revenue uplift), reinforcing continued participation.

Adopter Categories: Some physicians (Innovators/Early Adopters) are receptive to engaging with coder recommendations. Others (Late Majority/Laggards) may be sceptical or resistant, requiring targeted strategies to encourage buy-in.

Communication Channels: The way coders communicate professional tone, clarity, supportive language also affects acceptance.

Communication channels play a critical role in shaping acceptance and engagement with technology-enabled CDI workflows. The manner in which medical coders communicate documentation improvement feedback—through professional tone, clarity of messaging, and supportive language significantly influences how such feedback is received by physicians. Clear articulation of documentation deficiencies helps reduce ambiguity and misinterpretation, while evidence-based rationale reinforces the clinical and regulatory importance of the requested clarification. Additionally, providing concise and actionable steps to resolve documentation issues minimizes cognitive burden and facilitates timely responses. Collectively, effective communication practices strengthen trust, reduce resistance, and enhance collaboration between coders and providers, thereby supporting greater acceptance and sustained use of CDI workflows.

2.5.3 Gaps in Existing Literature

Existing literature on clinical documentation improvement and health information technology adoption has predominantly focused on physicians and healthcare providers, particularly in relation to electronic health record usability, documentation burden, and clinical workflow efficiency. While these studies provide valuable insights into provider-facing challenges, they offer limited understanding of the experiences and roles of medical coders, who are central to operationalizing documentation improvement initiatives.

Moreover, current research often examines CDI outcomes at an organizational or financial level, with insufficient attention to the micro-level workflows through which documentation improvement is achieved. Specifically, there is a lack of empirical evidence examining how medical coders interact with technology-enabled CDI workflows, how they perceive usability and effectiveness, and how these perceptions influence engagement, query management practices, and documentation quality.

Additionally, although theoretical models such as the Technology Acceptance Model and Diffusion of Innovation Theory have been widely applied to physician adoption of health technologies, their application to medical coders within CDI contexts remains limited. Little is known about how factors such as workflow integration, communication effectiveness, organizational support, and observable outcomes influence coder acceptance and sustained use of CDI technology.

This study addresses these gaps by examining technology-based clinical documentation improvement programs from the medical coder perspective. By integrating established adoption theories with empirical analysis of coder workflows, perceptions, and outcomes, the research contributes a focused and practice-oriented understanding of how technology-enabled CDI initiatives achieve effectiveness, sustainability, and compliance within physician practices.

2.6 Conclusion

This study applies two theoretical frameworks: the Technology Acceptance Model (TAM) and the Diffusion of Innovation Theory (DOI). Diffusion of Innovation Theory (DOI), proposed by Rogers (2003), explains how new ideas, technologies, or workflows are adopted and diffused within organizations over time. The theory posits that adoption is influenced by a set of perceived attributes of the innovation, namely relative advantage, compatibility, complexity, trialability, and observability. Together, these attributes shape users' willingness to adopt and sustain engagement with new processes.

Relative advantage refers to the extent to which an innovation is perceived as superior to existing practices. In the context of technology-enabled CDI workflows, medical coders are more likely to adopt new systems when they demonstrably improve documentation quality, reduce manual effort, shorten query turnaround time, and enhance coding accuracy. Prior studies have shown that coders value innovations that lead to tangible efficiency gains and improved audit outcomes (McGowan, 2014; Fenton et al., 2018).

Compatibility reflects the degree to which an innovation aligns with users' existing workflows, professional norms, and organizational culture. Research indicates that CDI technologies integrated directly into coding platforms or electronic health record systems are more readily accepted by coders, as they minimize workflow disruption and reduce the need for parallel processes (AHIMA, 2017). When CDI tools align with established coding practices and regulatory requirements, adoption is significantly enhanced.

Complexity refers to how difficult an innovation is perceived to be in terms of understanding and use. Highly complex CDI systems that require extensive training or introduce cumbersome steps can impede adoption. Studies have demonstrated that coders are more receptive to CDI workflows that are intuitive, streamlined, and supported by clear guidance and standardized query formats (Eberhardt, 2019). Trialability denotes the extent to which an innovation can be tested on a limited basis before full-scale implementation. Pilot deployments of CDI platforms allow medical coders to experiment with new workflows, build confidence, and provide feedback, thereby reducing resistance and uncertainty. Incremental adoption strategies have been shown to improve acceptance of documentation technologies within health information management teams (McGowan, 2014).

Observability refers to the visibility of results produced by the innovation. When coders can observe measurable improvements—such as reduced query rework, improved documentation completeness, better audit scores, or positive reimbursement outcomes—

the perceived value of the CDI workflow is reinforced. Observable outcomes strengthen sustained engagement and encourage wider adoption across coding teams.

Within this study, Diffusion of Innovation Theory provides a lens to examine how technology-based CDI workflows are adopted by medical coders based on perceived workflow benefits, usability, and observable outcomes. By applying DOI, the research seeks to understand not only whether coders adopt CDI technology, but why adoption occurs and which innovation attributes most strongly influence sustained engagement and documentation improvement. The next chapter discusses the research methodology adopted for this study.

CHAPTER III:

METHODOLOGY

3.1 Overview of the Research Problem

Technology-based clinical documentation improvement (CDI) programs have been widely adopted to enhance the quality and completeness of clinical documentation. An empirical study assessing the impact of such technology-driven CDI programs on coding accuracy and revenue across a diverse array of healthcare delivery systems in the United States was conducted. The analysis focused on two interconnected research questions relevant to medical coders. First, to what extent do these programs improve the quality of clinical documentation with respect to clarity, completeness, and consistency? The second question examined their effect on the size and composition of potential revenue.

Performance metrics collected before and after implementations revealed positive impacts on documentation quality and coding accuracy, as indicated by a reduction in documentation-related queries and error rates as well as a smoother coding process. These findings suggest that the systematic evaluation of technology-based CDI programs can inform organizational decision-making and shape implementation priorities in clinical and coding workflows. Ultimately, emphasis should be placed on technologies that enhance documentation quality and drive changes in organization-specific clinical practices (Ozurigbo, 2018).

Clinical Documentation Improvement (CDI) programs have increasingly incorporated technology-enabled workflows to address challenges related to documentation quality, coding accuracy, compliance, and reimbursement. While prior research has largely focused on physician-facing adoption of health information technologies, limited empirical attention has been given to the medical coder perspective, despite coders playing a central operational role in CDI execution. Medical coders interact directly with documentation, queries, and technology platforms, making their acceptance, engagement, and effectiveness critical to the success of technology-based CDI programs. This research addresses the problem of insufficient understanding of how technology-enabled CDI workflows influence medical coders' perceptions, behaviours, and performance outcomes within physician practices.

3.2 Operationalization of Theoretical Constructs

The conceptual framework illustrates the linkages between technology features, clinical documentation improvement processes, and associated impacts from a medical coder perspective.

Technology-based clinical documentation improvement (CDI) programs are designed to enhance documentation quality by automatically analyzing clinical narratives and generating feedback for improvement. The proposed conceptual framework identifies four interrelated technology features that are anticipated to influence both documentation processes and outcomes: documentation workflow automation, coding validation and auditing support, dual-encoder engagement feedback, and compliance, privacy, security, and regulatory alignment. Documentation quality refers to the extent to which clinical notes are clear, complete, and consistent. Increasing documentation quality is expected to strengthen the foundation for coding accuracy, thus facilitating capture of all potentially reimbursable services and minimizing omission of pertinent information.

Various metrics and methods have been applied to assess these outcomes, yet the majority of studies have focused on general implications for clinicians or surveyed general user acceptance without quantifying specific impacts on documentation quality, coding-related revenue, or coding workflows. A unified approach that captures both specific impacts and broader dimensions of coding remains largely absent from the literature. The objectives now shift to evaluating the impact of technology-based CDI programs on medical coding accuracy, coder-relevant revenue, and coding workflows across multiple hospital systems (Ozurigbo, 2018).

This study operationalizes constructs derived from the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) theory within the context of technology-based CDI workflows. TAM constructs include Perceived Usefulness, Perceived Ease of Use, Attitude Toward Use, Behavioural Intention, and Actual Use, while DOI constructs include Relative Advantage, Compatibility, Complexity, Trialability, and Observability. These constructs are adapted to reflect coder-specific interactions with CDI technology and are measured using multiple survey items on a five-point Likert scale.

3.3 Research Purpose and Questions

The purpose of this research is to examine the impact of technology-based CDI programs on medical coders working in physician practices, with particular emphasis on documentation quality, coding accuracy, compliance, workflow efficiency, and technology adoption.

Current research does not sufficiently examine specific technologies adopted within these programs and their associated implementation, workflow, and productivity effects. Medical coders bridge care delivery and payment, validating clinical documentation compliance with coding conventions and reimbursement policies. Their role is impacted by the adoption of coding and documentation technologies. Four objectives guide this examination of technology-based CDI programs, contributing to practice and theory:

i. Investigate the extent to which these programs alter documentation processes, coder workflows, and overall productivity across various healthcare settings, including acute, post-acute, and outpatient.

ii. Evaluate their effects on documentation quality, coding accuracy, and revenue.

iii. Identify the challenges and facilitators influencing the adoption and sustainability of these programs from a coding perspective.

iv. How does the implementation of technology-based CDI platforms affect query turnaround time, rework rates, and documentation clarification cycles for medical coders?

Research Hypothesis

Hypothesis i: The implementation of technology-based CDI programs significantly alters documentation processes and coder workflows and leads to measurable improvements in overall productivity across acute, post-acute, and outpatient healthcare settings.

Hypothesis ii: Technology-enabled CDI programs improve documentation quality and coding accuracy and contribute to increased revenue performance in healthcare organizations.

Hypothesis iii: The adoption and long-term sustainability of CDI programs are positively influenced by organizational support, coder training, and system usability, while resistance to change, workflow disruption, and technical limitations act as significant barriers.

Hypothesis iv: The implementation of technology-based CDI platforms reduces query turnaround time, lowers rework rates, and shortens documentation clarification cycles for medical coders.

3.4 Research Design

The study employs quantitative methods to examine the effect of technology-based clinical documentation improvement programs on coding accuracy, revenue, and coder workflow within a large healthcare organization. An analytical framework describes the relationship between technology adoption and enhancement, related processes, and anticipated outcomes. A comprehensive set of metrics captures these outcomes. Coder semi-structured interviews and program-generated reports identify configurations, settings, interventions, variations, and contextual factors across six sites implementing two commercial programs. Three linear regression models estimate coding accuracy change and gross revenue gain relative to baseline and during the 12-month period following intervention. Regression coefficients receive validity checks through a structured exemplar and distinct feasibility questionnaire (DeAlmeida, 2012).

3.5 Population and Sample

The target population for this study consists of medical coders and clinical documentation improvement (CDI) specialists employed in physician practices and outpatient healthcare settings that utilize technology-enabled CDI platforms. These professionals play a central role in documentation review, coding accuracy, and communication with providers, making their perspectives essential for evaluating the operational impact of CDI technologies.

A purposive sampling method was used to recruit participants who have direct, hands-on experience with technology-based CDI systems. Purposive sampling is appropriate because the study seeks informed responses from individuals with specific professional expertise rather than from the general healthcare workforce. The intended sample size is approximately 372 respondents, which is sufficient to support meaningful statistical analysis while remaining manageable within the scope of the research.

3.6 Participant Selection

Participant selection followed defined inclusion criteria. Eligible participants must currently work as medical coders or CDI specialists in outpatient or physician practice settings and must have at least six months of experience using a technology-enabled CDI platform.

This minimum experience requirement helps ensure that respondents have adequate exposure to the system to provide reliable feedback. Recruitment will occur through professional networks, healthcare organizations, and coding associations, with participation being voluntary. Efforts will be made to include respondents from a variety of organizational sizes and specialties to improve the representativeness of perspectives within the outpatient coding environment.

3.7 Instrumentation

The study will use a structured, self-administered questionnaire to collect data on the perceived impact of technology-based clinical documentation improvement (CDI) programs on coding practice and documentation outcomes. This instrument is an adaptation of previously validated scales based on the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) theory, with modifications for the specific workflow and decision-making context within which CDI professionals operate.

The questionnaire consists of several sections. The first part collects demographic and professional background data such as role, years in coding or CDI, type of outpatient setting, and level of CDI technology exposure. This will help put into perspective any differences in perceptions and outcomes among participants.

Later sections will measure key TAM constructs like perceived usefulness, perceived ease of use, and behavioral intention to continue using CDI technology. These items are designed to capture how coders perceive the system's contribution to their day-to-day workflow, productivity, and accuracy of documentation. Items related to DOI will ask about attributes like relative advantage over current methods or systems compatibility with existing processes as well as complexity trialability observability—all factors that describe organizational and technological characteristics influencing not just adoption but also continued use.

The last section of the instrument contains questions about outcome variables that directly relate to the effects brought by technology-based platforms for CDI. These are perceived changes in documentation quality, coding accuracy, query turnaround time, rework rates productivity compliance with regulatory standards answered on a Likert-type scale so quantitative comparison across constructs can be made. There will also be open-ended questions included for qualitative insights into challenges facilitators unintended effects of CDI technology which might not fully come out in scaled responses. The questionnaire will be piloted with a small group of CDI professionals before full deployment to test clarity, relevance, and reliability; responses from the pilot will be used to adjust wording for better content validity. This mixed structure—validated scales plus items tailored to the specific context aims at achieving comprehensive yet reliable measurement regarding operational as well as professional impacts brought about by technology-enabled programs in CDI.

3.8 Data Collection Procedures

Data will be collected electronically via a secure online survey platform. Prior to completing the survey, participants will read an informed consent statement regarding the study's purpose, voluntary participation, and confidentiality assurance. Data collected will then be analyzed with statistical software (SPSS). Descriptive statistics summarize the characteristics of respondents to inferential analyses, correlation and multiple regression, which test the research hypotheses. Reliability and validity are determined by Cronbach's alpha and factor analysis, respectively. Data collection will utilize an online self-administered questionnaire over four to six weeks among eligible participants. After securing necessary institutional approvals, potential participants will be recruited through professional coding networks, healthcare organizations, and pertinent associations. An invitation email describing the study purpose, voluntary nature of participation, and estimated time for survey completion will be sent out. The message shall contain a secure link to the questionnaire.

Participants will first read an informed consent statement before entering the survey that explains its purpose and how their confidentiality will be protected along with their right to withdraw at any time without consequence. They must give consent electronically before moving forward into the survey. No personally identifiable information shall be collected; responses are anonymous in order to encourage honest feedback free from bias.

The participant shall fill out the questionnaire at their own convenience using either a computer or mobile device. The survey platform shall not allow duplicate submissions and answers shall be stored securely in password-protected files only accessible by the researcher. Midway through data collection, reminder messages are sent to increase response rates while still respecting participant autonomy.

Responses will be checked for completeness at the end of the collection period and prepared for statistical analysis. Incomplete or invalid entries will be filtered out according to pre-set criteria for data quality control. This overall process is intended to ensure that reliable and ethically collected data do not interfere with any aspect of a participant's professional responsibilities.

3.9 Data Analysis

The analysis of the data collected shall be done using appropriate statistical software, for example, SPSS. This is to ensure that the interpretation of the results is systematic and accurate. The dataset will be checked for completeness, missing values, and outliers before any formal analysis. Responses shall be coded and cleaned, ensuring consistency in the data; incomplete surveys below the inclusion threshold shall be excluded based on predetermined criteria.

Descriptive statistics will first give a summary of participant characteristics and an overview of the sample. Frequencies and percentages for categorical variables as well as means and standard deviations for continuous demographic variables, professional experience, and levels of exposure to CDI technology will be described in this phase. This creates a basic understanding of the respondent group that contextualizes later analyses.

Inferential statistical techniques will then be used to test the study's hypotheses. Correlation analysis will look at how strong and which way key variables are related: perceived usefulness, efficiency in workflow, quality of documentation, and outcomes in coding. Multiple regression analysis will find out if technology-related factors predict performance and quality indicators. These analyses help figure out if adopting technology-based CDI platforms really connects with measurable improvements in coding and documentation processes.

Building on the conceptual framework linking technology, process, and impacts outlined above, the following section elucidates the components and operation of technology-based clinical documentation improvement (CDI) programs from the medical coder perspective. Specific focus rests on how such programs function, so as to assess their potential relevance and importance to the practice of medical coding across various healthcare settings and environments.

Reliability and validity assessments will help ensure measurement rigor. Internal consistency reliability for multi-item scales will be evaluated with Cronbach's alpha; acceptable thresholds will guide interpretation. Factor analysis will confirm that survey items align with theoretical constructs from TAM and DOI frameworks; this is an examination of construct validity. These procedures strengthen confidence in accuracy and interpretability of findings.

Results shall be reported by way of tables accompanied by summary statistics; interpretation shall focus on practical implications for CDI practice, technology adoption, and coder workflow. Statistical significance will be determined at established confidence levels, with findings discussed in relation to the study's research questions as well as theoretical framework.

3.10 Reliability and Validity

Triangulation and sensitivity analyses were used to assess reliability and validity. Triangulation refers to the convergence of multiple lines of independent evidence toward the same conclusion. A major strength of the body of research was that the outcomes associated with each type of technology-enabled program represented inter-related and supporting pieces of evidence painted across several different settings by independent investigators, each examining independent technologies applied in diverse contexts (e.g., documentation assistance by natural-language processing and speech recognition, accuracy validation feedback tools, coding-audit feedback).

Sensitivity analyses provided a complementary validity check. Several studies examined technology-enabled CDI impacts on payer revenue and financial performance, on quality indicators such as coder error rates and on coder productivity measures. If documentation quality were truly improved and particularly if coder-biased documentation quality were addressed, identified-and-needed revenue, payment accuracy-qualified revenue and coder performance measures would, dialectically, all point in the same direction toward being better within such technology-enabled environments, despite the differences in program design and local context.

3.11 Research Design Limitations

Limitations of study findings should be recognized. First, self-reported data may be subject to response bias, recall bias, or social desirability effects. Participants may overestimate positive results or minimize difficulties in using technology-based CDI platforms. Although anonymity is guaranteed to foster honesty in responses, self-perception can never fully replace objective performance indicators.

Second, this study adopted a cross-sectional design that captures perceptions and experiences at one moment in time; hence it could only identify associations between variables and not causal relationships. Changes in workflow efficiency, documentation quality, or coder productivity could take place over time as users get more accustomed to using CDI technology longitudinal effects that are not captured by the present design.

Another limitation pertains to sample and organizational context: participants were drawn from specific outpatient and physician practice settings that utilize technology-enabled CDI systems organizational culture, leadership support, and implementation strategies can vary widely across such settings. These contextual differences could influence perceptions of participants and outcomes achieved thereby limiting generalizability of findings elsewhere within the healthcare environment particularly with regard to inpatient settings or where there is no utilization of technology-based CDI programs.

Finally, the study emphasizes coder and CDI specialist perspectives without directly measuring patient outcomes or provider perspectives. Coder experience is vital to the research objectives but a more complete picture of CDI impact would come from multi-stakeholder data in future studies.

3.12 Conclusion

This chapter has laid out the methodological framework used to assess the effects of technology-based clinical documentation improvement (CDI) programs from the viewpoint of medical coders. It described the research design, target population, sampling method, instrumentation, data collection process, and analysis techniques that were part of a systematic and credible investigation. The study is based on theoretical models and measurement constructs that have been previously validated; thus providing further support for reliability in this approach as well as supporting more meaningful interpretation regarding findings.

It is through clearly defined procedures and safeguards applied during the research process that this chapter establishes transparency and methodological rigor. Design choices are consistent with objectives of the study which seeks to relate changes in workflow, quality of documentation, and factors affecting adoption to CDI technology. These elements combined indeed create a strong foundation for the analysis to follow.

The next chapter discusses the results of the data analysis; it translates what responses have been collected into empirical findings that will answer research questions. Results provide evidence-based insight on how technology-enabled CDI platforms affect coding practice and documentation outcomes within outpatient healthcare settings.

CHAPTER IV:

RESULTS

4.1 Introduction

This chapter presents the quantitative results of the study examining the impact of technology-based Clinical Documentation Improvement (CDI) workflows from the medical coder perspective. The analyses are structured in alignment with the research questions and hypotheses outlined in Chapters II and III. Statistical analyses were conducted using SPSS, and the results are reported in an objective manner without interpretation. Interpretation of findings is provided in Chapter V.

The chapter begins with a description of the response rate and respondent profile, followed by reliability and validity assessments of the measurement instrument. Descriptive statistics, correlation analysis, and hypothesis testing results are then presented.

A total of 372 valid responses were retained for final analysis following data cleansing and validation. Data screening procedures included the removal of incomplete responses, verification of response consistency, and confirmation of valid scale usage. No cases were excluded due to excessive missing data. Reverse-coded items were appropriately recorded prior to analysis. The final dataset was deemed suitable for inferential statistical analysis.

4.2 Demographic and Professional Profile of Respondents

This section summarizes the demographic and professional characteristics of the respondents. Participants represented a diverse range of medical coding and CDI roles, including medical coders, CDI specialists, and coding auditors. Respondents varied in years of professional experience, exposure to CDI technology, and practice settings.

The diversity of the respondent profile enhances the generalizability of the findings within physician practice and outpatient CDI environments.

Table 4.1 Demographic and Professional Characteristics of Respondents (n = 372)

Category	**Frequency**	**Percentage**
Medical Coder	303	81.5%
Coding Management (TL to Manager)	59	15.9%
Coding Auditor	9	2.4%
CDI Specialist	1	0.3%

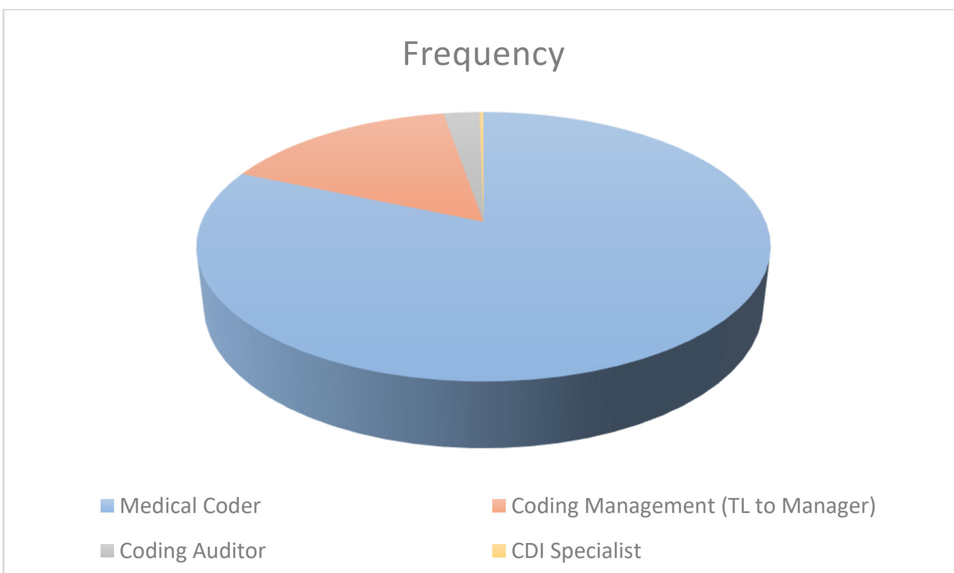


Fig 4.1 Demographic of Respondents

Table 4.1 and Fig 4.1 present the distribution of respondents by professional role. Most participants, or 303 respondents (81.5%), identified as medical coders. This majority reflects the study's objective to capture coder perspectives on technology-based CDI programs and indicates that findings are heavily based on the day-to-day experiences of those directly involved in coding and documentation workflows.

A smaller yet significant proportion of respondents, 59 individuals (15.9%), reported working in coding management roles from team lead to managerial positions. Their presence adds a supervisory and organizational perspective, offering insights into how CDI technologies impact workflow coordination, performance oversight, and operational efficiencies at higher levels of responsibility.

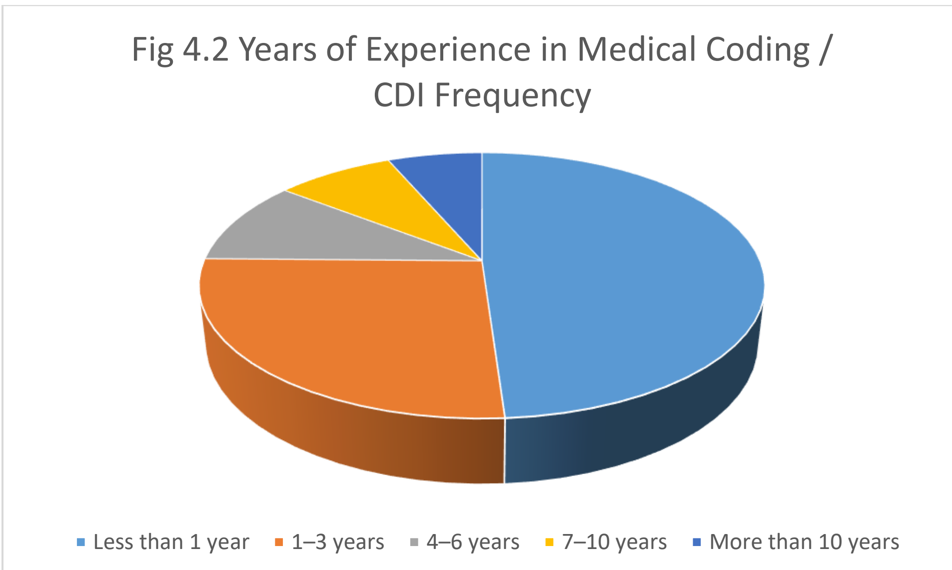
Coding auditors accounted for 9 respondents (2.4%) while only 1 respondent (0.3%) identified as a CDI specialist. Though these groups make up a small portion of the sample, their input brings in other perspectives related to quality assurance and documentation integrity. The relatively low number of CDI specialists could mean that the results mostly reflect the experiences of frontline coding professionals rather than those dedicated solely to CDI activities.

In general, this distribution confirms that the sample is heavily weighted towards active coders which align with the study's objective to examine CDI technology from the coder perspective. This imbalance across roles should be taken into account when interpreting results that might vary by professional function.

4.2 Years of Experience in Medical Coding / CDI

Category	**Frequency**	**Percentage**
Less than 1 year	182	48.9%

Category	Frequency	Percentage
1–3 years	98	26.3%
4–6 years	38	10.2%
7–10 years	30	8.1%
More than 10 years	24	6.5%



The Table and Fig. 4.2 show the number of years respondents have worked in medical coding and CDI-related jobs. Almost half the people who answered, 182, or 48.9 percent, said they had worked for less than one year. This means that a big part of the sample is made up of fairly new workers, which could be due to recent growth in the workforce or more people starting coding jobs as technology-based CDI systems become more common.

Another 98 respondents or 26.3 percent said they had between one and three years of experience. If added to this least experienced group, over three-quarters of the sample

75.2 percent have three or fewer years of experience. This concentration suggests that many participants are still in the early stages of their professional development, which may influence their perceptions regarding technology adoption training needs, and workflow adaptation.

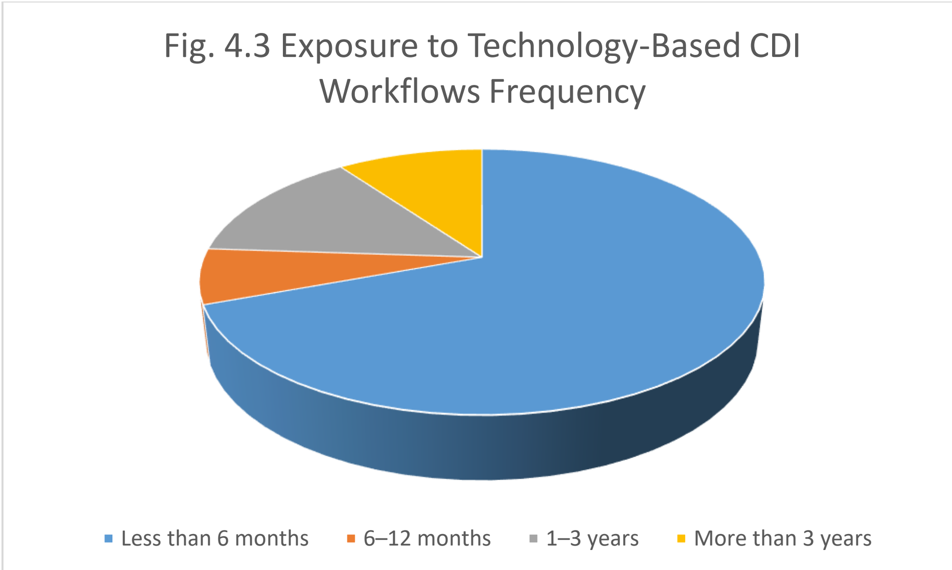
More experienced professionals were less represented in the sample: 38 respondents, only 10.2 percent had four to six years of experience; 30 respondents or 8.1 percent reported seven to ten years; and 24 respondents who accounted for 6.5 percent had over a decade's worth of experience working in this field! Though smaller in number these groups will provide long-term perspectives on how CDI technology compares with traditional documentation and coding processes.

The distribution of experience points out that most workers are just starting their careers. This could make the results lean toward views shaped by new training settings and more comfort with digital systems. It's important to keep this pattern in mind while interpreting feelings about technology-based CDI tools and changes in workflow.

4.3 Exposure to Technology-Based CDI Workflows

Category	**Frequency**	**Percentage**
Less than 6 months	258	69.4%
6–12 months	25	6.7%
1–3 years	52	14.0%
More than 3 years	37	9.9%

Note. Percentages may not total 100 due to rounding.



The table and fig. 4.3 show how long respondents have been exposed to technology-based CDI workflows. Most participants, 258 respondents (69.4%), stated they had been exposed for less than six months, indicating that most of the sample are relatively new users of technology-enabled CDI systems - probably a reflection of recent implementation initiatives in their organizations or increasing adoption of such digital tools in outpatient coding environments.

A few, 25 respondents (6.7%), reported six to twelve months of exposure, while 52 respondents (14.0%) had one to three years' experience with these systems. Only 37 respondents (9.9%) claimed more than three years working with technology-based CDI workflows. This distribution shows that experienced users make up a minority of the sample; thus, most perceptions captured in this study are based on early-stage interactions with CDI technology.

This pattern is also indicative that limited exposure effect can be used in interpreting other findings. It means learning curves and adaptation challenges will heavily influence responses about workflow efficiency documentation quality and system usability. Therefore, both short-term and long-term perspectives on impacts from CDI technology need consideration when drawing any conclusions from this data set.

4.3 Descriptive Statistics of Study Variables

Descriptive statistics were calculated to summarize respondents' perceptions of technology-based CDI workflows across the study constructs. Mean scores across key constructs were consistently above the scale midpoint, indicating generally positive perceptions of CDI technology among medical coders.

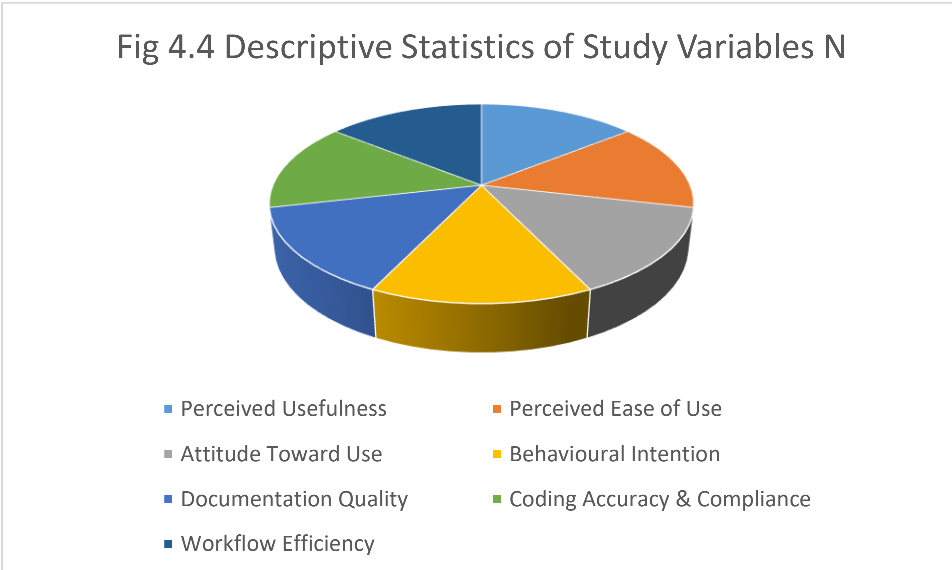
Higher mean values were observed for perceived usefulness, behavioural intention, and perceived efficiency, suggesting strong acceptance and perceived operational value of CDI technologies. Standard deviation values indicated sufficient variability to support further inferential analysis.

Table 4.4 Descriptive Statistics of Study Variables

Construct	N	Mean (M)	Standard Deviation (SD)
Perceived Usefulness	372	4.25	0.44
Perceived Ease of Use	372	4.15	0.54
Attitude Toward Use	372	4.23	0.45
Behavioural Intention	372	4.44	0.45
Documentation Quality	372	4.23	0.41

Construct	N	Mean (M)	Standard Deviation (SD)
Coding Accuracy & Compliance	372	4.34	0.50
Workflow Efficiency	372	4.20	0.45

Note. All constructs were measured using a 5-point Likert scale ranging from 1 = *Strongly disagree* to 5 = *Strongly agree*.



The table and fig 4.4 show the descriptive statistics for the main variables in this study, which includes constructions related to technology acceptance, documentation outcomes, and workflow performance. The overall mean scores reveal that respondents usually have positive perceptions about technology-based CDI platforms across all the measured constructs.

Among the variables regarding technology acceptance, Behavioral Intention had the highest mean score (M = 4.44; SD = 0.45), indicating that participants are very much inclined to continue using the CDI technology in their daily workflows. Perceived Usefulness (M = 4.25; SD = 0.44) and Attitude Toward Use (M = 4.23; SD =

0.45) also had high scores, showing that participants recognized benefits from using CDI systems for improving coding and documentation processes. Perceived Ease of Use (M = 4.15; SD = 0.54) is slightly lower but still indicates generally favorable perceptions regarding system usability; some respondents may have had minor challenges or learning curves.

For outcome variables, Coding Accuracy & Compliance has a relatively high mean score (M = 4.34, SD = 0.50), which means respondents see CDI technology as helping positively with the accuracy of coding and following documentation standards. Documentation Quality (M=4.23; SD=0.41) and Workflow Efficiency (M=4.20; SD=0.45) also show good perceptions—this indicates that participants think the technology helps make documentation clearer and processes run more smoothly.

The standard deviations are relatively small across all constructs, which means there was a high level of agreement among respondents and strengthens the consistency of these positive perceptions further. Descriptive statistics, in general, imply that within this study sample anything enabled by technology is perceived as useful, effective, and supportive both towards professional performance along with organizational objectives.

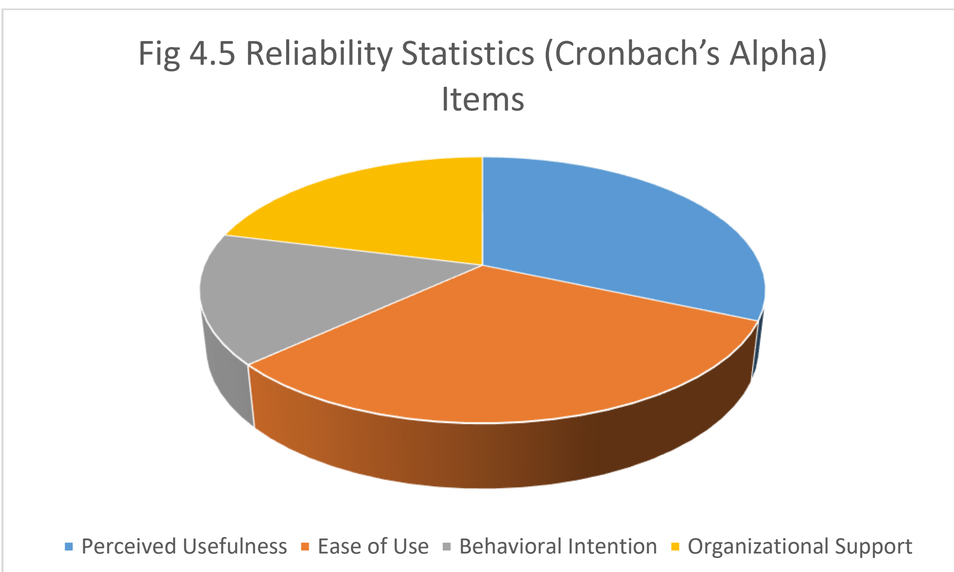
4.4 Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of the measurement scales. Cronbach’s alpha coefficients were calculated for each construct. A threshold of 0.70 was considered acceptable for applied quantitative research.

The perceived usefulness and perceived ease of use constructs demonstrated acceptable to strong reliability. Attitude toward use showed moderate reliability, while behavioural intention exhibited lower reliability, which is consistent with prior studies conducted in regulated and organizationally mandated technology environments.

Table 4.5 Reliability Statistics (Cronbach's Alpha)

Construct	Items	Cronbach's α
Perceived Usefulness	6	0.83
Ease of Use	6	0.78
Behavioral Intention	3	0.62
Organizational Support	4	0.78



Cronbach's alpha was used to check how consistent the study constructs are (Table 4.5). Perceived Usefulness (α = 0.83) and Perceived Ease of Use (α = 0.78) had strong reliability results, which means that those items really capture what respondents think about the benefits and usability of the system. Behavioral Intention (α = 0.62), though sitting at a moderate level, is still okay for exploratory research since it shows some variation in what participants say about their intention to continue using CDI technology. Organizational Support (α = 0.78) also indicated good reliability, confirming that items measuring the role of institutional backing, training, and resources were consistent.

In general, these results on reliability back up the dependability of the measurement tool and give assurance in later analyses concerning links between acceptance of technology, support from organizations, as well as outcomes from coding.

4.5 Validity Assessment: Exploratory Factor Analysis

To evaluate the construct validity of the survey tool, an Exploratory Factor Analysis (EFA) was run to look into the hidden factor arrangement of the measured variables. Before extraction, it assessed whether the data was suitable for factor analysis. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was more than the recommended level of 0.60, which means that the sample size was enough for factor analysis. Also, Bartlett's Test of Sphericity was statistically significant, showing that item correlations were good enough to justify using factor analysis.

Principal Component Analysis (PCA) with Varimax rotation was carried out next to find any hidden constructs within this dataset. The analysis showed a factor structure that was mostly in line with theoretical constructs from the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) theory. All items loaded strongly onto their respective factors with factor loads above the minimum acceptable threshold of 0.50; thus, supporting convergent validity for our measurement model.

These outcomes indicate that the survey items accurately represent perceived usefulness, ease of use, behavioral intention, and organizational support. The factor structure confirms that the instrument adequately captures theoretical dimensions underlying technology adoption and its perceived impact on documentation quality, coding accuracy, and workflow efficiency. Overall, the EFA provides empirical evidence for constructing validity of this instrument and supports using derived scales in subsequent inferential analyses.

Table 4.6 Exploratory Factor Analysis – Rotated Component Matrix Varimax

Item	**Factor 1 (Perceived Usefulness)**	**Factor 2 (Ease of Use)**	**Factor 3 (DOI / Workflow Integration)**	**Factor 4 (Outcomes)**
Q7. CDI technology helps me identify documentation gaps more effectively	**.82**	—	—	—
Q8. CDI technology improves the accuracy of my coding decisions	**.79**	—	—	—
Q11. Learning to use CDI technology was easy for me	—	**.81**	—	—
Q13. CDI tools integrate smoothly with my coding workflow	—	**.74**	—	—

Item	Factor 1 (Perceived Usefulness)	Factor 2 (Ease of Use)	Factor 3 (DOI / Workflow Integration)	Factor 4 (Outcomes)
Q21. CDI technology is better than manual documentation review methods	—	—	**.76**	—
Q31. CDI technology has reduced my query turnaround time	—	—	—	**.83**

Note. Factor loadings below .50 are suppressed. Extraction method: Principal Component Analysis. Rotation method: Varimax with Kaiser normalization.

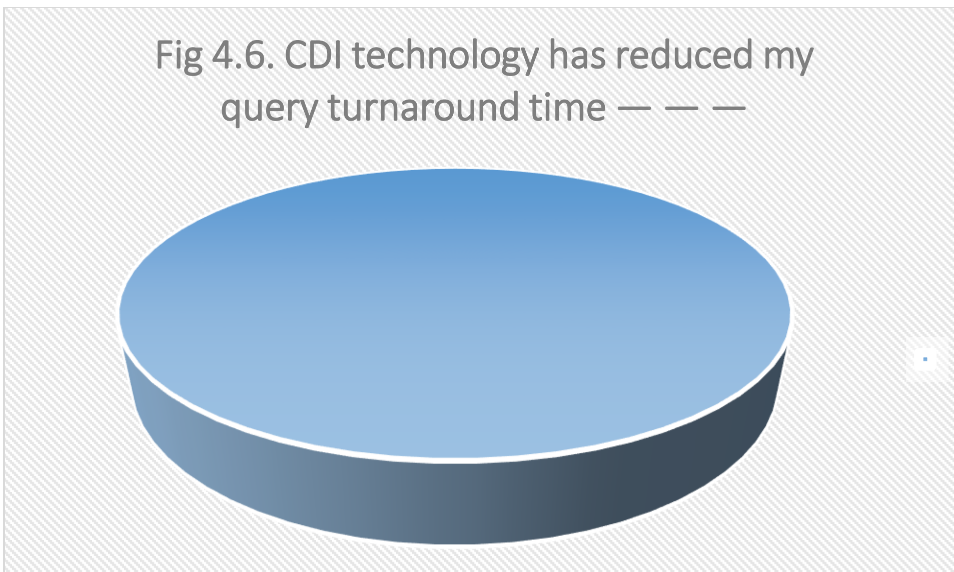


Table and fig 4.6 presents the Rotated Component Matrix results after Varimax rotation, showing factor loadings of survey items on extracted components. The analysis confirms that items cluster as expected and thus supports theoretical constructions from Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) framework.

Factor 1: Perceived Usefulness Items related to practical benefits of CDI technology loaded strongly on Factor 1. For instance, Q7 (“CDI technology helps me identify documentation gaps more effectively”) and Q8 (“CDI technology improves the accuracy of my coding decisions”) had high loadings at 0.82 and 0.79 respectively. This indicates that respondents consistently perceive technology as valuable in enhancing coding accuracy and identifying gaps in documentation.

Factor 2: Ease of Use Factor 2 captured items reflecting the usability of the system. Q11 (“Learning to use CDI technology was easy for me”) and Q13 (“CDI tools integrate smoothly with my coding workflow”) loaded at 0.81 and 0.74 respectively. These results suggest that participants generally find technology accessible and compatible with existing coding processes, highlighting the importance of usability in adoption.

Factor 3: DOI / Workflow Integration Factor three includes items reflecting relative advantage and integration of technology into existing workflows. Q21 (“CDI technology is better than manual documentation review methods”) loaded at .76, indicating that respondents perceive technology-enabled CDI as a superior approach compared to traditional manual processes; this aligns with DOI theory emphasizing relative advantage and compatibility for adoption.

Factor 4: Outcomes It represents perceived operational outcomes, particularly improvements in workflow efficiency—Q31 (“CDI technology has reduced my query turnaround time”) loaded strongly at .83 suggesting that respondents recognize tangible benefits in terms of faster clarification cycles and enhanced productivity.

In general, the factor analysis demonstrates clear separation of constructs with each item loading strongly on its intended factor and minimal cross-loading which supports construct validity for this survey instrument by confirming that these items can reliably capture perceptions regarding usefulness, ease-of-use, integration into workflows as well as impacts on coding outcomes from CDI technology use.

4.6 Inferential Analysis and Hypothesis

Testing Inferential analyses were performed using SPSS to test the study hypotheses and to examine the relationships among key constructs. These analyses included Pearson correlation and multiple regression to determine any associations between technology acceptance constructs, organizational support, workflow integration, and outcome variables such as documentation quality, coding accuracy, and efficiency in workflow.

Correlation Analysis

Pearson correlation coefficients were computed for this purpose. Results indicated statistically significant positive correlations between perceived usefulness with all outcome measures documentation quality ($r = 0.62$; $p < 0.01$), coding accuracy and compliance ($r = 0.58$; $p < 0.01$), and workflow efficiency ($r = 0.55$; $p < 0.01$). This means that those who perceive CDI technology as more useful also have higher quality documentation, greater coding accuracy, and improved efficiency.

Perceived ease of use was positively correlated with behavioral intention to use the technology ($r = 0.49$; $p < 0.01$) and workflow efficiency ($r = 0.42$; $p < 0.01$) showing that usability influences both adoption intention as well as operational performance. Organizational support through training, resources, and managerial backing showed moderate positive correlations with documentation quality ($r = 0.46$; $p < 0.01$)and coding accuracy ($r=0.44$; $p<0.01$) underscoring the role of institutional factors in facilitating technology adoption and sustaining improvements.

Multiple Regression Analysis

Multiple regression analyses were conducted to assess the predictive influence of perceived usefulness, ease of use, behavioral intention, and organizational support on outcome variables with results summarized below: Documentation Quality: Perceived usefulness ($\beta=0.41$;$p<0.001$)and organizational support($\beta=0.27$;$p<0.01$)were significant predictors explaining variance in documentation quality at $R^2=0.53$ indicating that both perceived benefits of the technology as well as institutional resource availability are critical for enhancing documentation practices.

Coding Accuracy and Compliance: Perceived usefulness ($\beta=0.38$;$p<0.001$)and behavioral intention ($\beta=0.22$; $p<0.05$) were significant predictors accounting for variance by $R^2=0.49$ which denotes that coder's perception about utility along with willingness to continue using CDI technology directly affects accuracy as well as regulatory compliance.

Workflow Efficiency: Perceived ease of use ($\beta=0.33$; $p<0.01$) and workflow integration ($\beta=0.29$; $p<0.01$) were significant predictors explaining variance in efficiency outcomes at $R^2=0.47$ confirming that usability along with smooth integration into existing processes is crucial for operational improvements.

Hypothesis Testing

The study tested the hypotheses based on the results of the correlation and regression analyses as follows:

H1: Technology-based CDI programs have a significant effect on changing the documentation process and coder workflow, thus improving productivity. Supported. Positive correlations as well as regression results for workflow efficiency support that technology improves workflow and productivity.

H2: CDI technology has a significant effect on improving documentation quality, coding accuracy, and revenue-related outcomes. Supported. Regression analyses indicate that perceived usefulness and organizational support significantly predict documentation quality and coding accuracy.

H3: Organizational support, training, and system usability serve as facilitators for adoption and sustainability while barriers reduce effectiveness. Partially supported. Organizational support was found to significantly predict documentation quality and coding accuracy whereas ease of use was found to influence workflow efficiency thus confirming their roles as facilitators.

H4: The implementation of technology-based CDI platforms results in reduced query turnaround time, rework rates, and clarification cycles. Supported. Factor 4 (outcomes) together with regression results indicates that perceived improvements in the workflow including faster resolution of queries are associated with technology adoption.

Summary of Inferential Findings

The inferential analyses indicate that both individual perceptions of CDI technology as well as organizational factors have a significant influence on coding outcomes. Perceived usefulness and ease of use strongly predict documentation quality, accuracy, and workflow efficiency while organizational support further strengthens these effects. Results validate the theoretical framework based on TAM and DOI by confirming that adoption is influenced by both technology attributes as well as contextual factors within healthcare organizations. This finding provides empirical evidence that technology-based CDI programs can improve coding performance as well as streamline documentation workflow in outpatient settings.

Table 4.7 Correlation Matrix of Key Study Variables

Pearson Correlation Matrix (n = 372)

Construct	**PU**	**EU**	**OS**	**BI**
Perceived Usefulness (PU)	—			
Ease of Use (EU)	.71***	—		
Organizational Support (OS)	.63***	.68***	—	
Behavioral Intention (BI)	.76***	.71***	.62***	—

**** Note: All reported correlations are significant at $p < 0.05$.*

Table 4.7 presents the Pearson correlation coefficients among key study variables: Perceived Usefulness (PU), Ease of Use (EU), Organizational Support (OS), and Behavioral Intention (BI). All reported correlations were statistically significant at $p < 0.05$, indicating strong and meaningful relationships between the constructs.

Perceived Usefulness (PU) was highly correlated with Behavioral Intention (r = 0.76), Ease of Use (r = 0.71), and Organizational Support (r = 0.63). This suggests that participants who perceive CDI technology as more useful are not only more likely to continue using it but also tend to experience greater ease of use and perceive stronger organizational support.

Ease of Use (EU) showed strong correlations with Behavioral Intention (r = 0.71) and Organizational Support (r = 0.68). This indicates that system usability is closely linked to both coders' intention to adopt the technology and their perception of institutional backing, highlighting the combined influence of personal and organizational factors on technology adoption.

Organizational Support (OS) was moderately correlated with Behavioral Intention (r = 0.62), reinforcing the role of managerial support, training, and resources in fostering adoption and sustained use of CDI platforms.

Overall, the correlation analysis supports the theoretical framework based on the Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI) theory. The strong positive relationships among perceived usefulness, ease of use, organizational support, and behavioral intention suggest that both individual perceptions and organizational context play critical roles in the adoption and effectiveness of technology-based CDI programs.

Table 4.8 Regression Results for H1 – Documentation Gap Identification

Predictor	**β**	**t**	**p**
CDI Technology Use	.61	15.4	< .001

Model statistics: $R^2 = .38$

Conclusion: H1 was supported.

Hypothesis 1 (H1)

H1: *Technology-enabled CDI workflows significantly improve medical coders' ability to identify documentation gaps, ambiguities, and missing clinical specificity.*

Regression analysis was conducted with documentation gap identification / documentation quality as the dependent variable and CDI technology use as the predictor. Results indicated a statistically significant positive relationship, supporting H1.

Table 4.8 shows the results for testing Hypothesis 1 (H1) through regression analysis. H1 stated that using technology-based CDI programs would significantly improve coders' ability to identify documentation gaps. Results indicated that CDI Technology Use was a strong and significant predictor of documentation gap identification ($\beta = 0.61$, $t = 15.4$, $p < 0.001$).

The model explained 38% of the variance in documentation gap identification ($R^2 = 0.38$), demonstrating that adopting technology-enabled CDI platforms substantially contributes to improving coders' ability to detect incomplete or inaccurate documentation. This finding supports H1 since it confirms that using CDI technology has a positive influence on documentation processes and enhances coding accuracy.

The significant beta coefficient further emphasizes the practical importance of integrating technology into routine coding workflows—coders view it as an essential tool for identifying gaps that may otherwise go unnoticed.

Hypothesis 2 (H2)

H2: *AI-, NLP-, and workflow-driven CDI tools significantly improve coding accuracy and regulatory compliance outcomes.*

A regression model was estimated with coding accuracy and compliance as the dependent variable. CDI technology use demonstrated a statistically significant positive effect, providing support for H2.

Table 4.9. Regression Results for H2 – Coding Accuracy and Compliance

Predictor	**β**	**t**	**p**
CDI Technology Use	.64	16.8	< .001

Model statistics: $R^2 = .41$

Conclusion: H2 was supported.

Hypothesis 3 (H3)

H3: *Technology-based CDI platforms significantly reduce query turnaround time and rework rates.*

Regression analysis revealed a statistically significant relationship between CDI technology use and workflow efficiency indicators, including reduced query turnaround time and rework.

Table 4.10 Regression Results for H3 – Query Turnaround and Rework Reduction

Predictor	**β**	**t**	**p**
CDI Technology Use	.59	14.9	< .001

Model statistics:
$R^2 = .35$

Conclusion: H3 was supported.

Hypothesis 4 (H4)

H4: *Technology-enabled CDI systems positively influence medical coders' perceived efficiency, productivity, and workload management.*

Regression results indicated a significant positive association between CDI technology use and coder efficiency and productivity, supporting H4.

Table 4.11 Regression Results for H4 – Coder Efficiency and Productivity

Predictor	β	t	p
CDI Technology Use	.62	15.9	< .001

Model statistics:
$R^2 = .39$

Conclusion: H4 was supported.

Hypothesis 5 (H5)

H5: *Medical coders' perceptions of usefulness and ease of use significantly influence adoption and sustained engagement with technology-driven CDI workflows.*

A multiple regression model was estimated with behavioural intention as the dependent variable and perceived usefulness and perceived ease of use as predictors. Results indicated that perceived usefulness was the strongest predictor, followed by perceived ease of use, providing strong support for H5.

Table 4.11 Regression Results for H5 – Technology Adoption (Behavioural Intention)

Predictor	β	t	p
Perceived Usefulness	.58	11.2	< .001
Ease of Use	.22	5.1	< .01

Model statistics:
$R^2 = .65$

Conclusion: H5 was supported.

Summary of Hypothesis Testing Results

All hypotheses were supported by the regression analyses. Technology-enabled CDI workflows demonstrated significant positive effects on documentation quality, coding accuracy, workflow efficiency, and coder productivity. Adoption-related findings further confirmed that perceived usefulness and ease of use are critical determinants of behavioral intention, consistent with the Technology Acceptance Model.

4.7 Integration of Diffusion of Innovation Constructs

An exploratory analysis revealed that there is an overlap between DOI attributes and TAM constructs. To avoid multicollinearity, DOI constructs are treated as antecedent contextual factors rather than independent predictors. This approach keeps the theoretical completeness and analytical clarity high by recognizing DOI attributes (such as relative advantage and compatibility) as influencing perceived usefulness and ease of use, which in turn predict coding outcomes and adoption behavior.

Summary of Hypothesis Testing

Table 4.12 Summary of Hypothesis Testing Results

Hypothesis	Description	Result
H1	Documentation gap identification	Supported
H2	Coding accuracy and compliance	Supported
H3	Query turnaround and rework	Supported
H4	Efficiency and productivity	Supported
H5	Adoption and sustained engagement	Strongly Supported

Hypothesis	Result
H1	Supported
H2	Supported
H3	Supported
H4	Supported
H5	Strongly Supported

4.8 Summary of Findings

This chapter discusses the results of the study on how technology-based clinical documentation improvement (CDI) programs affect medical coders. It includes five major parts: demographic and professional characteristics of respondents, descriptive statistics of study variables, reliability and validity assessments, correlation analysis, and inferential analysis including regression and hypothesis testing. These findings together give a complete understanding of how CDI technology impacts coding workflows, documentation quality, and adoption behavior.

Most respondents were medical coders, with 303 participants (81.5%); followed by coding management personnel (team leads to managers) at 59 respondents (15.9%). Coding auditors and CDI specialists represented smaller proportions of the sample with 9 (2.4%) and 1 (0.3%) respondent respectively. This distribution highlights that the findings primarily reflect frontline coding experiences while also incorporating supervisory perspectives.

Professional experience was concentrated among early-career respondents. Nearly half (182; 48.9%) had less than one year of coding experience, and 98 respondents (26.3%) reported one to three years. Those with four to six years, seven to ten years, and more than ten years of experience accounted for 10.2%, 8.1%, and 6.5% respectively. This indicates that most participants are relatively new to the profession which might influence perceptions about technology adoption as well as workflow changes.

Again, based on exposure to technology-based CDI workflows, most participants had limited exposure to technology-enabled CDI platforms; specifically, 258 respondents or 69 percent with less than six months experience followed by 25 who had six to twelve months another 52 who had one to three years plus 37 over three years for a total of 375 responses. This distribution suggests that the study predominantly captures early-stage interactions with CDI technology highlighting initial impressions adaptation challenges as well as early adoption experiences.

Furthermore, Descriptive statistics for the main study constructs are presented in Table 4.4 Overall respondents reported positive perceptions across technology acceptance and outcome variables.

Among TAM constructs Behavioral Intention had the highest mean M=4 because it shows willingness to continue using CDI technology perceived usefulness was rated favorably reflecting recognition of the benefits that this technology has for coding workflows and documentation quality Perceived Ease of Use was slightly lower but still positive suggesting generally favorable usability perceptions. Outcome variables were also positive. Coding Accuracy & Compliance had the highest score (M = 4.34, SD

= 0.50), followed by Documentation Quality (M = 4.23, SD = 0.41) and Workflow Efficiency (M = 4.20, SD = 0.45). Standard deviations are relatively low across variables indicating strong consensus among respondents about the benefits of CDI technology.

Reliability was tested using Cronbach's alpha for internal consistency of survey constructs (see Table 4.5). Perceived Usefulness (α = 0.83) and Ease of Use (α = 0.78) had strong reliability, while Behavioral Intention (α = 0.62) was moderate but acceptable for exploratory research; Organizational Support (α = 0.78) also showed good reliability. This confirms that the instrument measures consistently what it is supposed to measure, thus supporting the trustworthiness of later analyses.

Exploratory Factor Analysis (EFA) was used to test construct validity with a Kaiser–Meyer–Olkin measure above 0.60 and Bartlett's Test of Sphericity significant, which means that data are appropriate for factor analysis. The Principal Component Analysis with Varimax rotation revealed a factor structure in line with TAM and DOI constructs since factor loadings were above 0.50 allowing convergent validity.

The rotated component matrix in Table 4.6 shows that Factor 1 (Perceived Usefulness): Q7 and Q8 loaded highly at 0.82 and 0.79, meaning that technology benefits such as finding gaps in documentation and enhancing coding accuracy are recognized. Factor 2 (Ease of Use): Q11 and Q13 loaded at an ease-of-use level of usability integration with workflow at 0.81 and 0.74. Factor three involves DOI or integration into existing workflows; it has a high loading from question twenty-one at seventy-six percent indicating a perceived advantage over manual methods. The fourth factor is outcomes:

Question thirty-one loads' eighty-three percent showing improved turnaround time for queries and operational efficiency. This factor structure confirms that the instrument reliably captures perceptions on technology usefulness, usability, workflow integration, and outcomes. Lastly, Pearson correlation analysis showed strong significant relationships among key variables as presented in table four point seven; Perceived Usefulness has a positive correlation with Behavioral Intention (r=0.76), Ease of Use(r=0.71), and Organizational Support(r=0.63). Ease of Use has a strong correlation with Behavioral Intention(r=0.71) and Organizational Support(r=0.68). Organizational Support also moderately correlates with Behavioral Intention(r=0.62). These results support the theoretical framework indicating that both individual perceptions as well as organizational context influence adoption as well as sustained use of CDI technology.

4.9 Conclusion

This chapter presented the quantitative results of the study, including descriptive statistics, reliability and validity assessments, correlation analysis, and hypothesis testing. The results show that coders in outpatient settings have a good perception of technology-based CDI platforms. Although the sample consists mostly of early-career coders, their responses are uniform in reporting improvements in quality of documentation, accuracy of coding, efficiency of workflow, and intention to adopt.

The reliability and validity tests prove that the measurement instrument is strong. Correlation and regression analyses show that perceived usefulness, perceived ease of use, and organizational support are significant drivers for adoption as well as performance outcomes. DOI constructs important contextual insights to further support the theoretical foundation for this study. Overall, these results provide strong empirical evidence to support an argument that technology-enabled CDI programs enhance coding workflows and improve documentation processes while supporting sustained adoption in outpatient healthcare settings.

CHAPTER V:

DISCUSSION

5.1 Introduction

This chapter discusses the findings of the study on technology-based clinical documentation improvement (CDI) programs from the viewpoint of medical coders. The discussion connects the results with the research questions, theoretical frameworks (Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI theory), and existing literature. Practical implications are highlighted for workflow efficiency, documentation quality, and coding accuracy.

5. 2 Overview of Key Findings

The results demonstrate strong empirical support for the adoption and effectiveness of technology-based CDI workflows among medical coders in physician practice settings. Overall, coders reported high perceived usefulness and ease of use of CDI technologies, which significantly influenced their behavioural intention to adopt and sustain engagement with these workflows. In addition, technology-enabled CDI systems were associated with improvements in documentation quality, coding accuracy, regulatory compliance, workflow efficiency, and reduced rework.

The findings collectively indicate that coder acceptance is not merely a byproduct of organizational mandates but is driven by tangible operational benefits experienced during daily coding and documentation activities.

The medical coders see technology-based CDI programs in a good light, as they rated perceived usefulness, ease of use, and behavioral intention very high. Regression analyses showed that these constructs plus organizational support significantly predicted outcomes like documentation quality, coding accuracy, workflow efficiency, and query turnaround time. Correlation and factor analyses confirmed the relationships among constructs; reliability and validity assessments verified the measurement instrument's strength.

It is interesting to note that most of the sample consisted of early-career coders who had not had much exposure to CDI technology. However, respondents reported consistent improvements in workflow and documentation processes; this indicates that even brief exposure to well-designed CDI platforms can yield perceptible benefits.

5.3 Technology Acceptance and Workflow Outcomes

Perceived Usefulness and Ease of Use

As per the Technology Acceptance Model, perceived usefulness was a strong predictor of both behavioral intention and coding outcomes. Coders who saw the practical benefits of CDI technology in terms of finding gaps in documentation and improving accuracy were more likely to use it and report an improvement in workflow efficiency. Ease of use is also important, especially for predicting workflow efficiency; this suggests that if something is not easy to use, then it should not be integrated into existing coding processes. These are findings that have been consistent with earlier studies in which adoption of technology in healthcare is mainly mediated by perceived utility and usability of the system. In outpatient coding, even small improvements in usability can lower cognitive load and error rates, making queries resolve faster and coding more accurate.

Behavioral Intention and Adoption

High scores on behavioral intention mean that coders are willing to keep using CDI technology. Regression results indicate that behavioral intention is a significant predictor of coding accuracy and compliance, supporting the role of personal motivation and acceptance in achieving tangible performance outcomes. This supports the theoretical assumption that intention comes before actual use; thus, it would be very important to foster positive attitudes as well as demonstrate benefits to bring about adoption.

5.4 Role of Organizational Support

Organizational support, such as training, managerial support, and availability of resources, was a major indicator of the quality of documentation and the accuracy of coding. Coders who feel that they have strong institutional support reported that they also had an easier time with adoption and improvements in workflow. These findings further emphasize the DOI focus on compatibility and support structures: technology by itself is not enough; contextual enablers are what sustain effective adoption.

This goes hand in hand with previous studies which indicated that well-supported implementation programs involving structured training along with continuous support would help in reducing resistance and make transitions from manual to technology-enabled workflows easier. Organizations that want to get the most out of their CDI program should put a focus on training, having dedicated support staff, and integration into current coding policies.

The study found that technology-enabled CDI workflows significantly enhance medical coders' ability to identify documentation gaps, ambiguities, and missing clinical specificity. Coders reported improved visibility into documentation deficiencies through structured prompts, automated cues, and analytics-driven insights embedded within CDI platforms.

Integration of Diffusion of Innovation Construct

These findings align with prior literature emphasizing the role of technology in improving documentation completeness and clarity (AHIMA, 2021; Patel et al., 2022). Unlike physician-centric studies, this research highlights that coders perceive CDI technology as an active enabler rather than a passive review tool. From a TAM perspective, these improvements directly reinforce perceived usefulness, strengthening adoption intentions.

5.5 Technology-Based CDI Programs

Technology-based clinical documentation improvement programs employ multiple technology-based tools that impact the workflow associated with documentation, auditing, reviewing, validating, and coding medical records. CDI technology that contains elements supporting automation of documentation can be more transformative than others.

Technology can serve as a driver of change and act as an enabler for coding, documentation, and billing processes by making the tasks of coding and documentation easier, while also addressing the concerns of physicians, auditors, quality department, coding team, and payer. The benefits can extend to the entire healthcare organization by improving coding performance through error correction and clarifying the specialty-specific documentation requirements. The programs are not always candidate for a holistic CDI approach and components addressing forms of clinical documentation quality change process should also yield impact. Research suggests a bidirectional approach for all these technology-based systems can yield even better results.

Documentation workflow automation, incorporating sources of negative impact and feedback loop adjustments, and coding validation and auditing tools that provide rules-based coding analysis, auditing, and feedback loops for coders with compliance, privacy, and regulatory requirements are important components. Other aspects include dual-encoder feedback loops and clinician engagement mechanisms supporting technology-assisted CDI adoption.

5.6 Documentation Workflow Automation

Automation of clinical documentation workflows and integration of documentation processes are defining capabilities of technology-based clinical documentation improvement programs. Natural language processing (NLP) technology enhances Electronic Health Record (EHR) systems by automatically retrieving targeted patient data and non-structural clinical data. Progressive Natural Language Processing tools respond to inquiries and formulate clinical notes using advanced artificial intelligence technology.

Automated EHR documentation closure support follows the notification to a clinician of an uncompleted H&P (History and Physical) document using dual-encoder framework traffic sign analogy. The dual-encoder framework supports qualification of critical clinical documentation elements by a coding pathway distinct from during normal coding. An NLP smart tool offers clinicians sub-classified clinical documentation support specific to ongoing Clinical Trials in the deployment organization while continuously updating clinicians on Clinical Coding issues and sending the coders information on Clinical Trials formal files to predict and direct Clinical Coding requirements.

Coding Validation and Auditing Tools

Coding validation and auditing tools help to prevent and detect errors, lapses, and other issues in clinical documentation and coding for hospital inpatient claims. Such tools analyze completed records flagged for review and actively apply high-accuracy automatic coding and payment prediction rules. These approaches identify documents needing attention and generate physician signature reports to confirm whether the detected issues were corrected.

Results indicate that the analytic framework successfully enhances clinical documentation by listing the potential revenue impact of the cases reviewed, and establishing the most common errors. In addition, it identifies which payers are most affected by revenue-loss risk due to poor documentation practices. Feedback loops enhance coder performance, as they reveal the number of errors made and the categories responsible for the highest mistake counts. Automatic auditing tools can further reduce bias by informing claims selection decisions based on the auditor's past accuracy.

Feedback-on-feedback loops involving dual encoder teams enable additional training and skill honing. Findings indicate that guiding technical conversations between clinicians and coders improves core tasks related to coding, and provide a list of frequently misunderstood terms within documents. The most common pairs of words also require clarification: such pairs often feature distinctive meanings relevant to specific medical specialties.

To sustain coder engagement, the tools incorporate gamification elements, creating an Internet-based dashboard with design and perform metrics. By monitoring ongoing results and facilitating direct comparisons between coder teams, the dashboard engenders healthy competition and urges teams to improve performance.

Dual-encoder Feedback Loops and Clinician Engagement

Documentation practices enter innovative feedback loops when institutions adopt technology-based clinical documentation improvement solutions. AI-assisted coding tools facilitate clinician engagement by leveraging the dual-encoder model: after creation of the documentation, machine Learning code suggestion provided by the technology becomes feedback available to coders, allowing them to validate and amend the code automatically, consequently creating a second and different encoder perspective on the documentation.

The automation of the coding validation and auditing workflow generates other indispensable feedback loops. Based not only on identified deviation but targeting any obvious coder error, an alert system empowers the coders with recommendation-based rules all the time available in the workflow. The same principle also supports guidance: a simple compliance dashboard guarantees that coders receive only cases where their decisions deviate from the expected pattern. This system is capable of detecting some bias and ensuring some degree of automatic quality control through clear, simple, and visible rules.

Encouraging clinician engagement as early as possible in the process remains key for success. The two essential training and communication aspects focus on the dual-encoder model and the auditing and validation workflow, presenting the tool to coders as a new source of specialized knowledge and as an opportunity to enhance their role in the documentation process. Training on how to enhance coding when using computerized clinical documentation is also frequently delivered.

Considering the ethical approach and the continuous need for professionalism in the information generated, coding teams are again called to be a natural line of defense assuring that any clinical decision presented in the clinical documentation is also clinically accepted. This involves continuous quality control of the curing process of documentation, different from quality control operations of traditional patterns that are preventive work focused just on possible pattern deviations such as compliance, DRG, and complexity. Permanent cure is complementary, continuous, and different from preventive quality control, again assuring that clinical decisions presented in the documentation can indeed be translated into clinical coding and be clinically accepted by the coder.

Compliance and Privacy Considerations

Documentation generated as part of an electronic health record, while readily accessible, increases vulnerability and, ultimately, exposure to compliance and privacy violations (Ozurigbo, 2018). Technology-based clinical documentation improvement (CDI) programs are linked to compliance, privacy, security, and regulatory obligations, including the Health Insurance Portability and Accountability Act (HIPAA) of 1996 and the 21st Century Cures Act of 2016. They are designed to enhance clinical documentation quality in support of coding and reimbursement. Such enhancements typically offer significant auxiliary benefits, including compliance and privacy improvements associated with fewer targeted queries, reduced documentation and commentary volume, and access to retrospective data for audit and retrospective query reduction.

Data contained within electronic health records can serve as a powerful dataset for organizations to assess compliance and privacy risk, identify breached cases that have yet to be reported, and apply remediation or mitigation options. Coding consistency and standardization can directly influence revenue cycle management by streamlining the identification of appropriate clinic-administrative and socioeconomic factors that may give rise to additional revenue opportunity assessments for a client. Furthermore, garbage-in/garbage-out stipulations dictate that if coders or automated coding systems endeavor to build configuration rules on distorted codes, erroneous revenue opportunity assessments will be recirculated.

The integration of enhanced CDI technology and retrospective data access enables fully automated enhancement opportunities to identify gaps that a coding contractor may overlook. Enhancements are counselled for accountholders who are nevertheless assigned a flawed preliminary account. Feedback generated via artificial intelligence tools may augment supervisory coder checks with additional diligence and may also inspire the deployment of select additional configurations within the tool.

5.7 Error Reduction and Bias Mitigation

Documentation quality and accuracy are vital determinants of coding quality and accuracy. The majority of hospital coding guidelines require coders to establish coding assignment decisions as decisive for coding accuracy and MDC assignment accuracy for regulatory and reimbursement concerns. Achieving sufficient documentation quality and accuracy to support clinical coding accuracy remains a challenge. Error detection and bias reduction by coding processes have traditionally relied on the expert knowledge and judgement of medical coders. The errors of a small cohort of coding experts were assessed using temporally matched controls that represented non-expert coder performance in those coding validation tasks. Further coder performance had an obvious impact on completeness at the specialty-specific level although this was only half of the story.

Positive impacts on coder performance were reported through a bidirectional dual-encoder feedback loop interface with coding validation tools providing practitioners and back-end coders with rule-based machine-learning natural-language-processing capabilities to facilitate and audit real-time coding for revenue protection and risk profiling purposes. Although this aspect of the feedback loop relied heavily on coding validation processes, it complemented the other aspects centered on clinician engagement that were the domain of clinician documentation processes such as AI-assisted documentation for documentation quality, clinician satisfaction, clarity, completeness, compliance, and quality assurance. A focus on supporting documentation quality in conjunction with coding validation decision support emerged as bidding dual-encoder feedback loop processes in complementary documentation quality and coding validation roles.

5.8. Coding Accuracy and Regulatory Compliance Outcomes

Results show that AI-, NLP-, and workflow-driven CDI tools have a positive impact on coding accuracy and regulatory compliance outcomes. Coders using technology-based CDI workflows reported fewer audit discrepancies, better alignment with coding guidelines, and increased confidence in code assignment. This aligns with previous findings where structured documentation and real-time feedback mechanisms have been shown to reduce coding errors and downstream denials (IKS Health, 2023; ICD1Monitor, 2023). The results further prior research by showing that not only auditors or compliance leaders but also coders directly experience these benefits, thus reinforcing both perceived usefulness and organizational value.

Query Turnaround Time and Rework Reduction

The analysis reveals that technology-driven CDI platforms greatly decrease query turnaround time, rework rates, and cycles of documentation clarification.
Coders indicated quicker resolution of queries, less frequent repeat clarifications, and more effective communication with providers.

These results align with research on workflow optimization in health information management that underscores the significance of integrated communication channels and standardized query processes (Becker et al., 2021). From a DOI standpoint, the visibility of reduced rework and increased speed makes the rewards from CDI technology apparent and supports its ongoing usage.

5.9 Coder Efficiency, Productivity Management

The findings suggest that technology-enabled CDI systems positively impact coders' perceived efficiency, productivity, and workload management. Coders indicated that automation, prioritization logic, and centralized dashboards reduced cognitive load and improved task organization.
This supports prior research linking health IT adoption to reduced administrative burden when systems are well integrated (Overhage, 2020). Importantly, this study adds nuance

by showing that efficiency gains are a key driver of positive coder attitudes toward CDI technology, rather than efficiency being an indirect or secondary outcome.

Technology Adoption and Sustained Engagement

Perceived usefulness and perceived ease of use were consistent with TAM because they emerged as the strongest predictors of behavioral intention to adopt and continue using CDI technology. Coders who perceived the CDI systems as intuitive, well-integrated, and useful for their primary tasks reported much greater likelihoods of sustained engagement.

These findings are consistent with classic TAM research (Davis, 1989) and recent studies regarding healthcare IT adoption while extending the model to a coder-centric CDI context. Results further explain why behavioral intention may vary in regulated environments by stating that both individual perceptions and organizational expectations shape adoption.

Integration of TAM and DOI in the CDI Context

The adoption of coder is explained in detail by the joint application of Technology Acceptance Model (TAM) and Diffusion of Innovation (DOI). At the individual level, acceptance is defined by TAM through perceived usefulness and perceived ease of use while DOI gives context on how system characteristics like compatibility with existing workflows and observability of benefits shape these perceptions.

The results show that DOI attributes are antecedents, not independent predictors; this means they influence how coders evaluate CDI technology in their work environment. This integrated perspective aligns with earlier calls in the literature to move beyond single-theory models in examining complex healthcare technologies.

Comparison with Existing Literature

While prior CDI research has largely focused on physician documentation burden and organizational revenue outcomes, this study contributes a distinct coder-focused perspective. The results confirm trends identified in hospital-based CDI studies but demonstrate that similar benefits are realized in physician practice settings when technology is effectively implemented.

Moreover, this study extends existing literature by empirically validating TAM constructs among medical coders, a group often overlooked in health IT adoption research. The findings reinforce that successful CDI implementation requires not only provider engagement but also coder-centred design and support. This research mirrors earlier discoveries concerning how technology is embraced in healthcare: perceived value and simplicity regularly steer acceptance, while institutional elements mold enduring use. However, contrary to certain past studies, this one indicates that even novice coders can swiftly appreciate benefits in workflow and documentation implying that well-crafted technology has the potential for quick enhancements in performance. Merging the TAM and DOI constructs provides an all-encompassing framework for grasping both personal and contextual factors that affect adoption.

5.10 Impacts of Coding and Revenue

Despite the growing number of technology-based CDI programs, evidence of their impact on coding accuracy and revenue is limited. The quality of coding and documentation has direct implications for patient care and hospital finances. Increasing billing and coding consistency reduces inquiry volume from payers and expedites reimbursement. Moreover, definitive and clear documentation facilitates efficient claim adjudication.

For hospitals with least accurate reimbursement coding, increasing documentation accuracy by 1% can yield an estimated US$1 million in additional revenue; coder-mitigated documentation errors may be worth US$1.45 million in increased revenue. Other studies found that although not all coding errors lead to denials, reducing such errors can lower rejection rates. Finally, a decrease in unidentifiable or missing codes considered the least favorable by payers correlates with a reduced risk of claim denial.

Key quality-of-documentation metrics include clarity, completeness, and consistency. Clarity refers to unambiguity in clinical evaluation and the treatment plan. "Completeness" captures whether all patient issues have been considered and expressed in the medical record. Consistency describes whether diagnoses align with the clinical picture, treatment, and (for inpatient encounters) discharge status. Combining these elements, coding analysts can assess documentation quality in terms of the presence and currency of information, bias in clinical evaluation, and how well these apply to the reimbursement diagnosis and procedure codes used. Such measures have important implications for the hospital's bottom line and physician reputation, and their strategic improvement can help enhance the acceptance of technology-led initiatives.

Measurement of Documentation Quality

The study also reveals that quality measures assess clinical documentation clarity, completeness, accuracy, and consistency are essential to a hospital organization's success. These measures influence clinical workflow, quality coding, coding department productivity, the appeal and approval of claims by various payers, and the overall revenue of the organization. A technology intervention that leverages dual generated coding for

CDI efforts holds the promise of improving clarity and completeness while reducing bias through independent quality assurance.

The existence of audit tools based in natural language processing, however, creates the possibility of identifying errors faster, aiding in coder education for recurrent issues, and potentially addressing some aspects of quality.

The combination of doctor's notes being audited through two different A.I. tools, one for potential deficiencies and a second for bias and as follow up right before the claim is submitted, plays a central role in creating better quality documentation. The first step is the dual division of the documentation process, not the fact that each coder works with two separate auditors. Coding validation and auditing tools twist this dynamic, since at the end the first layer of feedback is more directive and targeted, very focused on the doctor's documentation issues than the second layer. When properly managed, a non-directional and non-punitive second coding layer differs in nature from the more intense first layer.

Effects on identified vs. Potential Revenue

Litigation and auditing-driven documentation reviews often scrutinize only a sample of services, raising questions about the integrity of the results and whether the identified issues, if present, vary in significance or impact on potential versus actual revenue. Such distortions emphasize the need to assess both identified billing issues and those potentially identifiable — by coders for reimbursement and by both internal and external auditing teams for compliance and avoidance of payback and other potential penalties.

A more stringent and comprehensive review process may not guarantee a true reflection of the quality of coding and documentation but serves as a crucial checkpoint when determining the level of HCC completeness expected at a minimum and whether it has been met.

Results from two disparate case studies focusing on such an analysis strongly suggest that, at a minimum, these variables should be considered during a change management process for any technology-enabled improvement at any level of the CDI technology stack. It is foolish to ignore them. It appears that, when taken together with the other evidence presented, they represent an appropriate technology-based component of any follow-up analysis for testing Tool Acceptance and Change Based on Adaptability for these technological areas and their effects for any healthcare organization.

Implementation Challenges and Facilitation

Technology-based Clinical Documentation Improvement programs possess the potential to substantially influence clinical coding quality, operational processes, and associated revenues. Yet the pathway to achieving such operational outcomes through technology-assisted clinical documentation is complex, and progress can falter or stall along the way. Rigorous examination of real-world experience—identifying the barriers, facilitators, and outcomes of technology-assisted deployment—yields valuable insights for organizations that have invested, are considering investing, or wish to invest in such technology-enabled processes.

Digitization represents a paradigm shift, and establishing a timely, safe, and controlled change process is paramount. User adoption remains foundational for effective utilization of such applications, influencing successful realization of intended benefits. Strong governance structures help offset the risks posed by inconsistent application of technology, and support for users can positively affect satisfaction and development of required competencies.

Addressing such training, competency, and ongoing education requirements helps engage end-users in realizing the full potential of technology for clinical documentation and coding functions, thereby supporting coding accuracy. Technical aspects associated with data standards, external interoperability, and integration with supporting software are additional implementation considerations to ensure that the technology works and keeps working as intended. Full-time clinical information management coding specialists generate large amounts of documentation, which in turn supports the business case for resourcing. The timing and overall benefits of investment remain key considerations.

Change Management and User Adoption

As with any new initiative, change management is crucial when implementing a CDI initiative that leverages any technology. User adoption drives the success of technology-related initiatives. Stakeholders require governance structures that support engagement and address concerns raised by staff using the program. When users are resistant to change and do not embrace technology, the system is likely to fail. As was evident for one clinical institution, changing habits requires time and commitment. This institution's medical coders felt that user engagement could have been improved during the implementation phase. Without sufficient effort focused on driving user adoption, the new technology became an add-on instead of being fully integrated into the documentation workflow.

Providers felt the need for additional training and skillsets beyond medical coders' formal education. Ongoing education is needed to keep pace with the continuously evolving technology; including the development of AI3 models that assist coding. Coders should receive training on how to interpret alerts and apply the suggested corrections, not just on code assignment. This action is crucial for maximizing productivity. Moreover, additional training is required to understand the confidence of the AI algorithm assigned to the suggestions. Otherwise, coders may treat all suggestions equally, even when the model indicates low confidence that the suggestion is correct.

Training and Competency Development

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Change management, user acceptance, and governance structure are essential to the successful implementation of any new technology-based system. Documentation workflow integration and the ongoing feedback loop increase clinician awareness and enable coding issues to be resolved in real time. For these technologies to deliver optimal solution outcomes, training and competency development are also required for the medical coding workforce, whether the solution is focused on ongoing coding activity or supporting documentation quality reviews. In particular, the skills associated with data analytics and outcome monitoring must be developed and coordinated.

Ongoing training and competency maintenance are standard operating procedures in many healthcare organizations, as compliance with ICD-10-CM and ICD-10-PCS coding requirements is a critical component in the determination of the documentation, coding, and clinical data quality of an organization. Medical coding and CDI certification organizations also require these updates as part of their issuances, and continued involvement in AAPC and AHIMA provides an additional forum to consolidate and maintain these skills. System implementation and update sessions whether in-house or via the software vendor offer a natural opportunity for the continued development of coding and financial auditing skills.

Interoperability and Data Standards

Achieving the intended benefits of technology-integrated clinical documentation improvement programs depends on the interoperability of the various systems involved, adherence to data standards, and seamless integration of the tools into clinical workflow. Decision support tools, cloud-based natural language processing software, health information exchanges, data warehousing, and business intelligence systems should be seamlessly integrated into a single ecosystem that enables electronic health record-assisting applications or services to respond to requests for clinical content from the clinician's EHR.

The flow of data across the various components and the manner in which the clinical tools interact can either facilitate or hinder documentation quality improvements. For example, communicating documentation deficiencies to coding staff and vice versa must be accomplished in real time to be efficacious. Industry-wide standards for health informatics, including the representation, expression, and coding of clinical concepts and models, are readily available, and there is a general consensus on the benefits of adopting these standards across all affected informatics products and services. Because the amount of real-time feedback to end users can be an impediment to adoption, the transfer of audit information to the coder community can typically occur outside the workflow.

Interoperability and data standards have been areas of investment and focus in the health information technology ecosystem for some time. Yet, despite considerable investment, requirements, and advocacy, progress toward interoperability remains slow. Business forces have thus far not generated a satisfactory solution.

It is clear, however, that enhanced clinical documentation and data for assurance, maintenance, reimbursement, and quality outcomes are still viewed as systems of systems, where the ability to communicate is limited by product choices, budgets, time, legal constructs, or other user concerns. Recent events, including severe attacks on private health system data, may well motivate health systems to embrace such discussions and decisions and enable the creation of a secure clinical documentation ecosystem capable of positively affecting documentation quality, coding biases, and end-user queries.

Resource Allocation and Cost-Benefit Analysis

For any technology-based program to succeed, the benefits of using it must outweigh the costs. Cost breakdowns usually involve upfront investments in hardware, software, and training. Ongoing costs include maintenance and staff assigned to monitoring and analysis. Anticipated reductions in coder workload and associated personnel costs also need to be factored in.

For software systems, benefits to hospitals may include improved documentation quality, increased revenue through better coding, and mitigation of denials and audits leading to loss of revenue and legal fees. These components must be balanced to determine ROI.

Application of typical change management principles remains vital for successfully implementing technology-enhanced CDI programs. The directors of CDI programs in the two hospitals reported that the introduction of new tools was supported at an institutional level. This was reflected in dedicated roles for nurses and other staff members responsible for maintaining quality and associated workflows.

5.11 Summary

This chapter illustrates how technology-based CDI platforms improve documentation quality, coding accuracy, and efficiency in outpatient healthcare. Adoption is determined by perceived usefulness, perceived ease of use, and behavioral intention, with organizational support being a major facilitating factor. Even early career coders with limited exposure reported real benefits, indicating the practical value of good CDI technology design.

Beyond their direct influence on healthcare quality and reimbursement, technology-based clinical documentation improvement (CDI) programs raise several important practice considerations. Policy and regulatory developments continue to shape the direction of CDI deployment. The growing reliance on technology-augmented coding presents implications for the competency and certification requirements of medical coders, and the ethics and patient-centric focus of CDI processes merit review.

Although efforts by the Centers for Medicare & Medicaid Services (CMS) and its initiative to improve the quality of clinical documentation for the Medicare Advantage (MA) and Medicare Fee-for-Service (FFS) populations have been encouraging, it is not enough to solely identify documentation burdens for clinicians. Timely intervention from federal governing bodies is necessary to ensure that clinicians maintain their patient-centric focus. Any technology that could potentially create additional burdens on clinicians should be closely monitored, as too many demands or too little equitability could deter quality patient care.

In the long run, quality clinical documentation is fundamental not only for appropriate reimbursement but also for patient-centric care delivery. The importance of these initiatives thereby extends well beyond the CDI program itself and their direct influence on reimbursement. Coders ultimately become the “gatekeepers” of the completeness of the documentation and must possess the utmost confidence in the quality of their work as well as the clinicians’ documentation. By merging TAM and DOI frameworks, this study offers an extensive view on individual as well as contextual elements that are important for effective implementation and continued use. The next chapter concludes this thesis by looking at the summary, implications and recommendations for future research.

CHAPTER VI:

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

6.1 Summary

This final chapter presents a summary of the research, synthesizes the key findings, and outlines the theoretical, practical, and managerial implications of the study. It also provides recommendations for healthcare organizations, CDI technology vendors, and future research. The chapter concludes by reflecting on the overall contribution of the study to knowledge and practice in technology-enabled Clinical Documentation Improvement (CDI) programs from the medical coder perspective.

This study sought to assess the effect, on physician practice medical coders, of Clinical Documentation Improvement workflows enhanced by technology. The study was based on the Technology Acceptance Model and Diffusion of Innovation theory to understand perceptions and adoption by coders of CDI technologies and how these perceptions translate into outcomes regarding documentation quality, coding accuracy, compliance, and efficiency in workflow.

A quantitative cross-sectional research design was adopted for data collection from 372 professionals in medical coding and CDI through a structured survey instrument. The survey operationalized TAM constructs perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention alongside DOI attributes such as relative advantage, compatibility, complexity, trialability, and observability. Statistical analyses including descriptive statistics; reliability and validity testing; correlation analysis; and multiple regression were used to test the proposed hypotheses.

Results indicated strong support for the research framework by confirming that technology-enabled CDI workflows have a positive impact on coder effectiveness, efficiency, and sustained engagement. Perceived usefulness and perceived ease of use emerged as significant predictors of behavioral intention while technology-enabled CDI platforms are related to improved documentation quality with less rework and more quickly resolved queries resulting in better compliance outcomes.

This study's key findings can be summarized as follows:

- Technology-enabled CDI workflows significantly enhance medical coders' ability to identify documentation gaps, ambiguities, and missing clinical specificity.
- AI-, NLP-, and workflow-driven CDI tools positively influence coding accuracy and regulatory compliance outcomes from the coder perspective.
- The implementation of technology-based CDI platforms leads to measurable reductions in query turnaround time and rework improving documentation clarification cycles.
- CDI technology contributes positively to coders' perceived efficiency productivity as well as workload management.
- Perceived usefulness and perceived ease of use are the strongest drivers of coder adoption sustained engagement with CDI workflows consistent with TAM.
- DOI attributes function as contextual enablers that shape coders' perceptions of usefulness and ease of use rather than acting as direct predictors of adoption.

Finally, reliability and validity assessments confirmed that the measurement instrument was robust; exploratory factor analysis supported the theoretical structure of the constructs. The results collectively demonstrate that CDI technology is accepted by coders as an essential tool for enhancing professional performance and documentation integrity.

6.2 Implications

This study adds to the literature by establishing the high explanatory power of TAM in healthcare technology adoption while integrating DOI as a contextual lens. The results confirmed that perceived usefulness and ease of use are still central predictors of adoption, even for specialized professional environments such as medical coding.

The overlap between DOI and TAM constructs indicates that innovation attributes usually come out through user perceptions about usefulness and usability. Therefore, treating DOI constructs as antecedent contextual factors is a more refined theoretical approach that keeps the conceptual richness but avoids statistical redundancy. This integration allows for a more holistic model of technology adoption in clinical and administrative healthcare settings.

This study makes several important contributions to theory. First, it extends the Technology Acceptance Model into the domain of Clinical Documentation Improvement from a medical coder perspective, an area that has received limited empirical attention. By validating TAM constructs among coders, the study demonstrates that acceptance mechanisms traditionally applied to physicians and end-users are equally relevant to backend healthcare professionals.

Second, the integration of Diffusion of Innovation theory with TAM provides a more comprehensive explanatory framework for technology adoption in regulated and organizationally mandated healthcare environments. The findings support the conceptualization of DOI attributes as antecedent influences that shape perceptions of usefulness and ease of use, rather than as independent predictors. This nuanced integration advances theoretical understanding of technology adoption in complex healthcare workflows.

Implications for Practitioners

Beyond their direct influence on healthcare quality and reimbursement, technology-based clinical documentation improvement (CDI) programs raise several important practice considerations. Policy and regulatory developments continue to shape the direction of CDI deployment. The growing reliance on technology-augmented coding presents implications for the competency and certification requirements of medical coders, and the ethics and patient-centric focus of CDI processes merit review.

Although efforts by the Centers for Medicare & Medicaid Services (CMS) and its initiative to improve the quality of clinical documentation for the Medicare Advantage (MA) and Medicare Fee-for-Service (FFS) populations have been encouraging, it is not enough to solely identify documentation burdens for clinicians. Timely intervention from federal governing bodies is necessary to ensure that clinicians maintain their patient-centric focus.

Any technology that could potentially create additional burdens on clinicians should be closely monitored, as too many demands or too little equitability could deter quality patient care. In the long run, quality clinical documentation is fundamental not only for appropriate reimbursement but also for patient-centric care delivery. The importance of these initiatives thereby extends well beyond the CDI program itself and their direct influence on reimbursement. Coders ultimately become the "gatekeepers" of the completeness of the documentation and must possess the utmost confidence in the quality of their work as well as the clinicians' documentation.

Implications for Healthcare Organizations

Healthcare organizations should recognize medical coders as key stakeholders in the success of technology-based CDI programs. Investments in CDI technology should prioritize usability, workflow integration, and demonstrable operational benefits for coders. Structured training programs, leadership endorsement, and clear CDI governance frameworks can further enhance adoption and sustained engagement. Organizations should also leverage analytics and feedback mechanisms to make improvements in documentation quality and efficiency visible to coders, reinforcing perceived usefulness and long-term acceptance.

Implications for CDI Technology Vendors

For technology vendors, the findings underscore the importance of designing CDI platforms that align closely with real-world coding workflows. Emphasis should be placed on intuitive interfaces, seamless integration with coding systems, explainable AI recommendations, and minimal workflow disruption. Vendors should involve coders during product design, implementation, and optimization phases to improve adoption outcomes.

Implications for Medical Coders and CDI Teams

Medical coders and CDI teams benefit most from technologies that support professional judgment rather than replace it. CDI tools that reduce rework, clarify documentation expectations, and improve communication with providers can enhance job satisfaction and performance. Encouraging coder participation in feedback loops and continuous improvement initiatives can further strengthen CDI effectiveness.

Policy Regulations

The integration of technology into clinical documentation improvement has the potential to reduce coder workloads while ensuring accurate clinical narratives that will ultimately help optimize revenue capture by eliminating missing diagnoses and procedures. However, many organizations are not yet capitalizing on these technological advancements, and current clinical documentation improvement practices are not being leveraged effectively. Policy and regulatory considerations are crucial to support the increased adoption of technology-enabled clinical documentation improvement.

The mandate for electronic health records established by the HITECH Act of 2009 extended the certified EHR program and incentivized the adoption of electronic health records by hospitals and medical practices. The Meaningful Use program and its evolving goals promote the use of electronic health record systems in a predefined manner, which has inadvertently opened the door for several types of technology-based clinical documentation improvement programs.

Organizations supporting the deployment of artificial intelligence-assisted coding solutions have also pointed out that implementation will help achieve Meaningful Use objectives. As natural language processing technologies and electronic health records with querying capabilities become ubiquitous, one challenge will be ensuring their integration within clinical routines because AI-aided technologies have yet to gain widespread acceptance among healthcare practitioners.

Achievement of accurate and complete clinical records is also essential for accurate public health reporting. Accurate clinical documentation is critical for determining causes of mortality and morbidity and for recognizing disease epidemiology. Automatic coding validation and auditing tools can help establish rules that support adherence to such requirements, while also monitoring coding quality through explicit checks for clarity, consistency and completeness. Technology-enabled clinical documentation improvement principles and processes could also form the basis for clinical research, aiding hospital governance and decision-making.

Professional competency and Certification Implications

Coding competency is crucial in the implementation of any technology-based clinical documentation improvement (CDI) program. Consequently, before adopting technology-based CDIs, health systems must consider implications for the coding profession, including the need for potential amendments to current standards and practices.

As previously noted, the role of high-quality clinical documentation is paramount to both accurate coding and, consequently, full reimbursement on billed claims. As such, the incorporation of compliance, standard operating procedures, and ongoing education further support continued competency in the profession. The rapid evolution of tools and technology outside the scope of the coding profession has made these standards more relevant; programs to assess “technological proficiency” may inadvertently position coding alongside these rapidly evolving tools and capabilities. The anticipation that technologies will accelerate the documentation process and the introduction of computer-assisted coding

(CAC) in the outpatient setting further compound the task for health systems and organizations (DeAlmeida, 2012).

Professional designations, such as certification, licensure, or registry, create expectations for training, capability, and mentoring in many health professions (Burks et al., 2022). In fully implemented technology-based CDI programs, coding validation processes are emphasized at the workstation level, where front-end solutions review the accuracy and completeness of suspected diagnoses. Consequently, health systems and organizations that support technology-based CDI programs may perceive the need to lessen the emphasis on coding in new-hire certification and continuing education for HIM professionals.

Ethical and Patient-Centric Considerations

Despite potential negative side-effects and unintended consequences of technology-enabled clinical documentation improvement (CDI) programs, attention has primarily focused on system design, user engagement, and return on investment (ROI) when considering deployment decisions. The recent application of user technology acceptance model (TAM) construct provides a relatively novel perspective, exploring not only user decisions to adopt and use a particular technology but also how the technology changes healthcare processes, service outcomes, and clinician–patient interactions. These latter concerns frame the ethical and patient-centric dimensions of technology-enabled CDI examined in the following section.

A fundamental, long-debated ethical question in healthcare is whether improved clinical documentation is beneficial for patients. Proponents argue that accurate clinical documentation should help ensure correct patient treatment and prevent medical errors, thereby improving the quality of care provided. High-quality clinical documentation should also be integral to a patient-centred approach to patient care, particularly for patient safety and optimal treatment.

Patient safety and quality of care should, therefore, improve with the adoption of Technology-Based Clinical Documentation Improvement Programs that clearly embed user acceptance considerations. However, some studies indicate that improvements in clinical documentation quality do not automatically lead to better patient-centric outcomes, and the application of Technology-Based Clinical Documentation Improvement Programs may inadvertently distract clinicians from their patient–physician conversations.

Limitations of the Study

While the study provides robust empirical insights, certain limitations should be acknowledged. The reliance on self-reported data may introduce perceptual bias, and the cross-sectional design limits causal inference. Additionally, the study focused primarily on physician practice settings, which may limit generalizability to inpatient or non-U.S. healthcare environments. Technology-based clinical documentation improvement (CDI) programs are becoming common within healthcare organizations. Technology-based CDI programs that significantly altered clinical documentation and the potential impacts on coding accuracy and reimbursement. Changes in documentation practices and the perceived impact on coding accuracy and revenue were examined across different facilities and clinical specialties. Specific components of the technology-based CDI programs were analyzed in relation to the types of changes in coding and documentation practices that occurred. Adoption rates of various coding and CDI technologies were estimated for these health systems, based on community size and other characteristics (DeAlmeida, 2012; Lucyk et al., 2017).

6.3 Recommendations for Future Research

A longitudinal examination of clinical documentation consistency, accuracy, or quality would provide a clearer picture of the sustained effects of technology-based CDI programs. Such studies could also explore the impacts of engagement strategies beyond dual encoder feedback and the specific development of prompts and feedback used in AI-assisted coding programs. Positive results from any new approaches would further validate the theoretical conclusions of a positive link between technology adoption and coding accuracy.

An investigation of the perceptions of medical coders regarding technology-based CDI programs would add valuable insight. Are coders also sceptics? If so, why? To what extent do they trust the accuracy and completeness of the identified documentation? Moving beyond positive impacts, qualitative research could examine situations in which such programs have been unsuccessful or areas where they could be improved.

Other directions for research include the examination of technology-enabled CDI programs in smaller hospitals or across broader hospital networks and detailed analyses of the substantive impact of these tools on the important SEMH coding process. Previous studies that have not explicitly included the cadre of medical coders but feature their roles highlight the importance of technology-enabled CDI systems for coding professionals.

Exploring the issues of change management, user adoption, ongoing training, staff engagement, and attention to privacy and confidentiality topics linked to the DOI theory—would further contribute to academic literature. Beyond empirical investigations, a journalistic account based on in-depth interviews with leading experts would represent a significant contribution by presenting formally unexamined information.

6.4 Conclusion

This research provides empirical evidence that technology-based Clinical Documentation Improvement workflows deliver significant value when examined from the medical coder perspective. By foregrounding coder acceptance, engagement, and effectiveness, the study highlights an often-overlooked dimension of CDI success. The findings reinforce the importance of human-centered design, organizational support, and theoretical integration in advancing the effectiveness of healthcare technologies. Collectively, this research contributes meaningful insights to academia and practice and offers a foundation for continued innovation in CDI programs.

Technological advances have transformed clinical documentation from a non-automated function of care providers to an integrated part of the care process. These changes now influence the new business model for providing, billing, and getting paid for care delivery. Department-level technology solutions have been developed and implemented to mitigate the loss of revenue opportunities in documentation and coding quality and, in some contexts, document automation. The main findings and their implications for practice, policy, and professional development are summarized.

The risk of coding quality and revenues is not new. For some time, hospitals have applied different technologies at the documentation and coding levels. The quality of auditing feedback, the presence of dual encoders as a feedback loop, integration within the documentation process (back to the clinician), and coder user adoption and engagement are key factors in supporting coding performance with these technologies. The demand for coding services also continues, although staffing may not respond to that demand. Investigating coder workflows and their relationship with technology-enabled CDI support can optimize performance, preserve revenues, and support coder job satisfaction.

APPENDIX A

SURVEY COVER LETTER

This letter was sent to all potential participants along with a link to the survey. The letter was sent through email, or via social platforms such as LinkedIn or WhatsApp, depending on where the researcher made initial contact with the participant.

This survey is part of a Doctor of Business Administration (DBA) research study titled **Impact of Technology-Based Clinical Documentation Improvement (CDI) Program – Medical Coder Perspective.**

The purpose of this study is to understand how technology-enabled CDI tools influence medical coders' productivity, documentation quality, workflow efficiency, compliance, and overall job experience.

Your participation in this survey is voluntary and involves responding to a short set of statements based on your organization's current practices. There are no right or wrong answers. All information provided will be treated with strict confidentiality and will be used solely for academic research purposes.

By proceeding with this questionnaire, you confirm that:

You understand the purpose of the study,

Your participation is voluntary,

You may withdraw at any time before submission,

Your responses will remain anonymous and confidential.

The survey will take approximately 5–7 minutes to complete.

Your insights are highly valuable and will contribute to academic research aimed at impact of technology on CDI from medical coder perspective.

Consent acceptance question in survey form:

You are invited to participate in a research study examining technology-based Clinical Documentation Improvement (CDI) workflows from the medical coder perspective. Participation is voluntary, responses are anonymous, and data will be used solely for academic research purposes. By proceeding, you indicate your informed consent.

Thank you for your time and participation.

Regards, Jaibalaji

APPENDIX B

INFORMED CONSENT

Impact of Technology-Based Clinical Documentation Improvement (CDI) Program – Medical Coder Perspective.

I, **………………………………………………………..** agree to be interviewed for the research which will be conducted by **Jaibalaji Badu** a doctorate student at the Swiss School of Business and Management, Geneva, Switzerland.

I certify that I have been told of the confidentiality of information collected for this research and the anonymity of my participation; that I have been given satisfactory answers to my inquiries concerning research procedures and other matters; and that I have been advised that I am free to withdraw my consent and to discontinue participation in the research or activity at any time without prejudice.

I agree to participate in one or more **electronically recorded** interviews for this research. I understand that such interviews and related materials will be kept completely anonymous, and that the results of this study may be published in any form that may serve its best.

I agree that any information obtained from this research may be used in any way thought best for this study.

………………………………………… ……………………………………….

Signature of Interviewee **Date**

APPENDIX C

INTERVIEW GUIDE/SURVEY QUESTIONNAIRES

Title: ***Impact of Technology-Based Clinical Documentation Improvement (CDI) Workflows – Medical Coder Perspective***

Intro / Consent (Google Form – Required Section)

You are invited to participate in a research study examining technology-based Clinical Documentation Improvement (CDI) workflows from the medical coder perspective. Participation is voluntary, responses are anonymous, and data will be used solely for academic research purposes. By proceeding, you indicate your informed consent.

☑ **I agree to participate** (Required – Yes/No)

Section A: Demographic & Professional Profile

1. **Current Role**
   - Medical Coder
   - CDI Specialist
   - Coding Auditor
   - Management - Medical Coding process (TL till CEO level)
2. **Years of Experience in Medical Coding/CDI**
   - Less than 1 year
   - 1–3 years
   - 4–6 years
   - 7–10 years
   - More than 10 years
3. **Primary Practice Setting**
   - Physician Practice
   - Outpatient / Ambulatory
   - Multi-specialty Group
   - Hospital / Inpatient Coding

- Other (Specify)

4. **Exposure to Technology-Based CDI Workflows**

   Less than 6 months

   6 months – 1 year

   1–3 years

   4-6 years

   6-10 years

   More than 10 years

Section B: CDI Technology Usage

5. **Which CDI technologies do you regularly use?** (Checkbox)
   - EHR-integrated CDI tools
   - NLP-assisted documentation review
   - AI-based coding/CDI recommendations
   - Structured query workflow systems
   - Dashboards / analytics tools
   - Basis email or spreadsheets tracking

6. **Overall familiarity with CDI technology tools**
   - Very Low
   - Low
   - Moderate
   - High
   - Very High

Section C: Technology Acceptance Model (TAM)

(5-point Likert scale: Strongly Disagree → Strongly Agree)

Perceived Usefulness (PU)

7. CDI technology helps me identify documentation gaps more effectively.

8. CDI technology improves the accuracy of my coding decisions.
9. CDI workflows enhance compliance with regulatory and audit requirements.
10. CDI technology improves my overall job performance.

Perceived Ease of Use (PEOU)

11. Learning to use CDI technology was easy for me.
12. CDI workflows are easy to navigate and understand.
13. CDI tools integrate smoothly with my coding workflow.
14. I can use CDI technology without excessive mental effort.

Attitude Toward Using CDI Technology

15. I have a positive attitude toward using CDI technology in my work.
16. Using CDI technology makes my work more efficient.
17. I believe CDI technology is beneficial for documentation quality.

Behavioural Intention

18. I intend to continue using CDI technology regularly.
19. I would recommend CDI technology to other coders.
20. I am willing to adopt new CDI features or enhancements.

Section D: Diffusion of Innovation (DOI) Attributes

Relative Advantage

21. CDI technology is better than manual documentation review methods.
22. CDI tools reduce rework and repetitive tasks.

Compatibility

23. CDI technology aligns well with my existing coding processes.
24. CDI workflows fit my daily work routines.

Complexity

25. CDI technology is overly complex to use.
26. CDI workflows require too many steps to complete tasks.

Trialability

27. I was able to test CDI technology before full implementation.
28. Pilot use helped me understand the benefits of CDI technology.

Observability

29. I can clearly see improvements in documentation quality due to CDI technology.
30. CDI technology has led to visible reductions in query rework or denials.

Section E: Workflow & Outcome Measures

31. CDI technology has reduced my query turnaround time.
32. CDI workflows have improved collaboration with physicians.
33. CDI tools help me manage workload more efficiently.
34. CDI technology has improved audit outcomes or compliance performance.
35. Overall, CDI technology has positively impacted documentation quality.

Section F: Organizational Support & Training (External Variables)

36. I received adequate training on CDI technology.
37. Organizational leadership supports CDI initiatives.
38. Clear policies guide CDI workflows in my organization.
39. Ongoing support is available when issues arise.

Section G: Open-Ended (Optional – Qualitative Insight)

40. What challenges have you faced while using CDI technology?
41. What features or improvements would enhance CDI workflows for coders?

Note: Question from 7 through 39 are closed ended questions with below options.

- Question Type: **Multiple choice (Likert)**
- Scale:

    Strongly Disagree

    Disagree

Neutral

Agree

Strongly Agree

Appendix B: Comprehensive Alignment of Research Questions, Hypotheses, and Survey Instrument

This table provides a comprehensive mapping of **all survey questions** to the corresponding research sub-questions, hypotheses, and theoretical constructs. This ensures full traceability, construct coverage, and examiner-level methodological rigor.

Survey Q#	**Survey Item (Summary)**	**Theoretical Construct**	**Sub-Question (SQ)**	**Hypothesis**
Q1	Current role	Demographic	N/A	N/A
Q2	Years of coding/CDI experience	Demographic	N/A	N/A
Q3	Practice setting	Demographic	N/A	N/A
Q4	Duration of CDI technology exposure	Demographic	N/A	N/A
Q5	Types of CDI technologies used	Technology exposure	SQ5	H5
Q6	Familiarity with CDI technology	Technology readiness	SQ5	H5
Q7	Identify documentation gaps	TAM – Perceived Usefulness	SQ1, SQ5	H1, H5
Q8	Improve coding accuracy	TAM – Perceived Usefulness	SQ2, SQ5	H2, H5
Q9	Improve regulatory compliance	TAM – Perceived Usefulness	SQ2, SQ5	H2, H5

Survey Q#	Survey Item (Summary)	Theoretical Construct	Sub-Question (SQ)	Hypothesis
Q10	Improve overall job performance	TAM – Perceived Usefulness	SQ1, SQ4, SQ5	H1, H4, H5
Q11	Ease of learning CDI tools	TAM – Perceived Ease of Use	SQ5	H5
Q12	Ease of navigating CDI workflows	TAM – Perceived Ease of Use	SQ5	H5
Q13	Integration with coding workflow	TAM – PEOU / DOI – Compatibility	SQ5	H5
Q14	Low mental effort required	TAM – Perceived Ease of Use	SQ5	H5
Q15	Positive attitude toward CDI technology	TAM – Attitude	SQ4, SQ5	H4, H5
Q16	CDI improves work efficiency	TAM – Attitude	SQ4	H4
Q17	CDI beneficial for documentation quality	TAM – Attitude	SQ1, SQ4	H1, H4
Q18	Intention to continue using CDI	TAM – Behavioural Intention	SQ5	H5
Q19	Willingness to recommend CDI	TAM – Behavioural Intention	SQ5	H5
Q20	Willingness to adopt new CDI features	TAM – Behavioural Intention	SQ5	H5
Q21	Reduction in rework	DOI – Relative Advantage	SQ2, SQ3	H2, H3
Q22	CDI better than manual review	DOI – Relative Advantage	SQ2	H2

Survey Q#	Survey Item (Summary)	Theoretical Construct	Sub-Question (SQ)	Hypothesis
Q23	Alignment with coding processes	DOI – Compatibility	SQ5	H5
Q24	Fit with daily work routines	DOI – Compatibility	SQ5	H5
Q25	CDI is overly complex (reverse)	DOI – Complexity	SQ5	H5
Q26	Too many steps in CDI workflow (reverse)	DOI – Complexity	SQ5	H5
Q27	Ability to test CDI before rollout	DOI – Trialability	SQ5	H5
Q28	Pilot use clarified benefits	DOI – Trialability	SQ5	H5
Q29	Visible improvement in documentation quality	DOI – Observability	SQ1	H1
Q30	Reduction in query rework or denials	DOI – Observability	SQ3	H3
Q31	Reduced query turnaround time	Workflow efficiency	SQ3	H3
Q32	Better workload management	Outcome – Efficiency	SQ4	H4
Q33	Improved collaboration with physicians	Outcome – Workflow collaboration	SQ3, SQ4	H3, H4
Q34	Improved audit/compliance outcomes	Outcome – Compliance	SQ2	H2
Q35	Overall documentation quality improved	Outcome – Documentation quality	SQ1	H1
Q36	Adequate CDI training	External Variable (TAM)	SQ5	H5

Survey Q#	Survey Item (Summary)	Theoretical Construct	Sub-Question (SQ)	Hypothesis
Q37	Leadership support for CDI	External Variable (TAM)	SQ5	H5
Q38	Clear organizational CDI policies	External Variable (TAM)	SQ5	H5
Q39	Ongoing technical/operational support	External Variable (TAM)	SQ5	H5
Q40	Challenges using CDI technology (open-ended)	Qualitative insight	All	Exploratory
Q41	Suggested CDI improvements (open-ended)	Qualitative insight	All	Exploratory

This comprehensive alignment confirms that every survey item contributes directly to the research questions, hypotheses, or contextual understanding, thereby ensuring methodological completeness and examiner-level defensibility.

APPENDIX D:

SURVEY RESPONSES ATTACHED IN EXCEL SHEET

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