Information system for diagnosis in pregnant chronic energy deficiency using a rule based system algorithm

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Abstract. The condition of Chronic Energy Deficiency (CED) has become one of the causes of high maternal mortality. Improper handling of CED will have an impact on the health problems of both mother and baby. This is because when the diagnosis is still using conventional methods, so it takes a long time or is not time efficient, an alternative is needed to improve the quality of information system-based services in diagnosing mothers with CED. In this research, an information system design was carried out using the SDLC (System Development Life Cycle) method with the waterfall model which includes: needs analysis, design, implementation, and offer. Analysis of speed data using respondents 15 chronic energy deficiency pregnant and static test using Mann Whitney obtained p-value 0.000 p <0.05, meaning that the information system built has a significant effect on the difference in speed in making diagnoses. This information system can be applied in health facilities.

1. Introduction
Maternal mortality rate is one of the main indicators of public health status, it can be identified by knowing the factors causing maternal death, one of the factors causing maternal death globally is bleeding which has a risk of malnourished pregnant [1]. The impact of nutrition experienced by the mother can affect the fetus, one of which is less than normal body weight [2].

Maternal nutritional intake has less effect on fetal growth, one of which is less than normal weight <2500 grams and stunting (short) [2]. One of the malnutrition problems is that the mother experiences a chronic energy deficiency that occurs due to an imbalance in the energy and protein intake of the mother which can be identified with an upper arm circumference (LILA) <23.5 cm [3]. In addition to insufficient nutritional intake, it can be influenced by other factors, namely less than optimal access to health services [3].

Public health cannot be separated from the role of health workers to provide optimal services. The task of health workers to provide services is not just a standard process of care. In this case, it will have an impact on service quality, for example, counseling media which is still carried out conventionally, so that it is inefficient and an alternative is needed to improve service quality by making breakthroughs in information system-based services.

Information systems are indispensable for managing the information cycle (starting from data collection to providing information feedback) and supporting the implementation of appropriate actions in planning, implementing and monitoring health system performance. The use of health
information systems can make it easy to understand, teach, connect, motivate, and empower individuals to overcome health problems [4]. Information systems are a new approach to providing information easily at the touch of a button, without cost, which can be accessed anywhere and anytime [4].

The information system that is accessed by the public, especially pregnant with chronic energy deficiency in order to get knowledge about pregnancy nutrition and early diagnosis of nutritional problems, so that the information system is expected to help maintain the content properly and minimize the risk of maternal mortality. The information system needed by pregnant in today's era is a system that can diagnose symptoms of a disease like an expert or expert. Expert system for diagnosing disease that starts with combining information and rules to produce a conclusion or purpose. Therefore, the researcher conducted research on information systems to diagnose chronic energy deficiency in pregnant using a rule base system algorithm.

2. Literature review
Nutrition is a component of the body that is very important for the body to function properly. In poor and developing countries, nutrition is a major problem. The reason is due to the lack of knowledge about the diversity of nutritious foods. One of the focus of attention on malnutrition in pregnant is chronic energy deficiency, a health problem due to insufficient energy intake for a long or chronic period of time [5].

The impact of malnutrition experienced by the mother can affect the fetus, one of which is less than normal body weight. Maternal nutritional intake is very influential on fetal growth, one of which is less than normal weight <2500 grams and stunting (short) [6]. Causes of chronic energy deficiency include low family support, low economic status, and lack of knowledge about nutrition [7]. Thus, an information system-based tool is needed to obtain nutritional knowledge [8].

Advances in information systems have an impact on human life, with nutritional problems. This study seeks to utilize information systems to solve these problems. Medical problems often take advantage of expert systems. Expert system is one part of artificial intelligence that uses fact knowledge and reasoning techniques to solve problems. Given criteria, the expert system can determine the right choice. The main purpose of this system is to effectively transfer knowledge to those who are not experts [9].

The workings of an expert system collect initial information by asking the user initial questions, then the expert system will track the solution / conclusion, so that it fits the information needed. Expert systems that are built using knowledge base reasoning have 2 methods, namely forward reasoning (Forward Chaining) and backward reasoning (Backward Chaining). Forward Chaining can be applied in determining proper nutrition in patients and producing the right solution based on conditions [10].

This research uses forward chaining methods. The results of this study are in the form of an expert system to estimate gestational age, which can be determined using the provisions of the gestational period, namely the first trimester, age ranges (0-12) weeks, the second trimester ages range (13-26) and the third trimester ages range (27-40). In addition, in knowing the gestational age in this expert system, it can be determined by the symptoms that are caused, from the symptoms experienced / chosen by the user, the system will process it so that it can produce the highest percentage to determine the gestational age, where the percentage on the basis of the symptom rule will be. used when there are the same type of symptoms. The highest percentage is likely to answer the gestational age of the symptoms that have been selected by the user [11].

3. Methods
In this study, there are 2 methods analyzed, namely methods in data collection and design of information systems. Collecting data in this study using different test, namely Mann Whitney with 15 respondents. The design of this information system uses the SDLC (System Development Life Cycle) method with a waterfall which is described in figure 1.
The stages of the SDLC method are:
1. Requirement analysis, at this stage a feasibility study is carried out to determine whether the information system to be developed is a viable solution. The fact that occurs in chronic energy deficiency pregnant in carrying out diagnosis is still using manual, so it is necessary to develop an information system to deal with this. The needs stage is needed to identify what information system users need and want, as for the user's needs, in this case, to diagnose and analyze existing conditions.
2. System design, the design stage aims to determine the detailed specifications of the information components (human, hardware, network and data) and information products that are in accordance with the results of the analysis phase. This design design uses a rule based algorithm.
3. Implementation and verification (creation and testing of program code), at this stage the researcher makes program coding and test program results, aiming to find out whether the system being developed is as expected.
4. Maintenance, this stage is carried out by system maintenance, such as monitoring, processing, evaluating and making improvements if the system that has been created needs to be repaired.

4. Results and discussion

4.1 Implementation of information systems
The main page of the nutritional needs recommendation information system contains a log in menu used to limit the access rights of pregnant (users) which can clearly be seen in Figure 2.
Your data menu contains the identity of the user / pregnant woman, while the data that must be inputted are general data and special data. General data contains name, address, occupation and education. Specific data containing the size of the upper arm circumference, BMI, body weight and height can be seen in Figure 3.

![Figure 3. Your data page](image)

The diagnosis page contains the results of the diagnosis based on data obtained from the upper arm circumference (LiLa) and the body mass index of pregnant / users. The diagnostic display can be seen clearly in Figure 4.

![Figure 4. Diagnostics page](image)

The solution menu contains advice or counseling aimed at conditions so that users read the nutritional needs of pregnant can be seen clearly in figure 5.
Production rules are a form of knowledge representation that is widely used in the development of expert systems. Knowledge representation using production rules is basically a rule in the form of IF THEN. The following is a representation of the expert system’s knowledge to diagnose the condition of pregnant using production rules. Production rules are outlined in figure 6.

4.2 System testing
This system testing is done to test and find out whether the system is running well and correctly in accordance with the expert system knowledge base. This expert system uses one type of testing, namely: Black box test and alpha test. In testing the Black Box Test, it involves a nutritionist. This test is emphasized on data input, determining the diagnostic rules and the output of the data that has been defined as the rule base. The alpha test was carried out by 15 pregnant and this questioner was given after the user tried to use the information system created by the researcher in order to find solutions to problems regarding the nutritional needs of pregnant. The results of the questionnaire are described in table 1.
### Table 1. Assessment of the system based on the TAM questionnaire

| Effectiveness Variable | Number | Question | Score | total % |
|------------------------|--------|----------|-------|---------|
|                        |        |          |       |         |
| Perceived usefulness   | 1      | -        | -     | 11      | 4       | 85     |
|                        | 2      | -        | -     | 9       | 6       | 88     |
|                        | 3      | -        | -     | 12      | 3       | 84     |
| Perceived Ease of Use  | 4      | -        | -     | 9       | 6       | 88     |
|                        | 5      | -        | -     | 7       | 8       | 95     |
|                        | 6      | -        | -     | 9       | 6       | 88     |
| Actual Use             | 7      | -        | -     | 10      | 5       | 87     |
|                        | 8      | -        | -     | 12      | 3       | 84     |
|                        | 9      | -        | -     | 13      | 2       | 82     |
|                        | 10     | -        | -     | 6       | 9       | 92     |
|                        | 11     | -        | -     | 11      | 4       | 85     |
| Attitude Toward Using  | 12     | -        | -     | 8       | 7       | 89     |
|                        | 13     | -        | -     | 10      | 5       | 87     |
|                        | 14     | -        | -     | 6       | 9       | 92     |
|                        | 15     | -        | -     | 10      | 5       | 87     |
| Behavioral Intention   | 16     | -        | -     | 7       | 8       | 95     |
|                        | 17     | -        | -     | 7       | 8       | 95     |
|                        | 18     | -        | -     | 10      | 5       | 87     |
|                        | 19     | -        | -     | 5       | 10      | 93     |
|                        | 20     | -        | -     | 8       | 7       | 89     |
| Average score of effectiveness | | | | 89 | 

From the results of the use of the system, it can be concluded that the system is feasible/effective to diagnose chronic energy deficiency pregnant with an average score of 89%. The highest acquisition of information systems acceptance based on the TAM questionnaire is there is an attitude toward using.

5. Analysis of data results

#### 5.1 Accuracy of diagnosis

In this study, the acquisition of data in diagnosing using an information system can be explained in Figure 7.

![Figure 7. Acquisition of diagnosis](image_url)
Figure 7 shows the data mostly with a diagnosis of chronic energy deficiency (CED) as many as 13. This proves that with this information system it can diagnose that the mother has a chronic energy deficiency condition based on the condition when inputting data / filling in this information system data.

5.2 Speed of diagnosis
The use of information systems has an influence on the speed of diagnosis and is proven by statistical tests using different tests. The test results were obtained using the Mann Whitney with a p-value of 0.000. The acquisition of diagnostic speed is obtained from the difference in speed in making diagnoses in the intervention group (using information systems) and the control group (using no information systems) described in Figure 8.

Figure 8. Speed of diagnosis

Figure 8 explains that the use of information systems affects the speed of diagnosis. In the control group, the average time was 11.2 minutes, while in the intervention group the average time was 1.8 minutes. This proves that the intervention group was 10 times more efficient than the group control. In line with Wallen's research, it is revealed that the development of information systems has an effect on making diagnostic decisions faster than without using information systems, thus affecting the quality of health services[12]. The use of information systems can shorten the time to be faster when making a diagnosis, so that detection is carried out appropriately and effectively [13].

6. Conclusion
Based on the results of the development and discussion, it can be concluded: determining the diagnosis by determining the condition of the mother based on Upper Arm Circumference and Body Mass Index first and the solution in the form of recommendations for nutritional needs in accordance with the condition of the mother using the IF, THEN rule base. The use of information systems in intervening shows that it is more time efficient than the manual method, so it has an influence on the speed of diagnosis. It is hoped that it will become a material consideration for policy makers, especially in planning nutrition education media programs with the latest media based on information systems, alternatives to conventional nutrition education are transferred to using information systems and become an alternative choice in obtaining nutritional information and helping to increase knowledge about nutrition because it can be accessed anywhere and anytime without having to go to a health worker.

References
[1] Say L, Chou D, Gemmill A, Tuncalp O, Moller A B, Daniels J D et al. 2014 Global Causes of Maternal Death: A Who Systematic Analysis. 2 6
[2] Kemenkes RI. Profil Kesehatan Indonesia Tahun 2017 Jurnal Ilmu Kesehatan 1–496
[3] Hapzah, Sirajuddin V H S 2013 Media Gizi Masy Indones. 2 2 64–70
[4] Faizah D 2013 J Ilm Mhs Kedokt Indones Mhs Kedokt Indones. 2 1 1–4
[5] Prawita A, Susanti AI, Sari P 2017 J Sist Kesehat. 2 4 186–91
[6] Kementrian Kesehatan RI. 2018. *Jurnal Ilmu Kesehatan* 1–496 p
[7] Wati L, Ermalia Y, Haslinda L 2016. *Jurnal Online Mahasiswa Fak Kedokt Univ riau*
[8] Ratnasari D D, Sutariyai 2015. *Jurnal Ilmiah Go Infotech* 21 2 25-31
[9] Muhtadun L, Handoko B 2017. *Sistem Pakar Diagnosa Keperawatan Kebutuhan Nutrisi Pencernaan Pasien dengan Metode Forward Chainning*. Universitas Dianuswantoro
[10] Tarigan A F 2014. *Jurnal TIMES* 3 2 25-29
[11] Mariani, Desy 2012. *Analisis Dan Perancangan Sistem Pakar Untuk Menentukan Usia Kehamilan Sistem Informasi STMIK AMIKOM Yogyakarta*
[12] Warren C E, Abuya T, Kanya L, Obare F, Njuki R, Temmerman M and Bellows B 2015. *BMC pregnancy and childbirth* 15 153
[13] Fajriya I I 2017. *Deteksi Kehamilan Resiko Tinggi dengan Sistem Informasi Berbasis Web*. unpublished Poltekkes Kemenkes Semarang