

Electronic Health Records Design in the Nutrition Care Center of Teaching Factory at Politeknik Negeri Jember, Indonesia

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Abstract: The Nutrition Care Center (NCC) is one of the teaching factories (TEFA) at Politeknik Negeri Jember that provides community nutrition services. Preliminary data collection found that the factory did not have complete health database of their staff so that nutritionists find it difficult to screen for non-communicable disease risk factors. In this study, the use of Electronic Health Record (EHR) equipped with Clinical Decision Support System (CDSS) was incorporated to record, retrieve, archive, and update patients and other medical records in the NCC. This system provides easier health record management for the nutritionist team at the NCC TEFA Politeknik Negeri Jember. Medical records help them conduct screening on non-communicable disease (NCD) risk factors and make clinical decision support for doctors/counselors which have missions to reduce NCD cases in the productive age. This study used a waterfall method model and collected data through a literature review, observation, and interviews. The results produced an application of a clinic database management in which all data and information could be integrated well to improve the quality of services and facilitate data storage and access. This study concludes that the EHRs generates quick and accurate information to support operations and decision-making in the NCC.

Keywords: CDSS, Database, EHR, NCC, Waterfall

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1. Introduction

The findings of Basic Health Research and a survey by the Indonesian Ministry of Health Research and Development Agency showed that the most common cause of deaths was non-communicable diseases (NCDs) in 2014, such as stroke, heart disease, diabetes, hypertension, and complications [1]. In 2007, 0.6% of patients in healthcare facilities were diagnosed with stroke. In 2013, this number increased to 0.7%. Diabetes case rates increased from 0.7% to 1.5%, and hypertension increased from 7.2% to 9.4%. One of the policy directions and strategies in the National Medium-Term Development Plan IV 2020-2024 is to improve NCD control [2]. NCDs were the catastrophic diseases most likely causing a high number of deaths in Indonesia before the pandemic [3]. The World Health Organization states that NCDs cause approximately 40 million deaths annually, and more than three-quarters of these deaths occur in developing countries [4].

The high number of NCDs occurs due to a lack of a system for early detection and health data records on NCD cases [5]. Clinical Decision Support System (CDSS) is a computer-based program that analyzes Electronic Health Record (EHR) for healthcare workers to provide specific recommendations in patient clinical decision-making [6]. CDSS is used as the latest strategy to support healthcare providers in NCD risk factors screening and intervention delivery to prevent NCD [4]. EHR consists of several components and simultaneous access. The main features of the EHR system include administration, clinics (hospitals, health centers, and clinics), radiology, laboratory, pharmacy, doctor, and clinical order input. Implementing a health information system such as an EHR can potentially improve the performance of healthcare facilities, save operational costs, and improve patient satisfaction [7]. Implementing the EHRs provides

promising evidence-based healthcare, higher levels of service completeness, accuracy, validity, access, and coordinated communication of patient information, safe prescription, utility of electronic health records for clinical diagnosis, adequate clinical decision support, and improved efficiency of medical practices [8]. The research team successfully developed and implemented electronic medical records in previous studies called E-posyandu [9] and Electronic Health Records (EHRs) in a family's health home clinic of Jember district [10].

However, the EHR systems made in the previous studies were different form that made by the nutritionist team in the Nutrition Care Center (NCC) of Teaching Factory (TEFA) Politeknik Negeri Jember. They created e-Posyandu to facilitate cadres in data entry on the health status of pregnant mothers and babies/ toddlers in integrated health posts as early detection of risk factors for maternal and infant mortality even stunting [9]. While the EHRs, the family's health home clinic of Jember district can produce accurate information fast and support operations and decision-making [10]. The EHRs in the Nutrition Care Center (NCC) Teaching Factory (TEFA) Politeknik Negeri Jember were made to identify risk factors for NCD based on patient's nutritional status i.e., hypertension and diabetes, with or without other comorbidities. The EHR standard is being developed in Indonesia and relates mainly to hospital-based environments although some data may also come from the community healthcare centers. Research conducted in a district of Central Java shows that the Banyumas district integrated the reporting and recording systems of several primary health centers with a computer system (using a Local Area Network close to a WAN) [11].

With the advancement of information and communication technology, it is necessary to implement EHR as CDSS in the NCC of TEFA of Politeknik Negeri Jember. NCC provides nutrition services for internal employees of the institution and the general public. The public can check blood sugar, uric acid, cholesterol, the water content in the body, protein, and minerals using the latest detection tools. In addition, the nutritionists provide services to meet balanced nutritional needs and prevent NCDs. However, the NCC only had paper-based nutrition status records stored on shelves, making it difficult for nutritionists to conduct NCD risk factors screening and data accuracy check. Paper-based systems have a limited lifespan and unclear mechanism due to a lack of space [12]. This study, therefore, aimed to design an electronic system for health records in the Nutrition Care Center of Teaching Factory.

2. Materials and Methods

This study was research and development (R&D) research. The source informants in this study were seven nutritionists, three admins and the Head of the Laboratory, and officers responsible in the NCC of TEFA Politeknik Negeri Jember. The research was conducted in April-December 2022. Data collection were carried out using interviews, observation, documentation, and a literature study. The analysis method used in this study was the Waterfall Model, a classic model yet systematic and sequential in building a software [13]. The Waterfall model was conducted at some stages as presented in Figure 1.

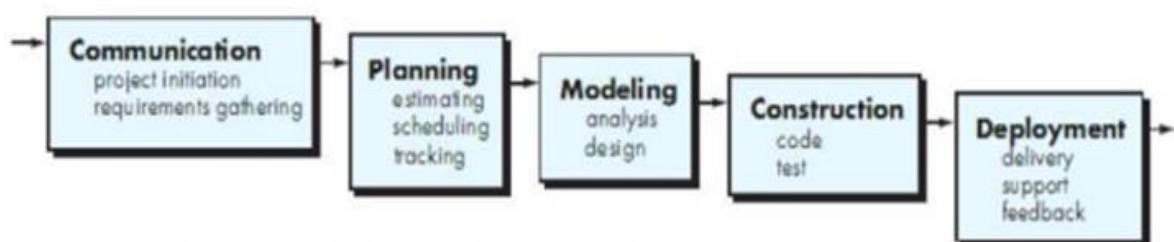


Figure 1. Waterfall Model Method

A. Communication

This step was an analysis of software requirements and data collection by meeting with users. The users were seven nutritionists and three admins of the institution. Researchers interviewed the users to ensure whether they required the development of information technology-based systems.

B. Planning

This process was a continuation of the communication stage where the requirement analysis began. The researchers analyzed the system requirements through observation and documentation to identify the patient's nutritional status. The interviews were done with the Head of the Laboratory and officers to discuss the users' expectations in the system development, including the system planning. The variables of the system were collected after the interview was completed.

C. Modeling

The next process focused on data structure design, software architecture, interface representation, and procedural details (algorithms). In this stage, documents of software requirements were produced and translated into a predictable software design before coding.

D. Construction

Construction was the stage of making codes (coding) and dealing with the software to maximize the use of computers. After the coding was completed, testing and correction on the errors were carried out in the system. The testing was conducted by inputting patient nutrition test results into the system.

E. Deployment

This stage was the final stage of making the software. After analyzing, designing, and coding, the finished system would be used by the users with regular maintenance. The researchers gave training to the users on how to use the system for nutrition test recording.

3. Results and Discussion

3.1 System Investigation

The system investigation stage was the earliest stage in this study. This stage was carried out by interviewing and observing the Head of the Laboratory and officers. The results of interviews and observations show that recording and reporting of patient examination results were done manually. This leads to obtaining less valuable data and information, especially in supporting NCDs. Figure 2 shows an example of the patient examination records in the NCC.

NO	NO RM	TANGGAL	NAMA KLIEN	ALAMAT & NO HP	ASSESSMENT	DIAGNOSIS	INTERVENSI	NAMA PENYAKIT
8	00008 ID: 74	14 Jan 2020	Bpk. Ariah	...	BB: 64,4 kg TB: 160 cm TD: 110/70 HR: 70 SPO2: 98% AV: 7,0	...	...	...
9	00009 ID: 75	14 Jan 2020	Ibu. Rahmah	...	BB: 54,9 kg TB: 152 cm TD: 102/68 HR: 85 SPO2: 98% AV: 7,0	...	...	...
10	00010 ID: 76	14 Jan 2020	Ayam. Widiana	...	BB: 99,2 kg TB: 170 cm TD: 170/80 HR: 80 SPO2: 98% AV: 7,0	...	...	...
11	00011 ID: 77	17 Jan 2020 18 Jan 2020 18 Jan 2020	Dokter Lelita (pemeriksaan)	STER ASACG Gula Gigi Gula Rasio	BB: 57,2 kg TB: 162,2 cm TD: 131/85 mmHg HR: 101 / 70 SPO2: 97,2 % AV: 7,0	...	...	...
12	00012 ID: 78	17 Jan 2020	Ardi (pemeriksaan)	Jl. Jawa 1/21	BB: 57,5 kg TB: 160 cm TD: 110/70 HR: 104 SPO2: 98% AV: 7,0	...	...	...

Figure 2. Patient Examination Result Recording Book at NCC

The picture above shows that patient examination records were not neatly organized and easy to damage. In addition, the officers crossed out the errors in writing and then corrected them. Such errors made the recording data difficult to read and less informative, especially in analyzing or detecting non-communicable diseases. This results are relevant to the previous research conducted by Damayanti et al. who stated that a paper-based system poses a great deal of difficulty in ensuring data accuracy as this system has a limited life after a certain period due to space limitations [14]. Moreover, some of the clinicians, particularly the doctors, indicated that typing information in a computer could be similar to writing on a paper, and typing speed could be increased through practice and training [11]. Therefore, the development of computer-based information systems would facilitate data storage and retrieval fast and enable intelligent processing or data compilation to provide accurate and quick benefit for patients.

3.2 System Analysis

System analysis results in different views of complex objects depending on the question of interest. Information system analysis often focuses on theories relevant to software engineering, such as data flow, workflow, and the use of information processing tools. However, CDSS that had been developed might be rarely used in the health sector, especially in clinics or laboratories, or teaching factories such as the NCC [15]. In the system analysis stage, researchers identified user needs, data sources, and information as a basis for system design. Based on the system analysis results, users, in this case, officers required the EHR system as a CDSS to support their daily work. Studies show that CDSS likely improves adherence to clinical guidelines. CDSS could directly enhance the quality of clinical documentation, for example, an obstetric CDSS featuring an enhanced prompting system to significantly improve the documentation of indications for labor induction and estimated fetal weight. With the advent of EHR, CDSS could be an ideal tool to implement shared decision-making between patients and providers and particularly to eliminate a lack of information which becomes a barrier to patient participation in health care [16].

Table 1. Recording and Reporting of Patient Medical Status in the NCC of TEFA

1.	No
2.	Medical record number
3.	Patient name
4.	Address
5.	Age
6.	Assessment
7.	Diagnosis
8.	Intervention
9.	Counselor name
10.	Examination date

The officers in the NCC stated that the EHR system could be equipped with a visit and examination report format, which could be printed once a month. In addition, the officers/admins also wanted the system to have a decision-making feature.

3.3 System Design

The construction of a web-based information system was the outcome of the analysis stage in this project to support and facilitate the midwives as the program's implementers. An outline and description of the system, as well as a storyboard, were developed. Modules, software programs, and instruments were created and determined to assess the quality of system modules [17]. The researchers built this system with a local web server (PHP) and ran it directly on the machine. An overview of the EHR design can be seen in Figure 3.

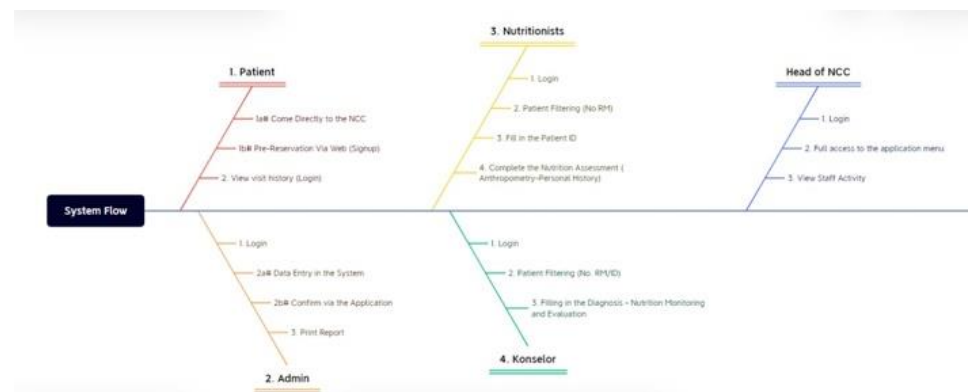
**Figure 3.** EHR's System Flowchart

Figure 3 shows the flow of the NCC system that includes each user's role in the application. Based on Figure 3, five users i.e. patient, admin, nutritionist, counselor, and the Head of NCC TEFA used the system. They had each authorization access to the system according to their needs. Patients could access the system to make a reservation via the website. If the patients came directly to the NCC, then the admins would enter their data for new visits or search the history data for return visits. Furthermore, the admin of NCC could log in, enter the patients' data into the system, confirm patients' reservation, and print their reports.

The nutritionists could log in to the system, filled the patients' IDs, filter their medical record number, and entered the nutrition assessment results. The nutrition counsellor also could log in to the system, filter the patients' medical record number, and describe the diagnosis based on nutrition monitoring and evaluation. Moreover, the Head of NCC of TEFA had full access to the system where they could view the officers' activities.

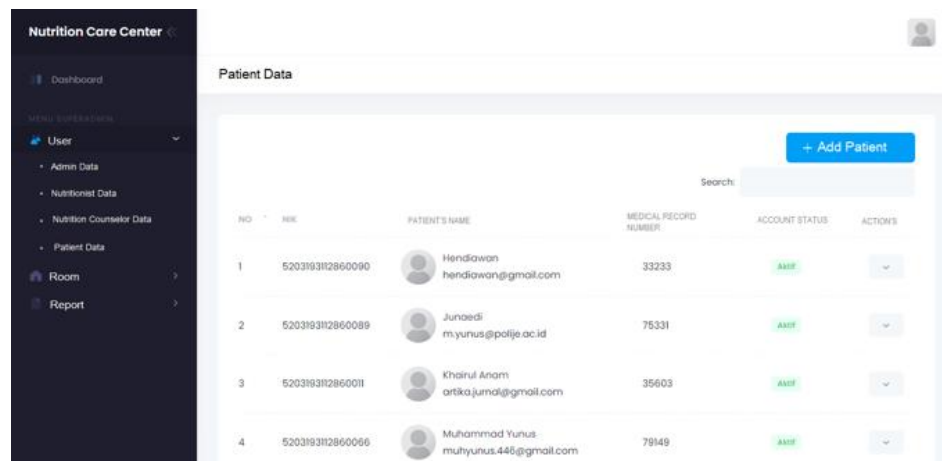


Figure 4. Patient's Data Input

Next, the users logged into the system and selected the patient data input menu. Data would appear automatically once patients clicked the search patient data menu to enter their data.

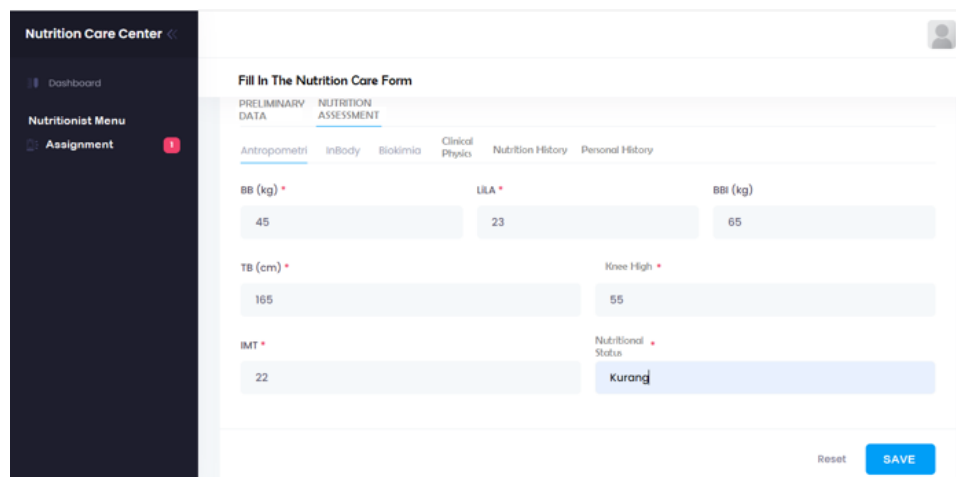


Figure 5. Assessment Data Input

For the next step, the NCC officers conducted an examination and assessment of the patients' nutritional status, such as anthropometry, in-body values, biochemistry, clinical physic, allergy history, and personal history. The assessment results were then entered into the NCC system by the officers.

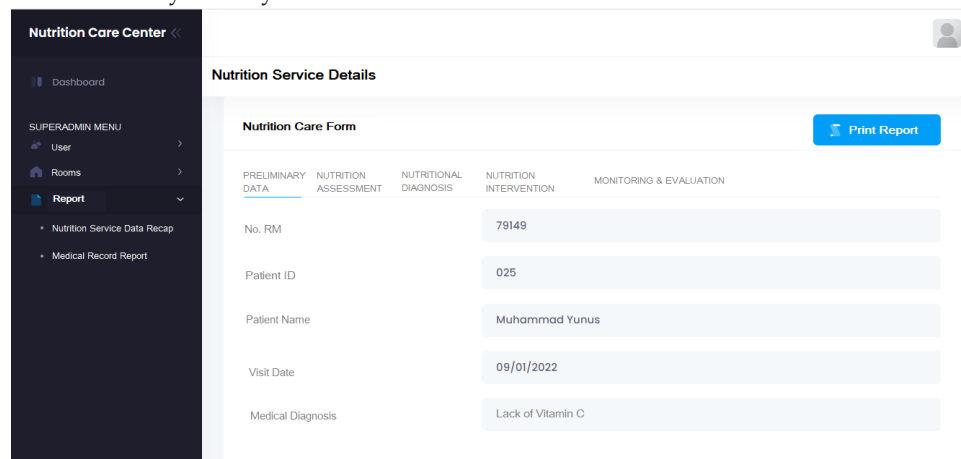


Figure 6. Results of the Diagnostic Process

The diagnosis entry is a crucial stage that determines the patients' nutritional status. The nutrition counselor would evaluate the patients' diagnosis results in the NCC system. If the system stated that the patient was suffering from NCD, the nutrition counselor would provide suggestions for prevention and improvement of the patient's health status.

At the end, the officers stored patient examination data of similar cases for later use. It would significantly assist nutrition counselors in determining and making decisions regarding the nutritional status of patients. Similarly, previous research shows that health information technology has a variety of important benefits in terms of quality and efficiency of service delivery based on the guidelines. These benefits include prevention, increased monitoring and surveillance, reduction of medication errors, and lessening of potentials for excessive or unnecessary services [14]. Furthermore, the decision support function is usually embedded in an electronic health recorder or computerized provider for order entry in a system [17].

3.4 System Implementation

Prototypes were tested on responders throughout the implementation phase [17]. The researchers deployed the web-based method to 10 respondents (NCC's officers) and the Head of NCC of TEFA. The users then utilized the system. Researchers conducted socialization and training on how to use the system. The officers stated that this information system was very good at recording examination results in the NCC. During the system implementation, the users provided feedback on how to improve the data entry form. Programmers and researchers are responsible for modifying the system based on the feedback in external trials. The system evaluation is done to produce a high-quality system which can meet user requirements [17].

4. Conclusions

The system made by the nutritionist team could provide easier management of health service data in the Nutrition Care Center (NCC) of Teaching Factory (TEFA). Patient examination data were kept for later use to assist nutrition counselors to determine and make decisions regarding the nutritional status of patients. For future researchers, periodic monitoring is needed to identify the sustainability of the EHR system used in the NCC. Also, officers have to convey the obstacles when using the EHR system. This study shows that the information system in the NCC was still not integrated with other health facilities. The next research has to be focused on analyzing the system information development to facilitate data integration between the NCC and other health facilities to avoid mismatch with or absence of patients' data.

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