IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.16, No.3, July 2022, pp. 239~250
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: https://doi.org/10.22146/ijccs.71963

Ontology-based Complementary Breastfeeding Search Model

Astrid Noviana Paradhita*[1], Anny Kartika Sari[2], Agus Sihabuddin[3]
[1*]Diploma of Business Management, Vocational School, Sebelas Maret University, Indonesia
[2,3]Department of Computer Science and Electronics, FMIPA UGM, Yogyakarta, Indonesia
e-mail: ***[1]astrid.noviana@staff.uns.ac.id**, [2]a_kartikasari@ugm.ac.id, [3]a_sihabudin@ugm.ac.id

Abstrak

Kebutuhan nutrisi untuk anak berbeda dengan orang dewasa. Data Kementrian kesehatan Republik Indonesia menunjukkan bahwa pada tahun 2017 ada 17.8% anak di bawah lima tahun (balita) mengalami malnutrisi, salah satunya terkait dengan masalah pemberian Makanan Pendamping ASI (MP-ASI). MP-ASI diberikan kepada bayi mulai usia 6 – 24 bulan. Penelitian ini bertujuan untuk membangun model pencarian MP-ASI berbasis ontologi dan mampu menjadi perawatan bagi bayi yang mengalami malnutrisi. Model pencarian dibangun untuk bisa memahami input bahasa alami yang diberikan pengguna. Model pencarian juga bisa melakukan reasoning dengan mengimplementasikan seperangkat aturan logika untuk mendapatkan pengetahuan tentang alternatif menu MP-ASI untuk bayi. Metode yang digunakan dalam penelitian ini adalah pengumpulan data, mendesain model pencarian, membangun ontologi, membangun SWRL, pemrosesan bahasa alami dan pengujian oleh pengguna dan ahli gizi. Penelitian ini berhasil membangun model pencarian MP-ASI berbasis ontologi dalam bentuk web semantik. Hasil pengujian menunjukkan bahwa web mampu menyediakan alternatif menu MP-ASI sesuai kebutuhan nutrisi bayi. Web semantik memiliki tingkat usability yang tinggi yaitu 4.01 dari skala 1 sampai 5.

Kata kunci*—Ontologi, semantik, semantic web rules language, pemrosesan bahasa alami*

Abstract

Children's nutritional requirements differ from those of adults. The health ministry's Indonesian data shows that in 2017, there were 17.8% of malnourished children under five years old (toddlers), one of which was related to complementary breastfeeding problems. Complementary breastfeeding is given to babies starting at 6–24 months of age. This research aims to build a complementary breastfeeding search model and be able to present it as a treatment for malnourished babies. A search model is built to understand natural language input given by a user. Also, it can do reasoning by applying a set of rules to obtain implicit knowledge about the complementary breastfeeding menu recommended for babies. The methods used in this research are data collection, designing a search model, building an ontology model, building SWRL, natural language processing, and usability testing by users and nutritionists. This research succeeded in building an ontology-based complementary breastfeeding search model in the form of a semantic web. The testing result shows that the web can provide an alternative complementary breastfeeding menu according to the baby's nutritional needs and has a high usability capability of 4.01 on a scale of 1 to 5.

Keywords— *Ontology, semantic, semantic web rules language, natural language processing*

Received January 6th,2022; Revised July 21th, 2022; Accepted July 30th, 2022

1. INTRODUCTION

Food contains nutrients derived from the ingredients used in the making process. Humans need to consume food every day to meet the nutritional needs of their bodies. Children's nutritional requirements differ from those of adults. Based on nutrition status monitoring by the health ministry of Indonesia in 2017, the number of children under five years old experiencing nutrition deficiency reached 17,8% [1]. The poor health condition of toddlers has prompted the government to initiate efforts to improve the nutrition status of toddlers, one of which is the provision of complementary breastfeeding men. [2] A states that malnutrition in society directly or indirectly affects 60% of the 10.9 million children who die each year and that 2/3 of the mortality rate is related to complementary breastfeeding practice in the first year of life. Hence, it is necessary to develop a technology to provide an alternative complementary breastfeeding menu according to the baby's nutritional needs. One of them is an ontology-based searching model. The search model will provide suggestions on certain things according to user needs. The output is a solution obtained after processing information that has been adjusted to the existing data query [3]. The rapid development of information makes data storage possible by using an ontology model [4].

Several related studies have been conducted in various domains. In health and its treatment domain, carried out by [5], which focused on obese thyroid patients, [6] focused on tuberculosis sufferers in India, and [7] focused on diabetic patients. In the field of food, [8] creates an ontology to provide healthier diet food. In the field of nutrition, [9] developed an ontology-based search model to help patients with vitamin D deficiency. In the food and health domain, [10] developed an ontology-based search system for food recipes for people with diabetes mellitus, gout, and hypertension problems. This research aims to build an ontology-based search model in the complementary breastfeeding domain.

An ontology model is used as the database in this research because it has the flexibility needed to form relationships between objects. For example, in this research, there is a relationship between the complementary breastfeeding menu and the ingredients needed to make it. Using ontology does not necessitate the creation of foreign key storage space in advance, and can be directly connected using a property as needed. Ontology also has the advantage of defining the relationship between objects in the form of a subject, predicate, and object (SPO). This definition will facilitate the system's understanding of input in the form of natural language. Ontology also has the facility to provide logical rules for the knowledge it has. These rules are called Semantic Web Rules Language (SWRL) as a logical reason to obtain some knowledge according to user desire. Therefore, this research uses the ontology model as its knowledge base, and the alternative breastfeeding menu provided is based on SWRL.

This research aims to provide clinical resources about complementary breastfeeding menus that meet children's nutrition needs. The combination of ontology knowledge and natural language processing allows a machine to better understand what the user needs because it is more flexible, defined, and logical. Therefore, the machine can find the best solution faster.

2. METHODS

The methods used in this research can be seen in Figure 1.

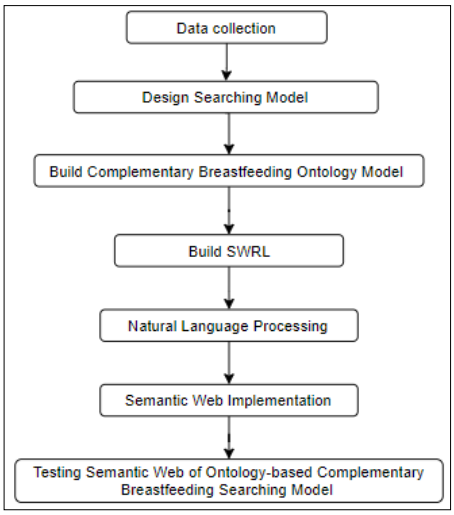

Figure 1 The methods used

2.1 Data Collection

At this stage, data regarding complementary breastfeeding recipes and nutrition was collected, which was obtained from several sources. Table 1 shows the data collection obtained to build the complementary breastfeeding ontology model.

Table 1 Data collection

No.	Source	Knowledge obtained
1.	[11]	▪ Nutrition information for Indonesian snacks
2.	[12], [13], [14]	▪ Food ingredient nutrition information
3.	[15], [16], [17], [18]	▪ Menu for complementary breastfeeding
4.	[19]	▪ The baby's nutritional needs
5.	[20], [21], [22], [23], [24]	▪ Food malnourishment treatment

2.2 Design Searching Model

Searching model design is divided into three main components: word checking, language processing, and information building. Figure 2 shows the design of the search model.

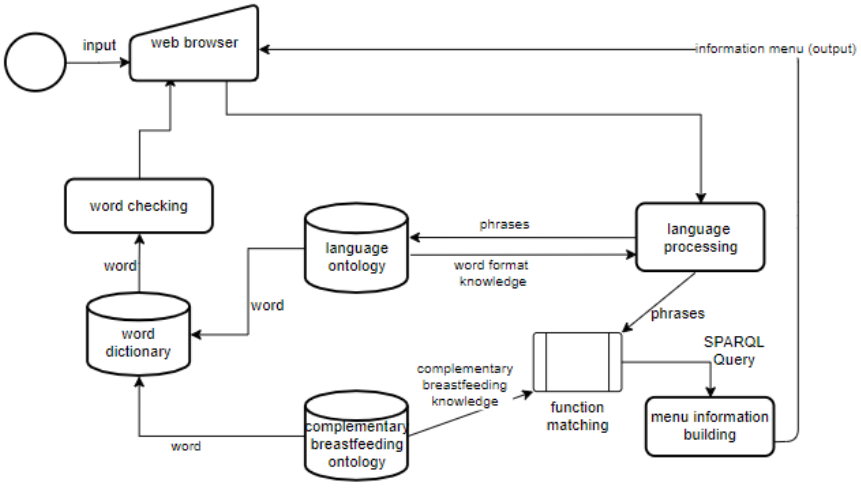

Figure 2 Design of Searching Model

2.3 Build Complementary Breastfeeding Ontology Model

The Ontology model was built using Protégé Portable Version 5.5.0. Modeling was done by determining its concepts such as class, subclass, object property, data property, annotation property, and SWRL according to the requirements needed.

2. 3.1 Class and Subclass

Class and subclass are the concepts of the complementary breastfeeding ontology. Classes and subclasses are created using nouns because they are considered subjects or objects in semantic relations. Figure 3 shows the class and subclass built on the ontology model.

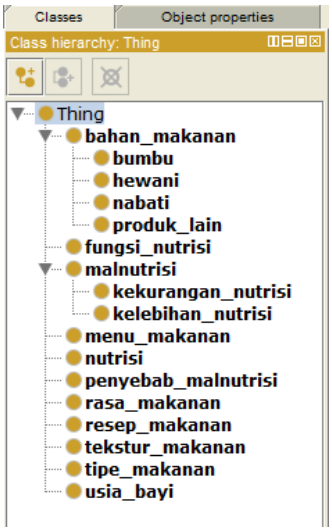

Figure 3 Class and subclass

2. 3.2 Object Property

An object property is used to define a relationship between one class and another so that there is a connection between classes. Figure 4 shows object properties built on an ontology model.

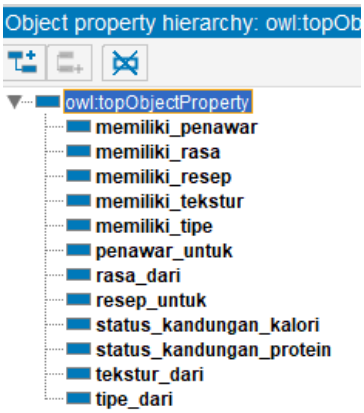

Figure 4 Object property

2. 3.3 Data Property

Data properties are similar to object properties. The distinction not only distinguishes between classes but also adds some value to it. Figure 5 shows data properties built on an ontology model.

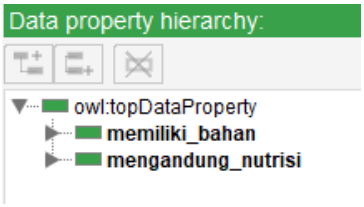

Figure 5 Data property

2. 3.4 Annotation Property

In ontology, annotation properties are used to link information between classes, object properties, data properties, and instances. Each annotation property consists of an annotation property and an annotation value. Annotation values can be IRI, literals, or instances. Figure 6 shows the annotation properties built on the ontology model.

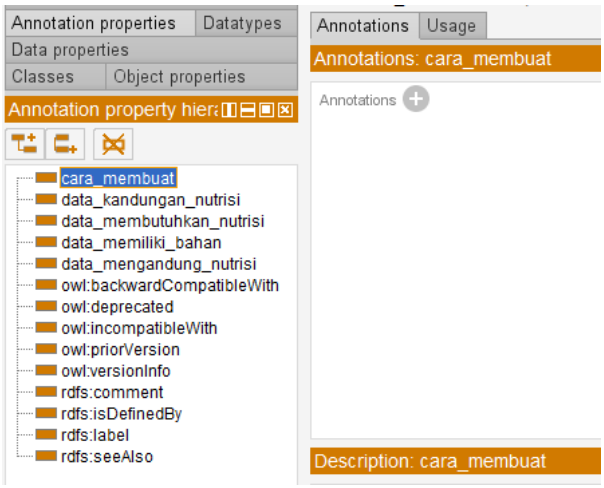

Figure 6 Annotation property

2. 3.5 Instance

Instances are individuals that represent ontology concepts. Everything can be an instance. Figure 7 shows an example of instances built on an ontology model.

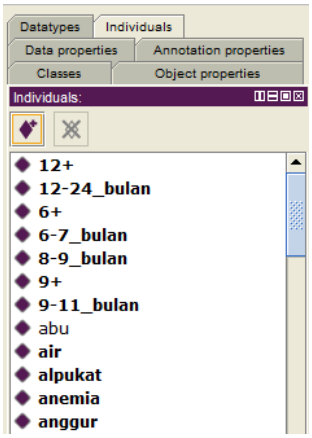

Figure 7 Instances

Figure 8 shows the ontology model this research built to build a complementary breastfeeding search model.

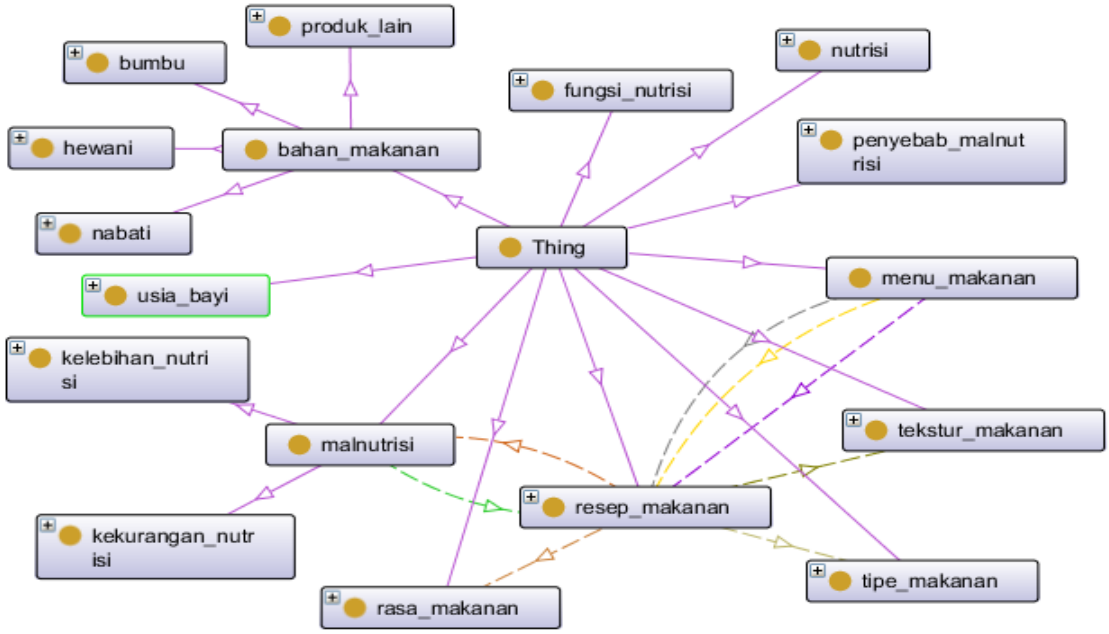

Figure 8 Complementary breastfeeding ontology model

2. 4 Semantic Web Rules Language

SWRL is a logical rule to do logical reasoning so that alternative complementary breastfeeding is close to actual treatment. It will be given by a nutritionist to provide complementary food according to the baby's needs. The rules that researchers used in this research are shown in Table 2.

SWRL	Result
SELECT DISTINCT ?resep_makanan ?usia_bayi ?malnutrition WHERE{{?resep_makanan mpasi:resepFor ?usia_bayi. ?malnutrisi mpasi:hasTreatment ?resep_makanan.?bahan_makanan mpasi:data_memiliki_bahan ?memerlukanBahan. ?resep_makanan ?memiliki_bahan ?value. filter regex(str(?usia_bayi),8-9 bulan"). filter regex(str(?malnutrisi),""). filter regex (str(?memiliki_bahan),"").}	recipes for babies aged 8-9 months with certain malnutrition

2. 5 Natural Language Processing

The search model will use a matching function to understand the user's natural language input. The function will be applied to the ontology that has been mapped into its triples. SPARQL Query: input is represented so the input can be recognized by the SPARQL Query. Figure 9 shows the concept that this research uses to process natural language input.

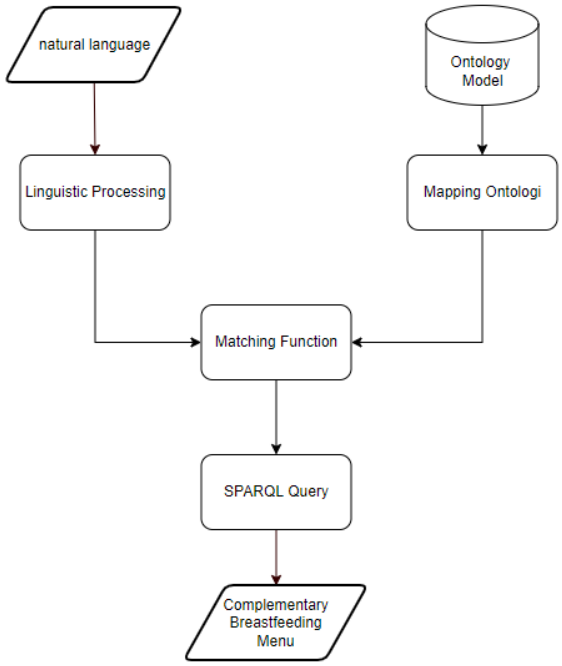

Figure 9 Natural language Processing

2. 6 Semantic Web Implementation

The Semantic Web was created using the Java programming language and the Visual Studio Code programming language editor. A variety of libraries are also used by the semantic web to handle user interface views, access ontology knowledge, and process natural language input. Several main components to building a semantic web of ontology-based complementary breastfeeding search models are :

a. Configuration

The configuration component was used to write all the main settings of all the libraries in the semantic web. Some configurations made are java spring configuration, API XML, OWL API, and Standford library configuration.

b. Ontology

The Ontology component is used to store all the knowledge needed, both complementary breastfeeding and language knowledge.

c. Tree

Programming component that is used for ontology mapping purposes. This component will change the ontology hierarchy into a tree node so it can be understood by the semantic web.

d. Data Collection dan Matching

Data collection functions as temporary storage of defined tree node forms of ontology knowledge. In data collection, a matching function process was carried out between knowledge and user input to find a match semantic value. Using semantic value information, the web will generate a SPARQL query to get alternative complementary breastfeeding recipes according to the user's wish.

2. 7 Testing

The test is carried out in two stages. First, the web was tested by a nutritionist to evaluate input and output validation based on clinical nutrition. Second, assess the usability capability of the semantic web, which includes usefulness, effectiveness, efficiency, learnability, and respondent satisfaction. Table 3 shows the rating scale that will be given by each respondent.

Table 3 Score Scale by Respondent

No	Score	Usability Rate
1.	5	Very Good
2.	4	Good
3.	3	Good Enough
4.	2	Bad
5.	1	Very Bad

The formulation used to evaluate usability is shown in Formula 1 (Rubin & Chisnell, 2008).

$$Nilai\ kriteria\ usability = \frac{Total\ score}{number\ of\ responden} \quad (1)$$

3. RESULTS AND DISCUSSION

This research succeeded in building a semantic web of ontology-based complementary breastfeeding searching models. can be accessed by typing http://localhost/website in a web browser. Figure 10 shows the semantic web main page.

Figure 10 Main page

Semantic websites are capable of detecting incorrect input and informing the user of the error. Figure 11 shows the notification that appears when a user gives the wrong input.

Figure 11 Error notification

The main ability of the semantic web is to understand natural language input by users. Figure 12 shows the output results obtained after the input was processed by the semantic web.

Figure 12 Output result

The semantic web of the complementary breastfeeding searching model can display information contained in a complementary breastfeeding recipe. Figure 13 shows complementary breastfeeding recipe information for "Pure Wortel dan Jeruk".

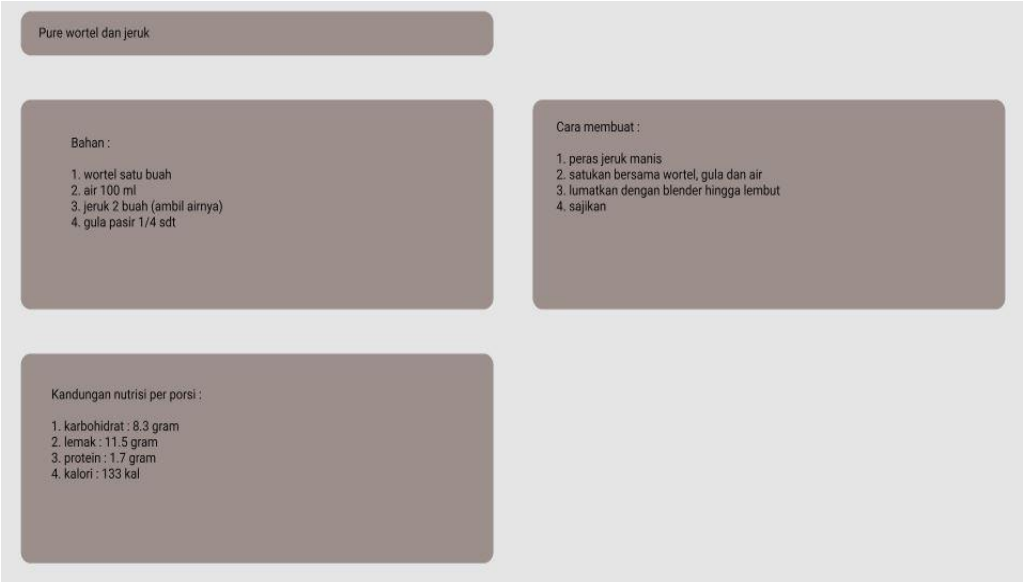

Figure 13 carrot and orange puree recipe

Nutritionists and respondents both tested the semantic web. Testing by nutritionists stated that the web appearance and features are simple, so it will be easily accepted by the public. The colors used are not too excessive, so it is comfortable to see. For malnourished treatment, the number of recipes needs to be increased so users can get a wider variety of

recipes. Overall, the web gets a score of 86,92 points on a scale of 0–100, so it can be said that it is feasible to be published and tested for public use.

Meanwhile, testing by users focused on semantic web usability capabilities. Testing is done by giving a questionnaire to a respondent. Respondents are users who have tried using the web. Of the 36 respondents using formula (1) for calculation, usability testing results were obtained as shown in Table 3.

Table 3. Usability Testing Result

Usability Aspect	**Score**
Usefulness	3,86
Efficiency	4,09
Effectiveness	3,95
Learnability	4,12
Satisfaction	4,03
Usability	4,01

4. CONCLUSIONS

This study succeeded in building an ontology-based complementary breastfeeding search model that takes into account the nutritional content of each food recipe for 6–24-month-old babies. Test results show that a validation test conducted by nutritionists, states that the web appearance and features are simple, so it will be easily accepted by the public. The colors used are not too excessive, so it is comfortable to see. For malnourished treatment, the number of recipes needs to be increased so users can get a wider variety of recipes. Overall, the web gets a score of 86,92 points on a scale of 0–100, so it can be said that it is feasible to be published and tested for public use. And semantic web usability capabilities that were tested by respondents showed that their usability capabilities level was good because they obtained 4,01 results on a scale of 1 to 5. This study succeeded in building a semantic web, based on an ontology model to get a better understanding of natural language input from users.

ACKNOWLEDGEMENTS

The author would like to thank the LPDP for providing financial support for this research.

REFERENCES

[1] Kemenkes RI, 2018, Situasi Balita Stunting di Indonesia, *Kementerian Kesehatan RI*, *1*, 2

[2] Ikatan Dokter Anak Indonesia, 2011, Asuhan Nutrisi Pediatrik, *UKK Nutrisi Dan Penyakit Metabolik*, 24

[3] R. Burke, 2007, *The Adaptive Web* (Vol, 4321), https://doi,org/10,1007/978-3-540-72079-9

[4] H. Gorski's, L. Aleksejeva & I. Poļaka, 2018, Database Concepts in a Domain Ontology, *Information Technology and Management Science*, *20*(1), 69–73, https://doi,org/10,1515/itms-2017-0012

[5] T. Muthuraman & G. Sankaran, 2014, A framework for a personalized decision support system for the healthcare application, *Health Science Journal*, *8*(2), 262–270

[6] K. Abhishek & M. Singh, 2016, An ontology-based decision support for tuberculosis management and control in India, *International Journal of Engineering and Technology*, *8*(6), 2860–2877, https://doi,org/10,21817/ijet/2016/v8i6/160806247

[7] R. F. Alharbi, J. Berri & S. El-Masri, 2015, Ontology-based clinical decision support system for diabetes diagnostic, *Proceedings of the 2015 Science and Information Conference, SAI 2015*, (July), 597–602, https://doi,org/10,1109/SAI,2015,7237204

[8] P. Doshi & V. Pandya, 2015, A Review on Design and Development of Decision Support System for Right Understanding About Some Food Products Supported By Issn : 2278-6252 Introduction : *International Journal of Advanced Research in Engineering and Applied Sciences*, *4*(4), 43–52

[9] T. Muthuraman & G. Sankaran, 2014, A rule-based decision support system for aiding vitamin D deficiency management, *Indian Journal of Science and Technology*, *7*(1), 48–52

[10] C. Agusniar, 2017, *Pencarian makanan dan resep masakan berbasis ontologi untuk penderita penyakit (studi kasus : asam urat, diabetes melitus dan hipertensi)*, Thesis, Universitas Gadjah Mada

[11] BPOM RI, 2013, *Informasi kandungan gizi pangan jajanan anak sekolah*, Jakarta: Badan POM RI

[12] Institute of Nutrition, of, 2014, *ASEAN Food Composition Database ASEANFOODS Regional Centre and IN FOODS Regional Database Centre* (1st ed,), Thailand: ASEANFOODS Regional Centre

[13] S. Size & A. Pears, 2004, *Fruit & Vegetable Nutrition Facts Chart*, Dole Food Company

[14] B. Stadlmayr, R. Wijesinha-bettoni, D. Haytowitz, D. Rittenschober, J. Cunningham, R. Sobolewski & U. R. Charrondiere, 2011, *Infoods guidelines for food matching*, Roma: Food and Agriculture Organization

[15] Department of Health Australia, 2014, Healthy food for babies and toddlers, In *Australian Guide to Healthy Eating* (1st ed, pp, 1–44), New South Wales: Commonwealth of Australia

[16] A. Istiany & A. B. Febry, 2017, *350 Resep MPASI & Makanan Sehat untuk Anak* (K, Ayu, Ed,), Jakarta: Demedia

[17] A. Savitri, 2018, *BUKU PINTAR 365 HARI MPASI TERLENGKAP.pdf* (E, Namara, Ed,), Bantul: Idesegar

[18] S. Soedibyo & F. Winda, 2017, Pemberian Makanan Pendamping Air Susu Ibu pada Bayi yang Berkunjung ke Unit Pediatri Rawat Jalan, *Sari Pediatri*, *8*(4), 270, https://doi,org/10,14238/sp8,4,2007,270-5

[19] K. F. Michaelsen, L. Weaver, F. Branca & A. Robertson, 2003, *Feeding and Nutrition of Infants and Young Children* (87th ed, F, Theakston, Ed,), Copenhagen: World Health Organization

[20] R. Dhaked, & M. C. Gupta, 2016, A critical review of malnutrition and its management 1 1 2, *International Journal of Medical and Health Research*, *2*(4), 43–47

[21] H. Kismul, J. Broeck, Van Den & T. M. Lunde, 2014, Diet and kwashiorkor : a prospective study from rural DR Congo, *PeerJ*, p, 17, https://doi,org/10,7717/peerj,350

[22] RSCM, 2015, *From Zero to Three: Golden Period for Golden Future* (6th ed,; D, R, Sjarif & K, Yuliarti, Eds,), Jakarta: Departemen Ilmu Kesehatan Anak FKUI-RSCM

[23] G. Srivastava, 2017, Protein Calorie Malnutrition, *Food, and Nutrition Journal*, *2*(04), 2–5, https://doi,org/10,29011/2575-7091,100036

[24] D. Muchtadi, 2001, TIMBULNYA PENYAKIT DEGENERATIF (Vegetables as Sources of Dietary Fiber to Prevent Degenera6]tive Diseases), *Jurnal Teknologi Dan Industri Pangan*, *XII*(1), 61–71

[25] J. Rubin & D. Chisnell, 2008, *Handbook of Usability Testing How to Plan, Design, and Conduct Effective Tests* (2nd ed,), Canada: Wiley Publishing, Inc