Web-Based System for Growth and Development Monitoring Early Childhood

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Abstract. The golden age and sensitive period in a child occurred at the age of zero to six years and it is the ages that children can quickly absorb knowledge around them. In this age, however, children are susceptible toward the arising deviation symptoms in their growth and development. Therefore, the deviation symptom in children should be detected as early as possible in order that it will not be permanent and the proper intervention and stimulation can be immediately administered. This study aimed to construct an information system based on the web in order to conduct either screening or detection for the children’s growth and development using Pre-screening Development Questionaire method. The method employed in this study is the one developing waterfall software. It consists of four steps, they are analysis, design, and test to the system. It is then the testing method using Black Box Testing and System Usability Scale (SUS). Based on the usability test on 30 child-caregiver respondents by employing SUS method, it was obtained score 78.33, meaning that the system can be accepted and included in the category of good-excellent.

1. Introduction
Growth and development is a period that will be certainly experienced and traversed by every child. Growth in a child is signed by either physical change or body measurement increased such as body weight gain, body height, head circumference size that can be measured by height and weight unit. While development tends toward the increasing skill in rough motion, smooth motion, speech ability, socialization, and independence. The first five years in a child usually known as the golden age and the opportunity window is the most rapid period of growth and development [1]. In the period as well, a child is able to quickly absorb the information around his/her environment [2]. Therefore, providing the suitable stimulation for a child will be able to guide them in an appropriate growth and development.
In this period, however, there are still found children experiencing retardation in their growth and development resulted from the lack of parent attention in providing children’s growth and development stimulus appropriate to their age from their parents [3]. Therefore in this period, development monitoring is very important to find out either the symptoms or growth and development disorders in children. Thus, intervention and stimulation can be early performed to prevent the occurrence of growth and development deviation in children and so that children can healthily grow and develop [4]. The lack of parental knowledge to monitor health in children results in unconscious disturbance in children [5]. Developmental disorders are usually detected in pre-school age children in Indonesia by 12.8% - 28.5% [6]. It is feared that it will continue to grow over time if it is not quickly resolved.

Indonesian Ministry of Health makes collaborative efforts with the Indonesian Pediatrician Association or Ikatan Dokter Anak Indonesia (IDAI) in compiling the instruments of Early Childhood Stimulation, Detection and Intervention (Stimulasi, Deteksi dan Intervensi Dini Tumbuh Kembang /SDIDTK) to prevent deviations in the growth and development of children. One of the instruments in SDIDTK is Pre-screening Development Questionaire (Kuisioner Pra Skrining Perkembangan/KPSP) [7]. KPSP is a questionnaire for screening children aged zero to six years. It has 9 to 10 questions regarding child development ability that will be answered by parents or caregivers [8]. Through screening, it is expected that parents, health workers, and public can find out the developmental deviations symptoms in children if they begin to appear and then prevention can be immediately conducted to prevent the occurrence of increasingly severe deviations [9].

KPSP method screening examination is performed every 3 months for children aged less than 24 months and once every 6 months for children aged 24 - 72 months. The implementation of KPSP requires parents to take their children to the public health center (Puskesmas) or integrated service post (Posyandu) for screening children, but the public health center still implements a manual system in conducting screening tests. The implementation of manual systems in screening is by using papers containing questions according to the age group of children, papers containing questions will be easily scattered or damaged and documentation to find out the results of screening will be more difficult to do due to missing or damaged papers containing the answers [10]. Technological progress is rapidly increasing; one of the advances in technology is desktop technology. The use of desktop technology is considered to be more efficient in KPSP since the results of answers to questions will be more documented and data will not be easily damaged [11].

Based on the description above, it can be formulated that a web-based information system for monitoring children’s growth and development is needed. Therefore this study aims to develop a web-based information system for child growth and development by using KPSP to monitor mental and motor development in a computerized system rather than manually so as to facilitate the administration of public health center and integrated service post staff in documenting the answer data for screening results.

2. Literature Review
Growth and development are almost the same thing but different in nature, and go together. They are important aspects in a child’s lifetime. One of the efforts to monitor the toddlers’ growth and development is the early detection stimulation of growth and development (stimulasi deteksi dini tumbuh kembang/SDIDTK). The SDIDTK implementation for infants is only documented at 13.28% and this documentation is felt to be less effective because it only focuses on infants aged zero to 12 months. Yet in every Posyandu there are other toddlers (ages 12 months and over to 72 months), in which toddlers (zero to 72 months) are the main target in the measurement [1]. While studies aiming to develop a system or application of early detection of child growth and development are still limited. Most studies already performed are focused on the KPSP effectiveness as SDIDTK instrument in child development [2].
Research related to developing a web-based decision support system regarding detection of child growth [3] and development has been carried out [4]. In their research, the development of web-based information systems regarding growth and development used the Denver II method to assist parents in order to clearly see their toddlers’ development. Similar research, namely developing information systems with the Denver II method [4]. Testing was performed by comparing the calculation results between the Denver manual test and the computerized Denver II test. It was then developed an early detection system based on multimedia [5]. The outcome of this research was combining sound and movement views in the systems it developed. The creation of a decision making website used the MOD (Making Online Decisions) model, the one that reminds parents to further intervene children and guide decision making [6]. Research using mobile technology has been carried out, namely by the use of Android-based smartphones. It employed a pre-screening developmental questionnaire method with the results of the answers to each question being seen by the child’s parents [7]. The Android application was then developed using the forward chaining method [8]. The study outcomes were android applications that were able to display stimulation according to the child’s age and screening tests in the application using the KPSP method. The study by developing android-based applications by evaluating stakeholders from child development experts was also conducted. The outcome was that the application could present the results of the child’s development and display the development graph of the child’s answers as the child gets older [9].

Based on the study by Kadi [10], the use of KPSP method in screening tests on children has a sensitivity value of 95% and a specificity value of 63% compared to the use of the Denver II method in screening tests on children. This study aims to utilize desktop technology in developing a web-based child growth and development detection system using the KPSP method in which the system is divided into three parts, namely for caregivers, Posyandu, and Puskesmas. Caregivers could answer the KPSP question and be able to see the results as well as the conclusions from the system answers, then the results of the child’s answers or data records would be stored in the Puskesmas database and thus make it easier for officers to document it.

3. Method
This study employed the waterfall method in building a web-based child growth and development detection information system. Waterfall method is the one using a systematic and sequential approach for software development ranging from requirements analysis, design, coding to testing[11]. Waterfall diagram used in the study can be seen in Figure 1.

![Waterfall Diagram](image)

3.1 Analysis
It is a requisite analysis stage including data from literature sources, tools for displaying on websites, and other documents needed by the system so that it will produce a website that is capable in performing the tasks expected by the user [12]. This website is intended for users who have children aged between zero and six years old in which users are able to see and conduct screening tests for children as well as print screening test results.

The functional requirement of SDIDTK materials currently still uses manual ones. Based on observations and literature in this study, it is possible to make a system using material from the
SDIDTK handbook and other literature sources. A nonfunctional requirement is Software and Hardware requirements in research.

3.2 Design
The design stage is a representation of the previous stage needs carried out by designing the interface on the website to facilitate users in operating the application.

Use Case Diagram is the one illustrating user interaction with websites. Use Case Diagram used to explain the web for caregivers and Posyandu officers can be seen in Figure 2 and that for Puskesmas administrators can be seen in Figure 3.

Use case in Figure 3 describes the interaction between the user and the web created. User interactions that can be performed on the web are parents or caregivers log on the web then fill in the child’s data in the form of the child’s name, parent’s name, child’s gender, date of birth, and address and then conduct a screening test by answering a series of questions according to the child’s age that appears on the website page. Parents can see the screening test results and then print them. Just like in the use case of either parents or caregivers, the difference between Posyandu use cases is that the Posyandu can view and print historical results from the data of children who have had screening at the Posyandu.

Activity Diagram is the one describing the process and work path by the information system created both from the user side and from the system itself. The activity diagram starts from the beginning of the main page when the user starts the system until the system finishes running. Activity Diagrams on the early detection information systems of child development can be seen in Figure 4.

3.3 Coding
Coding stage is translating design into programming language. It is written in accordance to the program design in order that users can easily operate the website. The programming language used in this study is PHP and wireframe namely Codeigniter.

3.4 Testing
Program testing needs to be done in order to test the website effectiveness and to find out whether the information system is able to meet user needs. Testing on this website used Black Box Testing and Usability Testing. Black Box Testing is a web functionality testing made to find errors that occur in
the system or malfunction in the program. While Usability Testing is the one to find out whether the web is in accordance with what is expected by users by considering the context which includes effectiveness, efficiency, and satisfaction.

| User | Web | Database |
|------|-----|----------|
| Input username and password | LOGIN | |
| Enter child data | Added child examination | |
| Answering questions | Showing questionnaire according to age | |
| Showing Results | Print the results | |
| Logout | Logout | |

![Activity Diagram](image)

**Figure 4.** Activity Diagram

### 4. Result and Discussion

#### 4.1 Result

This study resulted in an early detection information system for child development based on web with KPSP questionnaire method which has three different interface parts, namely interface for caregivers, Posyandu, and Puskesmas. As operating the system, the user will be directed to the login page, the user needs to log in by entering a username and password to be able to access or open the system. Login page is shown in Figure 5.

However, if the user does not have an account or is not registered on the system, the user needs to register an account on the account register page by entering the username, full name, password and then selecting the closest Posyandu. The Account List page is shown in Figure 6.

After the Puskesmas administrator has successfully logged into the system, the administration officer will be directed to the Puskesmas initial interface page that displays the number of caregiver users and registered Posyandu users. The Puskesmas interface page is shown in Figure 7.

On the Puskesmas page, officers can increase the number of Posyandu and add some question items every month that will appear according to the child’s age at the time the caregiver conducts a child screening test. The Posyandu page is shown in Figure 8 and the Monthly Question Page is shown in Figure 9.

Puskesmas administrators can also view all data and the final results of children who have already taken a screening test, and Puskesmas administrator can print the results by selecting the month of the
child’s examination. The Child Data Page is shown in Figure 10 and the Print Results Page is shown in Figure 11.

Figure 5. Login Page

Figure 6. Account List Page

Figure 7. Puskesmas Interface Page

Figure 8. Posyandu Page
Figure 9. Monthly Question Page

Figure 10. Children’s Data Page

Figure 11. Print Results Page
Unlike the initial Puskesmas interface page, the initial interface page for caregivers displays a list of children from caregivers or parents. Prior to conduct a screening test, the caregiver needs to press the “add child examination” button then fill in the child’s data. The caregiver Interface Page is shown in Figure 12.

![Caregiver Interface Page](image1.png)

**Figure 12. Caregiver Interface Page**

Having added the child’s data as the child’s name, parents’ name, child’s birth date, gender, and address, the caregiver can start the screening test by clicking on the “start test” button. After pressing the “start test” button, the caregiver will be directed to the question page that is appropriate to the child’s age based on the child’s date of birth. The Questions page is shown in Figure 13.

![Question Page](image2.png)

**Figure 13. Question Page**

After answering KPSP questionnaire questions, the system will calculate answers from caregivers then display test results based on answers from caregivers or parents. The Results page contains a list of questions and answers that have been completed as well as conclusions from the test results. The results page is shown in Figure 14.

The Posyandu interface page does not differ greatly from the Caregiver interface page. The one that differentiates on the Posyandu page is that it can show all the children list who have had screening and registered on the Posyandu.
4. 2 Testing
The study was conducted using two testing methods, namely Black Box Testing and System Usability Scale (SUS) testing. Black Box Testing is implemented to examine the system functions whether it run well or find an error in the program [11]. The test results of the Black Box Testing are shown in Table 1.

Table 1. Black Box Testing

| No | Item               | Scenario                                                                 | The expected output                                                                 | Result         |
|----|--------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------|
| 1  | Account login      | User enters username and password                                        | Enter to the account page                                                              | Successful     |
| 2  | Input child’s data | Enter the child’s data as the child’s name, address, parent’s name, and the child’s birthday | Child data is stored in the database                                                   | Successful     |
| 3  | Add question       | Puskesmas Administrator clicking the Add Question button                  | Successfully added data and saved in database                                          | Successful     |
| 4  | Question of the month Edit question | Input children’s data then display questions according to the child’s age Administrator pressing the “edit” button | Showing questions according to age Displays data for editing and then the updated data will be stored in the database | Successful     |
| 5  | Answer question    | Caregivers enter the child’s data, as name, date of birth, gender and address. Then press the “start test” button | Displays questions according to the child’s age as the screening test begins          | Successful     |
| 6  | Final result       | Having answered the questions, and thus it displays the conclusions and the answer results to questions | Showing the answer results and conclusions from questions                              | Successful     |
| 7  | Print result       | User clicks on the final result print button                              | Print the final result of child data                                                   | Successful     |
| 8  | Print history      | User clicks on the history button                                         | Print examination history                                                              | Successful     |
| 9  | Edit data          | User clicks on the edit button then enters the data update                | Data successfully updated on the database                                              | Successful     |
| 10 | Add Posyandu       | Puskesmas administrator clicks the Add Posyandu button and enters new Posyandu data | Posyandu data was successfully stored in the database                                  | Successful     |
| 11 | Erase data         | User clicks on the delete button                                          | Data was deleted from the database                                                    | Successful     |
| 12 | Logout page        | Click “Logout” button                                                     | Return to the login page                                                              | Successful     |
Based on Table 2 Black Box Testing, the system functionality has been able to run well and in accordance to what is expected.

SUS is a valid, effective, and reliable measurement tool for a testing by making scores that can be achieved on a system [13]. Testing in this study was conducted on caregivers or parents who have children with a vulnerable age of zero to six years in the area around Pabelan, Kartasura. It was performed by distributing questionnaires to 30 respondents, namely parents and caregivers of children. Respondents were given an explanation of system and the opportunity to try it before they filled out the questionnaire form already given. The test questionnaire was prepared using the SUS format shown in Table 2.

| No | Question                                                                 | Score |
|----|---------------------------------------------------------------------------|-------|
| 1  | I am thinking of using this system again.                                  | 1     |
| 2  | I find this system is complicated to use.                                 | 2     |
| 3  | I find this system is easy to use.                                        | 3     |
| 4  | I need assistant from other people or technicians in operating this system.| 4     |
| 5  | I find the system features have been running properly.                   | 5     |
| 6  | I find that there are many inconsistencies in this system.               | 6     |
| 7  | I think other people will quickly understand how to use this system.     | 7     |
| 8  | I think this system is confusing.                                         | 8     |
| 9  | I find that there are no obstacles in operating this system.             | 9     |
| 10 | I need to get used to first before operating this system.                | 10    |

Score calculation was performed after testing is completed. Calculations with odd numbered questions (1,3,5,7,9) were calculated by subtracting 1 from the number of points obtained by respondents, for even numbered questions (2,4,6,8,10) were calculated by subtracting 5 from the total number of points obtained by respondents. The scores were then sum up. Final score assessment is the number of respondents score multiplied by two point five [14]. The SUS Respondent Score calculation results are shown in Table 3.

The calculation results of respondents’ SUS scores presented in Table 3 resulted in total SUS score of 2350. Then to look for the average value of the total SUS score, it can be seen in equation (1).

$$\text{Average value} = \frac{\sum_{i=1}^{n} x_i}{N}$$

$$x_i = \text{Total SUS score}$$

$$N = \text{Total respondent}$$

The average value of the total score SUS = \frac{2350}{30} = 78.33

The average value of the SUS score is used to assess how well the system measures the SUS score. The detection information system for early childhood growth and development showed a score of 78.33 which means the system was acceptable (acceptable) and included in the good category (good-excellent). The calculation results of the average SUS score can be matched with the SUS score rating shown in Figure 15.

5. Conclusion

Early childhood growth and development information system was created to help monitor growth as well as development in children aged zero to six years. Based on the black box test results, the
system is able to carry out screening checks on children and then produce the same output as by means of manual checks and screening data can be seen by Posyandu officers and Puskesmas to provide the appropriate stimulations as suitable to the child’s age. Based on the SUS test, the system obtained a score of 78.33 which proves to be acceptable and it is included in the good-excellent category.

Table 3. SUS Respondent Score

| Respondent | No 1 | No 2 | No 3 | No 4 | No 5 | No 6 | No 7 | No 8 | No 9 | No 10 | Total Score | Final score (score * 2.5) |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|--------------------------|
| 1          | 5   | 1   | 5   | 2   | 4   | 1   | 5   | 1   | 5   | 2   | 31          | 77.5                     |
| 2          | 3   | 2   | 3   | 2   | 4   | 4   | 2   | 3   | 2   | 3   | 30          | 75                       |
| 3          | 4   | 2   | 4   | 3   | 3   | 3   | 2   | 4   | 3   | 3   | 31          | 77.5                     |
| 4          | 4   | 2   | 4   | 2   | 4   | 2   | 3   | 1   | 4   | 2   | 28          | 70                       |
| 5          | 4   | 3   | 4   | 2   | 4   | 3   | 4   | 3   | 5   | 3   | 35          | 87.5                     |
| 6          | 4   | 4   | 1   | 4   | 4   | 2   | 3   | 4   | 4   | 3   | 33          | 82.5                     |
| 7          | 4   | 2   | 5   | 0   | 2   | 2   | 5   | 2   | 3   | 2   | 27          | 67.5                     |
| 8          | 5   | 2   | 4   | 4   | 4   | 2   | 5   | 1   | 4   | 1   | 32          | 80                       |
| 9          | 5   | 3   | 4   | 2   | 4   | 2   | 3   | 3   | 4   | 3   | 33          | 82.5                     |
| 10         | 3   | 2   | 4   | 1   | 5   | 3   | 5   | 1   | 4   | 3   | 31          | 77.5                     |
| 11         | 3   | 1   | 4   | 1   | 4   | 2   | 4   | 2   | 5   | 2   | 28          | 70                       |
| 12         | 4   | 2   | 4   | 2   | 5   | 2   | 4   | 2   | 4   | 1   | 30          | 75                       |
| 13         | 5   | 4   | 0   | 4   | 5   | 3   | 5   | 3   | 4   | 5   | 38          | 95                       |
| 14         | 4   | 2   | 5   | 1   | 4   | 3   | 5   | 1   | 4   | 5   | 34          | 85                       |
| 15         | 3   | 1   | 5   | 1   | 4   | 3   | 4   | 1   | 3   | 2   | 27          | 67.5                     |
| 16         | 3   | 2   | 4   | 2   | 4   | 3   | 4   | 2   | 4   | 2   | 30          | 75                       |
| 17         | 4   | 2   | 4   | 2   | 4   | 2   | 4   | 2   | 4   | 3   | 31          | 77.5                     |
| 18         | 4   | 2   | 4   | 2   | 5   | 2   | 4   | 2   | 4   | 2   | 31          | 77.5                     |
| 19         | 4   | 2   | 4   | 3   | 5   | 2   | 5   | 2   | 4   | 3   | 34          | 85                       |
| 20         | 4   | 2   | 4   | 4   | 4   | 2   | 4   | 2   | 4   | 4   | 34          | 85                       |
| 21         | 4   | 2   | 3   | 2   | 4   | 2   | 4   | 2   | 4   | 4   | 31          | 77.5                     |
| 22         | 4   | 2   | 4   | 2   | 4   | 2   | 4   | 2   | 4   | 4   | 32          | 80                       |
| 23         | 5   | 2   | 5   | 1   | 5   | 1   | 5   | 1   | 5   | 1   | 31          | 77.5                     |
| 24         | 5   | 2   | 5   | 3   | 5   | 1   | 5   | 2   | 5   | 4   | 37          | 92.5                     |
| 25         | 4   | 2   | 5   | 2   | 5   | 1   | 4   | 1   | 4   | 4   | 32          | 80                       |
| 26         | 5   | 2   | 5   | 2   | 4   | 3   | 4   | 2   | 4   | 4   | 35          | 87.5                     |
| 27         | 4   | 2   | 5   | 2   | 4   | 3   | 3   | 2   | 1   | 3   | 29          | 72.5                     |
| 28         | 4   | 1   | 4   | 1   | 5   | 1   | 4   | 1   | 4   | 1   | 26          | 65                       |
| 29         | 4   | 1   | 5   | 1   | 5   | 1   | 5   | 2   | 4   | 1   | 29          | 72.5                     |
| 30         | 4   | 1   | 5   | 1   | 4   | 2   | 5   | 1   | 5   | 2   | 30          | 75                       |

SUS Total Score 2350

Figure 15. SUS Score Rating

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