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by I Gede Wiryawan

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Early Detection Of Development To Children Aged 0 – 24 Months With Developmental Pre-screening Questionnaire Model Using Certainty Factor Method

Indah Qurrothul Uyun [1], I Gede Wiryawan [2,*], Mukhamad Angga Gumilang [3] and Nugroho Setyo Wibowo [4]

[1] Teknik Informatika, Politeknik Negeri Jember; indahuyun@gmail.com
[2] Teknik Informatika, Politeknik Negeri Jember; wiryawan@polije.ac.id
[3] Teknik Informatika, Politeknik Negeri Jember; angga.gumilang@polije.ac.id
[4] Teknik Informatika, Politeknik Negeri Jember; nugroho@polije.ac.id
* Correspondence: wiryawan@polije.ac.id

Abstract: An expert system is a computer application designed to help solve specific problems, one of which is the problem of developmental deviations in children aged 0-24 months. This expert system aims to detect early whether the child has deviations from his development by selecting a questionnaire according to the user's baby age. Method, The expert system in this study uses the Certainty Factor. The calculation method aims to determine the percentage of possible developmental deviations in children. This study's results obtained the accuracy of the expert system method of 100% from 75 experiments carried out directly by experts.

Keywords: Expert System, Child Development, Certainty Factor

Abstrak: Sistem pakar adalah aplikasi komputer yang dirancang untuk membantu memecahkan masalah tertentu, salah satunya adalah masalah penyimpangan perkembangan anak usia 0 – 24 bulan. Sistem pakar ini bertujuan untuk mendeteksi secara dini apakah anak mengalami penyimpangan terhadap perkembangannya dengan cara memilih kuesioner sesuai dengan usia bayi pengguna. Metode Sistem pakar dalam penelitian ini menggunakan Certainty Factor. Metode perhitungan yang bertujuan untuk mengetahui persentase kemungkinan penyimpangan perkembangan yang terjadi pada anak. Hasil penelitian ini diperoleh tingkat akurasi dari metode sistem pakar sebesar 100% dari 75 percobaan yang dilakukan langsung oleh pakar.

Kata kunci: Sistem Pakar, Perkembangan pada Anak, Certainty Factor

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1. Introduction

Children are an invaluable asset to the nation. Children are part of the young population who must be considered to develop optimally. The developmental interests of children must be given high priority. If children are not cared for properly, they will experience deviations in their development, affecting their future. The development of children is very dependent on the upbringing and mindset given by parents.

Many parents think that if the child is not sick, the child will not experience problems with his health, including his development. The toddler period is a crucial period for growth and development; children's ability in language, social understanding, creativity, and emotional intelligence sprints and describes the basis for further development [1]. The

lack of stimulation in children can result in a lack of brain stimulation, so the child's development is not optimal. Therefore periodic stimulation is needed at every opportunity to detect early if the child has developmental irregularities and can be treated immediately [2].

In 2018, according to data from the World Health Organization (WHO), 28.7% of children under five experienced growth and development disorders. Indonesia was the third country with the highest prevalence in Southeast Asia. Indonesia itself still needs serious attention. The rate of growth and development delays is quite large, which is around 5-10% experiencing general developmental delays. 2 out of 1,000 babies have motor development disorders and 3 to 6 out of 1,000 babies also have hearing problems, and 1 in 100 children have low intelligence and speech delays [3].

The rapid growth and development in the first 1,000 days of life make monitoring children's growth and development significant at this age. The first 1,000 days of life are counted from conception in the mother's womb until the child is two years old. In children aged < 2 years, there is very rapid brain development. This period is called the critical period of development and is the right time to make a recovery if there is a developmental disorder. So, parents must monitor the growth and development of their children, especially at the age of < 2 years[4].

In obstetrics, to determine whether a child's development is normal or abnormal, two models can be used: the Denver Developmental Screening Test (DDST) or the Developmental Pre-screening Questionnaire (KPSP) model. KPSP model aims to assess the development of children in four aspects, namely the development of gross motion, good motion, speech and language skills, as well as social and independence of children from 0 to 72 months. The DDST model is generally used for developmental screening in children in urban areas [5], while in rural areas, it still uses the KPSP model [2].

Based on the above background, the researchers propose the development of an expert system research with the title "Early Detection of Developmental Deviations in Children aged 0-24 Months with the KPSP Model Using the Certainty Factor Method". This research expects to be used to better at knowing developmental deviations in children, can provide solutions for early treatment, and can provide certainty values for developmental deviations. Before starting this study, the researchers completed several relevant previous studies. The first is a study related to analyzing one of the factors that influence stunting cases [6]. ext is a study that visualizes stunting case data using a digital map based on a geographic information system. The previous study will be able to be integrated with this proposed study [7].

2. Materials and Methods

2.1. Research Time and Place

This research was completed within six months and took place at the Department of Information Technology, Politeknik Negeri Jember and Yosorati Village, Sumberbaru District, Jember Regency.

2.2. Research Materials and Tools

The materials and tools used in this research are:

- Asus laptop processor Intel(R) Core(TM) i3-4005U CPU @ 1.70GHz 1.70 GHz, Memory 4 GB DDR3, 15 Inch Screen, Windows 10 Operating System;
- Figma to create system user interface design;
- Visual Studio Code as a code editor;
- Xampp as local web server and MySQL as database management system;
- Web Browser to run the system created.

2.3. Research Stages

This activity starts from the problem identification stage, literature study, data collection, system design and implementation, system testing, analysis of results, and report generation. Figure 1 shows the stages of activities in the research carried out.

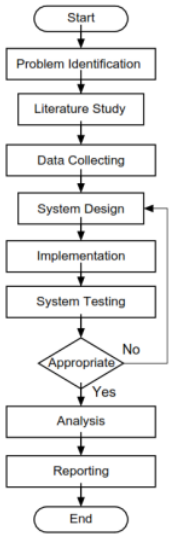


Figure 1. Research Method

1. Problem Identification: The first step in this research is to formulate the problem to be taken and what is the right solution for the problem. From the results of problem identification, it is hoped that the expert system to be built should be able to identify developmental deviations in children aged 0-24 months;
2. Literature Study: The next step is to do a literature study to find out more about the knowledge that will be applied to the system to be created. The literature is sourced from books related to research reports and scientific journals published on the internet;
3. Data Collection: The following research stage is data collection which will become the system requirement. Data about expert systems, the Certainty Factor method, various KPSP model questions, infant age rates, infant deviation solutions, and types of child development. The total data in this study were 75 data on infants aged 0 - 24 months which were obtained from midwives from the Sumberbaru Health Center in Yosorati village;
4. System Design: The next step is to carry out the planning stages of system development in the form of a design to make it easier for users to understand the system to be made;
5. System Implementation: The next step is implementing the previous system design based on the related demand analysis. Implementation is the coding stage using the PHP programming language and MySQL database;
6. System Testing: The testing step is carried out to determine whether the system can work according to the previous plan. The test phase is used to find errors and ensure the expert system will provide accurate results;
7. Analysis of Results: Analyzing the results is a continuation of system testing. The aim is to understand the function of the system design that has been designed previously;
8. Reporting: The final step is to make a report, which is to report the results of the activities carried out from the research that has been done.

2.4. Developmental Pre-screening Questionnaire (KPSP)

According to the Ministry of Health, the Health Service has collaborated with the Indonesian Pediatrician Association (IDAI) to develop various stimulation, testing, and early developmental intervention tools for children aged three months to 72 months, namely the Developmental Pre-Screening Questionnaire (KPSP) [8]. This tool is suitable for Puskesmas health workers, doctors, midwives, nurses, nutritionists, public health educators, and psychologists, and also for officers from other departments to perform tasks that stimulate and detect developmental deviations in children from an early age.

The purpose of screening/examination of child development using KPSP is to determine whether the child's development is normal or there are deviations. KPSP contains two kinds of questions: questions answered by the caregiver or mother and the procedure for ordering the caregiver or mother to carry out the tasks written in the KPSP.

2.5. Certainty Factor Method

Shortliffe Buchanan first introduced the Certainty Factor in 1975. A certainty factor is a method to prove a fact that is certain or uncertain. This theory is presented in the degree of confidence. CF states the degree of confidence in an event (fact or hypothesis) based on evidence (expert opinion). This method is commonly used in expert systems to diagnose something that is not certain [9]. The certainty Factor formula is defined as follows:

$$CF(h, e)=MB(h, e)-MD(h, e) \quad (1)$$

From function (1), it can be interpreted that CF [h, e] is a certainty factor, MB [h, e] is a measure of belief, namely the level of confidence in the hypothesis (h) if given evidence (e) between 0 and 1, and MD [h, e] is a measure of disbelief, namely the level of distrust of the hypothesis (h) if given evidence (e) between 0 and 1 [10]. There are several combinations of certainty factors for certain premises:

3.1.1. Certainty Factor with one premise

$$CF[h, e]=CF[e]*CF[rule]=CF[u]*CF[e] \quad (2)$$

From the function (2) above, it can be interpreted that CF[u] is the confidence value given by the user while CF[e] is the confidence value given by the expert.

$$CFcomb\,[CF1, CF2\,] = CF1 + CF2 * (1 - CF1\,) \quad (3)$$

From function (3), it can be interpreted that CF1 is the first result of the previous equation and the value of CF2 is the second result of the previous equation. Meanwhile, CFcomb is the CF value of the combination of CF1 and CF2.

2.6. Single Decision Threshold Testing

A single decision threshold is chosen to measure system reliability and detection capability. The working principle of this method is to compare the system results (prediction value) with results by experts. In this study, a midwife (actual value). The Confusion Matrix table illustrates the distribution of the description of the system test results, which are then mapped into a table. The general terms used are [11]:

1. True Positive (TP) is if the patient's disease is proven correct and the agnostic test results indicate the presence of disease;
2. True Negative (TN) is if the patient's disease is found to be incorrect and the agnostic test results do not indicate disease;
3. False Negative (FN) is if the patient's disease is proven correct, but the agnostic test results do not show the disease;

4. False Positive (FP) is if the patient's disease is not proven, but the agnostic test results indicate the presence of the disease.

3. Results

This study resulted in a website-based expert system that can be used to detect early developmental deviations in children aged 0-24 months with the KPSP model. The Certainty Factor method is used to determine the percentage of possible developmental deviations in children by calculating the number of each failed sector/developmental aspect.

To produce possible developmental deviations in children, what must be done is that parents are required to answer the KPSP model questions according to the age of the baby. The system will calculate the Certainty Factor. Data on age, developmental aspects, KPSP questions, and baby stimulation were obtained from the 2019 SDIDTK guidebook and verified by experts [8].

3.1. User Interface Implementation

3.1.1. Main Page

When the user presses the website link from this expert system, the application's main page will appear, which can be seen in Figure 2.

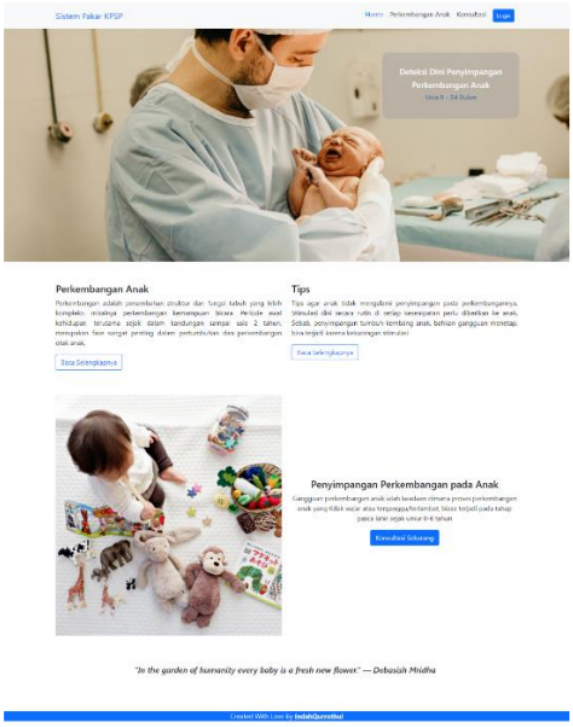


Figure 2. Main Page User Interface

3.1.2. Consultation Page

This consultation page is a page for users to conduct consultations. Before entering the questionnaire, the user must fill in personal data, which serves as a recap of the user data of this expert system. Figure 3 is a display for filling out the user data form. While Figure 4 is a display of the consultation page of this system.

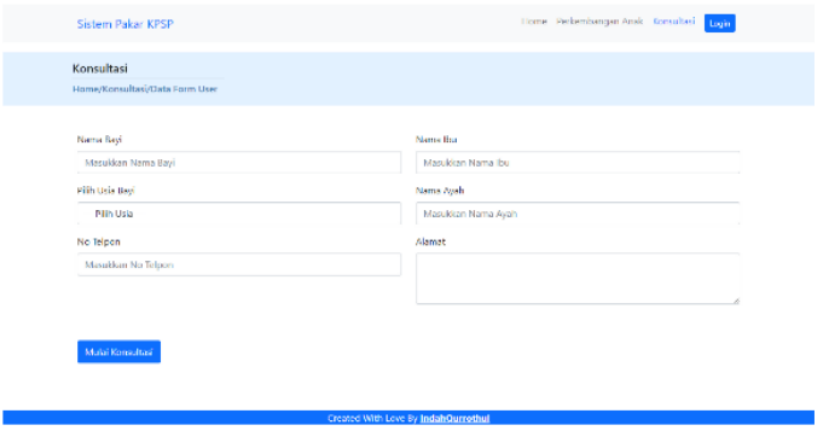


Figure 3. Form Input Consultation Page

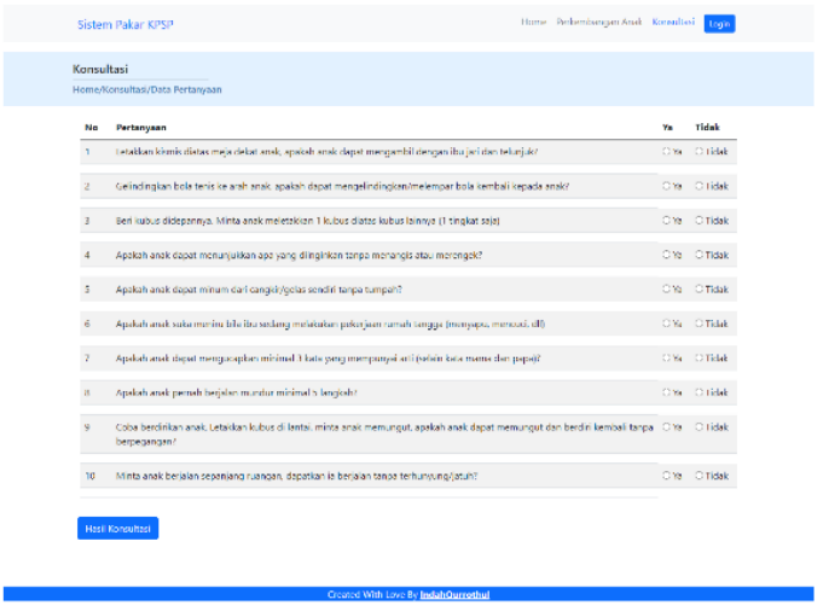
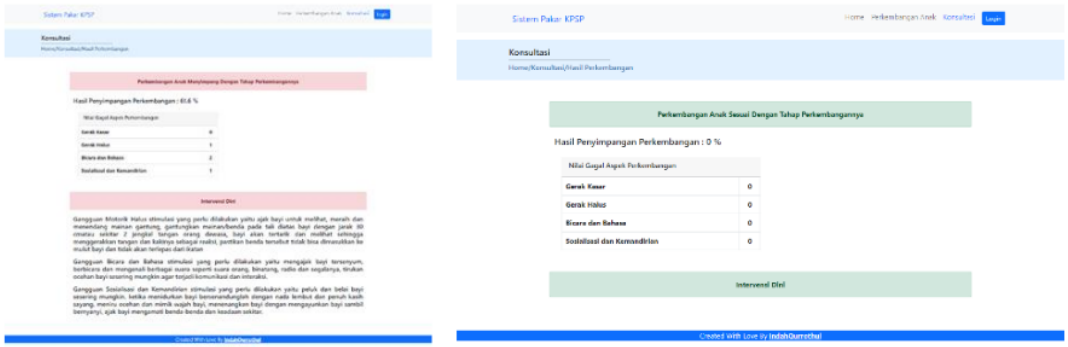


Figure 4. Consultation Page User Interface

3.1.3. Consultation Result Page

The consultation results page is a page that contains the results of the consultation for early detection of developmental deviations in children that users have carried out. This page will contain the type of child development, whether the child's development is appropriate, doubtful, or deviant, as well as the percentage of possible developmental deviations that occur in the child and the weight of failure in each sector of the existing developmental aspects. Not only that, but the results of this consultation also show early intervention or stimulation that parents or caregivers can carry out if the baby has doubtful or deviant developmental disorders. Figure 5(a) is a page display of the results of the consultation for abnormal baby development. Figure 5(b) is a page display of the consultation results for appropriate baby development.



(a) (b)

Figure 5. Results of Consultation Page User Interface: (**a**) Results of Consultation Abnormal Page User Interface; (**b**) Results of Consultation Normal Page User Interface.

3.2. Calculation of the Certainty Factor Method

From the KPSP assessment, an expert CF score is given. To get the CF value of the expert by doing the CF equation, namely the MB value minus the MD value, where the value is obtained from the results of expert interviews. So that the expert CF value is obtained, which is 0.2 for each aspect of development, while the user answered the selected questionnaire with the confidence weight, the confidence weight was obtained from the SDIDTK book with a value of Yes = 0, No = 1. An example of calculating child development is as follows:

Child A did a consultation at the age of 0-3 months and got the results that the number of failed sectors 1 (gross motion) was 0. the number of failed sectors 2 (fine motion) was 2. the number of failed sectors 3 (speech and language) was 1. the number of failed sectors 4 (socialization and independence) is 0.

Based on the consultation results, it is calculated using equation (2) of the CF method:

CF_failedsector1= CF_User *[CF]_Pakar

CF_failedsector1= 0 * 0.2

CF_failedsector1= 0

CF_failedsector2= CF_User *[CF]_Pakar

CF_failedsector2= 2 * 0.2

CF_failedsector2= 0.4

CF_failedsector3= CF_User *[CF]_Pakar

CF_failedsector3= 1 * 0.2

CF_failedsector3= 0.2

CF_failedsector4= CF_User *[CF]_Pakar

CF_failedsector4= 0 * 0.2

CF_failedsector4= 0

After each failed sector is calculated, proceed with the following equation: CF combine. As calculated below:

$$CF_{comb1}(CF_1, CF_2) = CF_1 + CF_2 * (1 - CF_1)$$
$$= 0 + 0.4 * (1 - 0)$$
$$CF_{old1} = 0.4$$

$$
\begin{aligned}
CF_{comb2}(CF_{old1}, CF_3) &= CF_{old1} + CF_3 * (1 - CF_{old1}) \\
&= 0.4 + 0.2 * (1 - 0.4) \\
CF_{old2} &= 0.52 \\
CF_{comba}(CF_{old2}, CF_4) &= CF_{old2} + CF_4 * (1 - CF_{old2}) \\
&= 0.52 + 0 * (1 - 0.52) \\
CF_{comb} &= 0.52 \\
Presentase &= CF_{comb} * 100\% \\
&= 0.52 * 100\% \\
&= 52\%
\end{aligned}
$$

Based on the calculations that have been done, the percentage result is 52%. The baby's development may be a "doubtful" baby development according to the parameters for the level in this system, namely:

1. If the final score is 0-20%, the child's development is normal;
2. If the final score is 21 – 60% of the child's development is doubtful;
3. The child's development deviates or abnormal if the final score is 61 – 100%.

3.3. System Accuracy Testing

Testing the accuracy of the early detection system for developmental deviations in children aged 0 – 24 months was carried out by Midwife Insiyah A.Md. Keb, who is an expert on the expert system that has been designed. System accuracy testing is carried out to determine what percentage of system accuracy is seen from the final results of the consultation. At this stage, the expert will conduct the test and then calculate the number of tests successfully carried out, which can be seen in Table 1. The accuracy test was carried out 75 times with the provisions of the baby's age 0-24 months. Then it can be seen how accurate the expert system for early detection of developmental deviations has in this child. System accuracy testing is represented using a single decision threshold (one feature) [1].

There are four possible decisions in the single decision threshold, namely TP (True Positive), where the expert results manually and the applic

ation state Normal. FP (False Positive) where the test results manually stated Abnormal, but the application declared Normal. FN (False Negative) where the test results manually state standard but the application states Abnormal. TN (True Negative) where the test results manually and in the application, state deviate.

Table 1. System Accuracy Test Results

No	Identification of Expert	Identification System	Conclusion
1	Normal	Normal	appropriate
2	Normal	Normal	appropriate
3	Normal	Normal	appropriate
4	Normal	Normal	appropriate
5	Doubtful	Doubtful	appropriate
6	Doubtful	Doubtful	appropriate
7	Abnormal	Abnormal	appropriate
8	Abnormal	Abnormal	appropriate
9	Abnormal	Abnormal	appropriate
10	Abnormal	Abnormal	appropriate
…	…	…	…
75	Abnormal	Abnormal	appropriate

System validity is assessed by calculating the TP, TN, FP, and FN values from the test results:

$$TP = \text{Normal - Normal}$$
$$TP = 41$$
$$TN = \text{Abnormal - Abnormal}$$
$$TN = 18$$
$$FP = \text{Abnormal - Normal}$$
$$FP = 0$$
$$FN = \text{Normal - Abnormal}$$
$$FN = 0$$
$$\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)} \times 100\%$$
$$\text{Accuracy} = \frac{(41+18)}{(41+18+0+0)} \times 100\%$$
$$\text{Accuracy} = 100\%$$

From the calculation of the Single Decision Threshold test method above, the early detection system of developmental deviations in children aged 0 - 24 months with the KPSP model using the Certainty Factor method got an excellent accuracy value of 100%.

Table 2. Scenario and Result of Blackbox testing

Feature	Case	Result	Conclusion
Knowledge Base (Administrator)	- Press Knowledge Base on the sidebar	- The knowledge base data page appears, containing the knowledge base info in the system.	Consistent
	- Press the add data button	Show form add knowledge base data	Consistent
	- Fill in the add data form (data is incomplete or incorrect), press the save button	- Failed to add a new knowledge base due to incomplete data	Consistent
	- Fill in the add data form (complete and correct data), press the save button	- Successfully save new knowledge base data	Consistent
	- Press the edit action button	- Show knowledge base data edit form	Consistent
	- Change the contents of the knowledge base data (data is incomplete/incorrect), press the save button	- Failed to modify knowledge base data due to incomplete data	Consistent
	- Change the contents of the knowledge base data (complete and correct data), press the save button	- Successfully changed knowledge base data	Consistent
	- Press the delete action button	- Successfully deleted knowledge base data	Consistent
Consultation (User)	- Access the consultation page	- The user data/user biodata form page appears	Consistent
	- Fill in the user data form/user biodata (data not complete/incorrect), press the start consultation button	- Failed to go to the consultation page	Consistent
	- Fill in the user data/user biodata form (complete/correct data), press the start consultation button	- Successfully filled in user data, the consultation page appears	Consistent
	- Answering the consultation question/questionnaire incompletely, press the consultation result button	- Failed to go to the consultation results page, there is a notification that selects an answer that is still empty	Consistent
	- Answer the complete consultation question/questionnaire, press the consultation result button	- The consultation results page appears in the form of information on the type of child development, developmental deviations in the form of percentages, and the required stimulation	Consistent

3.4. Blackbox Testing

System functionality testing is done first by using Black Box testing. The things tested include application details such as the appearance of the application, the functionality in

the application, and the suitability of the application based on the previously designed application flow. This black box test will be carried out by two system examiners, coming from system experts who have long been lecturers and system researchers. For test results, the tester will give a value of "Consistent" if the expected result is as expected, and if the expected result is not as expected, the tester may give a value of "Not Consistent." The results of the black box test show "appropriate" results for each form of application testing, meaning that all functions in the early detection system for child developmental deviations have worked well and can be used. Some samples of the test results carried out by the two system testers can be seen in Table 2.

4. Discussion

After testing the system, the results obtained from the test results are as follows (1) The system accuracy test is carried out 75 times by experts (2) The system accuracy test results are 100% (3) From the results of testing the early detection system of developmental deviations in Children with the KPSP model using the Certainty Factor method can help the general public, especially mothers or caregivers, in early detection of developmental deviations in children.

5. Conclusions

From the research that has been done, the following conclusions are obtained. The system for early detection of developmental deviations in children aged 0-24 months with the KPSP model using the Certainty Factor method was developed using the PHP programming language, CodeIgniter Framework, and MySQL database. The Certainty Factor method is implemented to detect developmental deviations in children aged 0-24 months with the KPSP model by first grouping the user with no answers in each developmental aspect and then multiplying the user CF with expert CF. The next step is calculating CF combined for every aspect of development. After getting the final result of the CF, combine calculation to get the final result in the form of a CF combine percentage multiplied by 100% so that the results of possible developmental deviations in the user are obtained.

Based on 75 trials of system accuracy testing by Midwife Insiyah A.Md. Keb as an expert, this study got an accuracy rate of 100%, with the answer 75 times accordingly. Based on the results of User Acceptance testing from Experts and Users, this early detection system for developmental deviations aged 0 - 24 months is appropriate for experts in conducting examinations. So overall, the conclusion in this study is that early detection of child development has been completed based on experiments conducted by experts using actual data and evaluations carried out by experts with users. For general users, parents, or caregivers, this system can assist in detecting developmental status in children in order to achieve optimal child development optimally. This research can still be developed by adding several child development tests such as hearing, visual, and mental-emotional tests to identify more complex child development.

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