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Email : editorijhess@gmail.com

Design Af A Computer-Assisted Coding System With Rule-Based Validation Based On ICD-10 At STIKES Wira Medika Bali

Ni Luh Dwie Ratna Dewati Saraswati[1)], Ika Setya Purwanti[2)], Made Wahyu Aditya[3)]
[1,2,3)] Medical Records and Health Information Study Program, Diploma Three Program,
Sekolah Tinggi Ilmu Kesehatan Wira Medika Bali, Denpasar, Indonesia

*Corresponding Author
E-mail: radew1225@gmail.com

Abstract

The coding of diagnoses and procedures is a critical activity in health information management, yet it remains prone to errors that affect claim accuracy and the financial sustainability of healthcare facilities. Inaccurate coding can lead to upcoding or downcoding, both of which carry administrative and financial risks. This study aims to design a Computer-Assisted Coding (CAC) system with rule-based validation based on the International Classification of Diseases, 10th Revision (ICD-10), tailored to the learning environment at STIKES Wira Medika Bali. A qualitative descriptive approach using a system design research methodology was employed. Data were collected through literature review and observation of the diagnosis-coding learning process at the Medical Records Management Laboratory. The analysis identified functional requirements for accepting diagnosis input, facilitating ICD-10 code search, and providing automatic validation notifications based on predefined rule-based criteria. The system design produced a flowchart, Context Diagram, Data Flow Diagram (DFD), Entity Relationship Diagram (ERD), and a user interface prototype comprising a login page, a main page with diagnosis input and code-search features, and validation result notifications. The resulting design provides a structured foundation for developing a fully functional CAC application that supports more systematic, accurate, and efficient diagnosis coding education.

Keywords: ***Computer-Assisted Coding; Rule-Based Validation; ICD-10; Diagnosis Coding; Health Information Management***

INTRODUCTION

Medical records, according to the Regulation of the Minister of Health of the Republic of Indonesia No. 24 of 2022, constitute documents containing patient identity, examinations, procedures, treatments, and other services provided to patients. One essential stage in hospital medical records management is the coding process—the activity of assigning codes to diseases or procedures using letters and numbers in accordance with the latest standards, namely the International Statistical Classification of Diseases and Related Health Problems (ICD). With the advancement of digital technology, medical records management has progressively shifted toward electronic systems while maintaining the principles of data security, confidentiality, and integrity (Peraturan Menteri Kesehatan RI, 2022).

Ministerial Decree No. HK.01.07/MENKES/312/2020 stipulates that one of the core competencies for Medical Records and Health Information (MRHI) professionals is proficiency in clinical classification, disease coding, and clinical procedure coding. However, in practice, inaccurate coding remains prevalent, affecting the amount of claims received. Coding errors can result in upcoding—where an assigned code carries a higher tariff, thereby posing a fraud risk—or downcoding—where the assigned code carries a lower tariff, causing financial losses for the healthcare facility (Amanda et al., 2023). Research by Hapsari et al. (2024) revealed that diagnosis coding inaccuracy rates reached as high as 72.77%. Similarly, Munandziroh et al. (2024) found that 50 out of 126 medical records contained coding errors, with the majority occurring in the selection of the fourth character.

The high rate of coding errors indicates a gap between graduate competencies and professional demands in the field. Therefore, beyond equipping students with knowledge and skills through practice, the development of systems as tools to improve the accuracy and efficiency of the coding process in healthcare facilities is essential. One approach that can be adopted is the utilization of

electronic-based systems, such as Computer Assisted Coding (CAC) with Rule-Based Validation, which functions to assist in the determination of diagnosis codes by providing recommendations and validation of codes used in accordance with prevailing standards and rules (Campbell & Giadresco, 2020).

Computer Assisted Coding (CAC) is a computer-based system designed to assist medical records personnel in assigning diagnosis or procedure codes automatically based on clinical patient data. The system works by extracting information from electronic medical records and matching it against disease code standards such as ICD-10 using Natural Language Processing. According to Campbell and Giadresco (2020), CAC systems play a crucial role in enhancing the efficiency and accuracy of the diagnosis coding process. Dai et al. (2024) demonstrated in their recent research that NLP-based CAC systems are capable of increasing the speed and consistency of Diagnosis Related Group (DRG) coding in hospitals with significant accuracy levels.

Rule-Based Systems are computer programs capable of generating specific information based on rules stored in a knowledge base. Tokede et al. (2024) stated that rule-based algorithms have proven effective for identifying specific diagnoses from structured medical record data with high specificity and accuracy. The rule-based approach also enables systems to provide automatic alerts when discrepancies are found between clinical data and selected diagnosis codes. Falter et al. (2024) further explained that rule-based logic can be used to detect specific clinical conditions in medical record data and improve diagnosis identification accuracy at the hospital level.

Based on observations conducted at the Medical Records Management Laboratory of STIKES Wira Medika Bali, the diagnosis coding learning process is still performed manually using ICD-10 as the reference. For diagnoses with more complex classification and coding rules, such as Diabetes Mellitus and Neoplasms, the process of searching and validating codes requires considerable diligence to determine codes that comply with ICD-10 rules. Moreover, no Computer Assisted Coding (CAC) system or any other system that can assist in automatic diagnosis code validation is currently available at the laboratory.

This study, therefore, aims to: (1) analyze user needs and preferences for the system; (2) design the system workflow (flowchart); and (3) design the user interface for a Computer-Assisted Coding system with rule-based validation based on ICD-10 at STIKES Wira Medika Bali.

RESEARCH METHODS

This study employed a qualitative descriptive approach using a system design research methodology. This approach was chosen because the research focuses on the process of designing and developing a Computer Assisted Coding model based on Rule-Based Validation that functions to assist in searching, selecting, and validating diagnosis codes according to ICD-10 standards more effectively and efficiently. The system design research method was used because this study aims to produce a system design as a solution to user needs. The study was conducted at the campus of STIKES Wira Medika Bali, specifically at the Medical Records Management Laboratory. The research was carried out over a two-month period from May to June 2026.

The population of this study comprised all students of the Medical Records and Health Information (MRHI) study program at STIKES Wira Medika Bali who potentially use the CAC system based on rule-based validation as a supporting medium for learning and diagnosis coding based on ICD-10. Samples were selected using purposive sampling, with criteria including MRHI students who had received ICD-10 diagnosis coding instruction and understood the basic diagnosis coding process.

Data collection was conducted through two primary techniques. First, a literature review was performed, encompassing scientific journals, research articles, and official references related to Computer Assisted Coding (CAC), ICD-10, and Rule-Based Validation methods to establish the theoretical foundation. Second, observation was carried out at the Medical Records Management Laboratory of STIKES Wira Medika Bali to understand user needs and the constraints faced by

students in searching, selecting, and validating diagnosis codes during the learning process. Observation results served as the basis for determining system requirements.

The research procedure comprised four stages. The preliminary study stage involved identifying problems and reviewing literature on CAC, ICD-10, and Rule-Based Validation. The observation stage gathered data on user needs and the current diagnosis coding learning process. The design stage produced the system workflow using a flowchart, Context Diagram, Data Flow Diagram (DFD), Entity Relationship Diagram (ERD), and user interface designs for the CAC system. The reporting stage documented all research findings systematically in accordance with scientific writing standards.

Data analysis employed a qualitative descriptive method. Data obtained from the literature study and observation were analyzed to identify user needs and system requirements. The analysis involved grouping and interpreting collected information to determine features, processes, and components needed in the CAC system. The analysis results served as the foundation for the system design process, including the construction of the flowchart, Context Diagram, DFD, ERD, and user interface design.

RESULTS AND DISCUSSION

Research Setting Overview

The Medical Records Management Laboratory is a learning facility used to support practical activities for students of the Medical Records and Health Information study program at STIKES Wira Medika Bali. The laboratory is designed to resemble a medical records work unit found in healthcare facilities, enabling students to gain practical experience that closely mirrors actual working conditions. Activities conducted include various medical records management units such as registration, assembling, indexing, coding, analysis, reporting, and medical records storage. In coding activities, students are required to understand disease classification rules and coding procedures accurately in order to determine diagnosis codes that conform to ICD-10. The laboratory is equipped with seven computer units that support learning activities and health information system design.

Requirements Analysis

The system requirements analysis was conducted based on observations at the Medical Records Management Laboratory of STIKES Wira Medika Bali. Observations revealed that the diagnosis coding learning process is still performed manually using ICD-10 books as the primary reference for determining and validating disease diagnosis codes. Students must search for diagnoses in the alphabetical index and re-verify them in the tabular list to ensure the selected code conforms to applicable classification rules.

Observations also showed that no Computer Assisted Coding (CAC) system or any other system is available at the laboratory to assist with automatic diagnosis code validation. The entire validation process still depends on users' understanding of ICD-10 coding rules, a condition that potentially leads to errors in diagnosis code selection, particularly in cases requiring the application of specific classification rules.

Based on these conditions, functional system requirements were identified: the ability to accept diagnosis and diagnosis code inputs, perform validation based on ICD-10 rule-based criteria, and display validation results to users. Non-functional requirements include web-based system design with a simple interface that is easy to understand and can serve as a supporting medium for diagnosis coding education.

System Design

The system design phase encompassed the creation of several design artifacts. A Context Diagram was developed to depict the system's highest-level overview, illustrating the processes occurring within the system in a concise data flow diagram format. This was followed by a Data Flow Diagram (DFD) Level 0, which expanded on the Context Diagram to detail the entities involved and data flows between processes. An Entity Relationship Diagram (ERD) was also produced to describe

the relationships between entities in the system, including user data, diagnosis data, ICD-10 codes, and validation rules.

User Interface Design

Login Page. The login page serves as the initial page displayed when users access the CAC system. It functions as the user authentication process before users can access the diagnosis code validation features. Users must enter a username and password in the designated fields, then press the login button to enter the system. The system provides authentication feedback through pop-up notifications: a successful login notification directs users to the main page, while a failed login notification informs users that the entered credentials are invalid and allows them to re-enter their data.

Main Page. The main page of the SICODI system is used for diagnosis code validation. Users can enter a diagnosis in the designated field, then search for or enter a diagnosis code in the code field. After data entry, users press the "Check Code" button to verify the correspondence between the diagnosis and the entered code. A logout button on the lower left redirects users to the login page.

Validation Result Notifications. The system provides three types of validation result notifications. First, a "Code Correct" pop-up appears when the entered code matches the selected diagnosis, confirming that the diagnosis code is accurate. Second, a "Code Partially Correct" pop-up appears when the entered code is related to the selected diagnosis but is not yet specifically appropriate, informing users that the code needs to be reviewed and adjusted. Third, a "Code Incorrect" pop-up appears when the entered code does not match the selected diagnosis, notifying users that the code cannot represent the intended diagnosis and that they need to search for or enter a correct diagnosis code.

Discussion

The system design results demonstrate that the proposed CAC system with rule-based validation can address the identified problems in manual diagnosis coding education. By providing automatic validation through predefined rules based on ICD-10 standards, the system offers immediate feedback to users, which is expected to enhance coding accuracy and learning effectiveness. The three-tier notification system (correct, partially correct, and incorrect) provides graduated feedback that helps students understand not only whether their code is wrong, but also how close they are to the correct answer, thereby supporting a more nuanced learning experience.

The design aligns with prior studies that highlight the benefits of CAC systems in improving coding accuracy and efficiency (Campbell & Giadresco, 2020; Marcou et al., 2024). While previous research focused primarily on developing or validating algorithms for clinical data classification and identification (Hammami et al., 2021; Ganz et al., 2024), this study contributes a novel application of CAC in an educational context, specifically designed for the learning needs at STIKES Wira Medika Bali. The structured design artifacts—flowchart, Context Diagram, DFD, ERD, and user interface prototypes—provide a comprehensive foundation for future implementation and development into a fully functional application.

CONCLUSION

The diagnosis coding learning process at the Medical Records Management Laboratory of STIKES Wira Medika Bali is currently still performed manually using ICD-10 books. The absence of an automatic validation support system means that the process of searching and verifying codes is heavily dependent on students' independent understanding of ICD-10 rules. User needs analysis indicated that the designed system must possess functional capabilities to accept diagnosis input, facilitate ICD-10 code search, and provide automatic validation result notifications based on rule-based criteria to ensure code conformity with classification standards.

The system design successfully produced data flow and system structures documented in a flowchart, Context Diagram, Data Flow Diagram (DFD), and Entity Relationship Diagram (ERD). A user interface design focusing on usability aspects was also successfully created, comprising a login

page (user authentication), a main page featuring diagnosis input, ICD code search, and diagnosis code validation result notifications. It is recommended that future research advance this study to the implementation stage (coding and development) by converting the interface design and database schema into a fully functional prototype application. Furthermore, system effectiveness testing (trials) should be conducted to measure the accuracy of the rule-based algorithm in detecting and mitigating coding error risks across various diagnosis cases, not limited to specific diseases such as Diabetes Mellitus.

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