



## Application-Based Development of Alternative and Augmentative Communication System for Children with Cerebral Palsy

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**Abstract:** Based on the observation results, children with cerebral palsy were the subjects of the study. They communicate using gestures such as pointing accompanied by meaningless vocalizations. Only some people can immediately understand what the child intends. When they need something, the child will cry and scream. Based on these obstacles, the children need media as an alternative and augmentative communication system that can support them in communicating with their modalities and needs, one of which is using symbolic pictures and voice output. This research aims to design an alternative and augmentative communication program based on the children's assessment results. This research uses a qualitative approach with data collection techniques such as interviews, observations, and documentation. The study results in a program design expected to be implemented as a comprehensive tool to assist children in communication.

**Abstrak:** Berdasarkan hasil observasi, anak dengan cerebral palsy yang menjadi subjek penelitian. Berkomunikasi dengan gesture seperti menunjuk disertai dengan vokalisasi yang tidak bermakna. Tidak semua orang dapat langsung mengerti apa yang anak maksudkan. Ketika membutuhkan sesuatu anak akan menangis dan berteriak. Berdasarkan hambatan tersebut anak membutuhkan media berupa sistem komunikasi alternatif dan augmentatif yang dapat mendukung mereka berkomunikasi dengan modalitas dan kebutuhan mereka, salah satunya dengan bantuan simbol gambar dan output suara. Tujuan penelitian ini adalah untuk menyusun rancangan program sistem komunikasi alternatif dan augmentatif berdasarkan hasil asesmen anak. Metode penelitian ini menggunakan pendekatan kualitatif dengan teknik pengumpulan data berupa wawancara, observasi dan dokumentasi. Penelitian ini menghasilkan sebuah rancangan program yang diharapkan kedepannya diwujudkan menjadi sebuah media utuh yang dapat membantu anak dalam berkomunikasi.

## A. Introduction

Humans are social beings who are interconnected with one another through the process of communication. Through communication, people can share information messages and express opinions and desires. Tommy Suprpto (in [Rovasita, 2018](#)) suggests that communication is the transfer of 'information' or messages from the message's sender to the recipient, which aims to understand the content or intent of the message mutually. Communication can be done using various verbal and non-verbal approaches, such as gestures, eye contact symbols, and facial expressions ([Department of Communities, 2018](#)). The communication course requires two or more people to receive and convey messages. Communication ability is closely related to delays or damage to other systems, cognitive, sensory, motor, psychological, emotional, and environmental abilities ([Aditama, 2018](#)).

Cerebral palsy (CP) describes a group of disorders of the development of movement and posture, causing activity limitation, attributed to non-progressive disturbances in the developing fetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbance of sensation, cognition, communication, perception, and/or behavior and/or by a seizure disorder ([Himmelmann et al., 2017](#)). Cerebral palsy is a motor disorder located in the brain's nerve center. Children with cerebral palsy cannot perform everyday activities such as walking, walking, or talking due to physical, motor, and intelligence disturbances ([Irfan et al., 2022](#)). In [Dewi et al \(2019\)](#), children with cerebral palsy experience difficulties in communicating, especially in verbal communication skills. The abnormality of the muscles in the speech organ causes the speech disorder experienced. According to [Novak \(2014\)](#), in his journal entitled Evidence-Based Diagnosis, Health Care, and Rehabilitation for Children With Cerebral Palsy that 1 in 4 Children with Cerebral Palsy have problems with communication. They can't even speak verbally. Muscles in speech organs that experience stiffness or paralysis (spasm), such as the tongue, lips, and lower jaw, can cause incorrect articulation. Further, according to Hardman ([Karyana, 2013](#)), 45% of children with cerebral palsy experience cognitive barriers. Limited cognitive abilities are also one of the causes of communication difficulties, and they need help translating what is heard and seen, so they cannot receive complete language information.

People with complex communication needs may need more communication skills to meet their needs. According to the [Department of Communication \(2018\)](#), a person is categorized as a CCN if: 1) may not have speech and will rely on other methods of communication, such as pointing or gestures; 2) May use speech but it may be difficult to understand; 3) Some people may be able to communicate but have difficulties understanding what other people say. Further, complex communication needs are divided into developmental and acquired disabilities. Some examples of developmental disabilities are; 1) Intellectual disability, 2) Down syndrome, and 3) Autism. This research will focus on examining CCN individuals with cerebral palsy. Some people may be able to communicate but have difficulties understanding what other people say. Children learn through trial and error with language and build on their experiences and feedback to acquire literacy.

Children with complex communication needs are given different opportunities to interact if they can independently, resulting in not acquiring oral language. Individuals are given the opportunity to use augmentative and alternate forms of communication to communicate their wants and needs with all the communication they have. Alternative and augmentative systems can be used to augment spoken output or function as an alternative to speech for those persons whose output is limited to unintelligible vocalizations (Erickson & Geist, 2016).

Even with communication limitations, children with cerebral palsy have the same right to express their wants and needs as children in general. Connor (in Hidayat, 2016) suggests that: there are at least seven aspects that need to be developed in every CP child, namely: (1) intellectual and academic development, (2) assisting physical development, (3) increasing emotional development and acceptance child's self, (4) maturing social aspects, (5) moral and spiritual maturity, (6) increasing self-expression, and (7) preparing the child's future. Communication needs factors due to poor oral-motor function can be improved using augmentative communication devices in children with adequate cognition (Dabney et al., 2020). Children with cerebral palsy must learn to express themselves, share experiences with others, and express their desires. Children with cerebral palsy can use alternative and augmentative communication systems to develop their communication skills. For children with cerebral palsy, incorporating AAC is one aspect of a more significant focus on supporting and developing a child's full range of communication skills (Smith & Hustad, 2015). Augmentative and alternative communication (AAC) should be used to augment or replace communication for individuals with cerebral palsy when the individuals are not able to communicate with all of their familiar and unfamiliar communication (Hidecker, 2020).

Alternative and augmentative communication is the media and methods used by individuals with communication barriers to communicating with the environment reciprocally, even without verbal or spoken communication (Dewi et al., 2019). Augmentative communication is designed to support a person's speaking ability, while alternatively, it is to replace the communication approach of someone who has difficulty speaking verbally due to physical barriers or language development. AAC is a communication tool, system, strategy, replacement tool, natural supportive speech, or Augmentative and Alternative Communication (AAC) (AssistiveWare, 2020). These tools support someone who has difficulty communicating using speech. AAC covers all the ways people communicate without, or in addition to, verbal speech, including methods used by people with typical speech (Zisk & Dalton., 2019). According to Beukelman & Mirenda (2013), AAC is designed with a combination of various communication approaches tailored to the needs of someone who needs them. According to Coyne (2016), AAC includes all communication forms used to express thoughts, needs, wants, and ideas.

Further, types of AAC are divided into unaided and aided. Unaided AAC refers to communication strategies that do not require external aid. That is, the person uses whatever is available to them using their own body. This may include using eye gaze, facial

expression, gestures, body language, and tone of voice. While aided AAC refers to communication strategies that involve using an external item. These are divided into 1) low/light technology equipment, such as a communication board, photographs, or natural objects; 2) high technology aids, such as a computer or speech-generating device (SGD). According to Blackstone & Berg (2013), choosing the most appropriate type of AAC system needs to consider the following: 1) What are the child's communication needs? 2) Is the AAC system based on the child's abilities? 3) How does the child use the AAC system? 4) How are the cognitive ability and child's visuals? Both unaided and aided AAC can be used at varying levels of complexity to support a variety of communicative intents.

Based on field findings, it was found that children with cerebral palsy had stiff left legs and arms but could optimize the function of their right hand to carry out other activities. Children communicate with minimal gestures; not everyone can immediately understand what they mean. When they need something, the child will cry and scream. Parents and teachers have tried to understand the child's wishes, for example, by giving all the objects pointed at by the child. If the child responds by taking the object, the child wants it. If it is not the object, the child will cry then other objects will be given. Still, things this is less effective because it is possible that it is not the object that the child wants, besides that Efforts like this are also ineffective when the child expresses a desire that is in the form of activity, namely the desire to eat, drink, urinate, get cold and so on, etc. should be with conditions of communication difficulties like this the child needs media that can help him to convey his needs and people around the child can also understand the children needs more effectively children need training for the development of communication to express their needs and desires not necessarily verbally. This can be done with alternative and augmentative communication media that have an output of image symbols representing the child's wishes and sounds. For this reason, researchers are interested in compiling an alternative and augmentative communication system program for children with cerebral palsy based on the results of an assessment of the child's ability to communicate.

Some research related to the development of the AAC system includes research in the form of literature studies regarding strategies for developing assistive technology for the development of communication in children with CP (Riswari et al., 2022). Research conducted by Dewi et al (2019) developed mid-tech AAC media with components like buttons and drawing boards for children with cerebral palsy. Furthermore, there is also the development of type high-tech AAC system application-based for people with CP in general (Young et al. 2018). Based on previous research studies, it becomes a reference for this research. The research that will be conducted further explores and describes how the process of preparing the AAC system for children with cerebral palsy who are the research subjects. This research is expected to produce an AAC system program before it is compiled into operational AAC media. This research needs to be done so that it can provide insight for both readers and teachers about how the process of preparing the AAC system before it becomes a communication medium that can help children with cerebral palsy express their needs.

This research aims to develop an AAC system based on the results of assessments in children with cerebral palsy. The specific objectives of this study are 1) Knowing the objective conditions of children's abilities. Data related to the objective condition of the child was found to be an essential consideration in preparing the AAC system program for children with cerebral palsy; 2) Knowing how to program the AAC system. This point describes the design of the AAC system program that has been compiled and program validation by experts.

## B. Method

This study uses a qualitative approach with a case study research design. Subjects in this study were children with cerebral palsy diplegia at eight years old. This research was conducted through several stages. **The first stage** is the initial data collection stage, both empirically and theoretically. Empirical data is data related to the objective condition of the child, namely the results of language, cognitive, physical, and social communication assessments. At the same time, the theoretical data reference previous research and other theories about the AAC system and its development. **The second stage** is the stage of preparing the AAC system, and this stage is carried out by analyzing the findings of the child's objective conditions and the theory of the development of the AAC system. **The third stage** is the final stage, where the program that has been compiled is validated by the validator. A child teacher and media development expert validated this AAC system program. Suggestions from the validator become material for improving the AAC system program, which can be realized into an application or communication medium for children with cerebral palsy.

The steps of the research method can be summarized through the chart as follows.

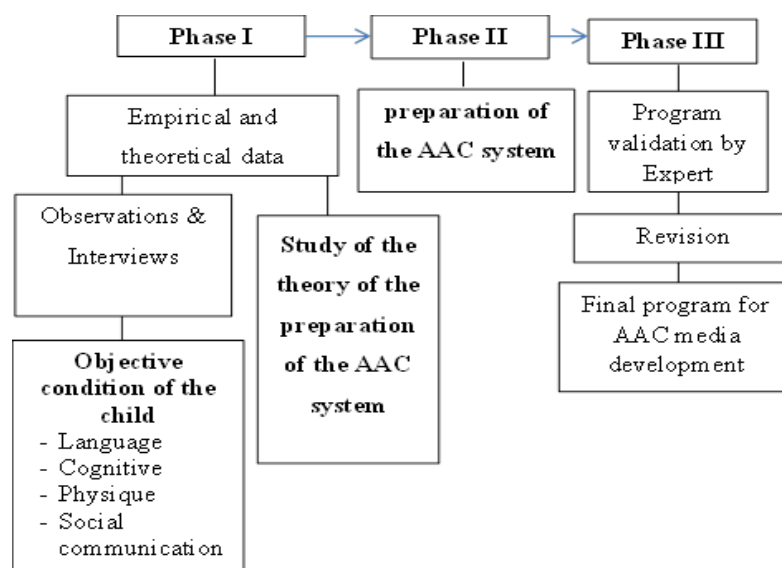


Figure 1. Research Stages

Technique data collection was used in this study, namely interviews and observation related to the child's ability to communicate and other aspects of development that support children's communication, such as language, cognitive, sensory-motoric, and social communication. This research uses triangulation to test the validity of the data used in This research. Researchers use various techniques to disclose data carried out to data sources, namely through interviews with teachers and parents about children's communication skills and then strengthened by observation to assess the child's ability and documentation.

## C. Result and Discussion

### Result

#### 1. Subject Objective Conditions

The first stage before developing an augmentative and alternative communication system is finding related data objective condition of the child before using the augmentative and alternative communication system through an assessment, which produces a profile of children as a consideration in the development of the augmentative and alternative communication system. The ability to communicate is closely related to delays or damage to the system of others, cognitive, sensory, motor, psychological, emotional, and environmental abilities (Aditama, 2018). Aspects of the abilities that will be assessed in children are language, cognitive, motor, and social communication. According to Coyne (2016), the strategy for preparing augmentative and alternative communication systems must be made based on the needs of its users so which can be a lifestyle, environment, social conditions, and peers, so not only observing children, researchers also conducted interviews and observations on teachers and parents of children who are the people closest to the child. Based on the study results, a child's ability profile is a deep modality development of the augmentative and alternative communication (AAC) system. Namely as follows;

##### a. Language

The subject's receptive language has several modalities, namely responding when his name is called, making eye contact, and understanding simple "point" and "take" instructions with the help of pointing toward objects. However, children are still not able to respond to the word no, point to objects according to pictures, and understand vocabulary as well as adjectives and verbs. Subjects need to practice recognizing simple instructions and vocabulary more, and communication partners should provide interventions by introducing new vocabulary with simple and repeated instructions. Provide modeling to children when introducing words and instructions and with the help of media that can attract children to understand vocabulary and instructions.

In expressive language, children only express their desires with simple gestures. Gestures shown by the subject, such as pointing, shaking, and nodding. The child's sound has no meaning, such as screaming "aa .." and groaning. So it is difficult for people around them to understand children. To understand the child's desire, parents and teachers will bring all objects that the subject might want in front of him. Sometimes also confirmed by

pointing towards objects the child might want while asking, "Do you want this?". But the approach given by teachers and parents has been less effective so far. Often the child is angry by crying or screaming if the wrong object is given.

The subject needs media that helps them communicate, even though not verbally. Communication media can be visual/image (primary) and acoustic/sound (optional) to convey the subject's wishes because he cannot use language verbally.

#### **b. Cognitive**

Cognitively, the subject already knows natural objects. The subject also knows some objects and objects around them based on pictures, such as pictures of eating and sleeping activities and pictures representing happy and sad emotions the subject is still not able to recognize, for cognitive abilities such as recognizing shapes, colors, numbers, and letters, them. In its implications for the augmentative and alternative communication (AAC) system, children need augmentative and alternative communication (AAC) media that uses communication symbols in the form of authentic images or graphic images similar to natural objects. However, after the AAC system is compiled, the subject needs time to recognize these symbols and understand the vocabulary of objects and activities that he often encounters and carries out before finally being able to use the augmentative and alternative communication (AAC) system in communication activities.

#### **c. Sensory and Motoric**

The results of observations and interviews show that children's sensory hearing and vision abilities are good. Children can hear as usual. From the results of observations, the child responds when his name is called and responds to the music he likes. Children can also see usually, which is evidenced by children who can watch their favorite cartoon videos at normal viewing angles. Children smile when they see their mother even though the mother is far away from the child. when a toy object is shown, and then the child moves in the direction of the object's movement.

The subject can perform motor activities such as pressing, holding, throwing, and touching with his right hand while the child's left hand is stiff. He can do other activities such as sitting, rolling, and moving places by dragging. The subject can also control their right hand to swipe and touch icons on the cellphone screen. In its application to the augmentative and alternative communication (AAC) system, the subject needs an AAC system that he can easily access using their right hand.

#### **d. Social Communication**

The subject can communicate using simple gestures, such as pointing towards objects, nodding and smiling when agreeing, and shaking their heads when disagreeing. When they want to call their mother or need something, the child will scream to attract attention. Children are not yet able to communicate verbally like children in general. In connection with the implications of preparing the augmentative and alternative communication (AAC) system for children's social communication skills, children need AAC media to help them communicate, although not verbally. Media is facilitated by using

visuals/images as the primary media and auditory/sound media as supporting media (optional) in helping children convey their wants and needs to others.

## 2. Preparation of Augmentative and Alternative Communication (AAC) System

According to Blackstone & Berg (2013), the preparation of the AAC system needs to consider the following: 1) What are the child's communication needs? 2) Is the AAC system based on the child's abilities? 3) How does the child use the AAC system? 4) How are the cognitive ability and child's visuals? Based on this, the primary considerations for formulating the AAC system are as follows.

**Table 1.** primary considerations for formulating the AAC system

Need Communication Child	Possible AAC System	Method Use System AAC	Ability Cognitive and Visual	Settings and Goals
The child or subject needs media to help him communicate, even if not verbally. This matter because a child's way of communicating is with very limited gestured	<p>AAC system with help using symbol system in the form of an image that represents the word to be communicated by the child</p> <p>AAC application-based so that it can be accessed with phones/tablets</p> <p><b>AAC Contents:</b> <b>SYMBOL COMMUNICATION:</b></p> <ul style="list-style-type: none"> <li>• Profile (child image)</li> <li>• Desire: want, don't want, and are</li> <li>• Activity: eating, drinking, urinating, defecating. Sleep.</li> <li>• Condition: Freezing, Heat, and pain</li> </ul>	The child gets access to AAC systems by pressing the icon, a symbol of communication. That icon pressed will give sound output.	<ul style="list-style-type: none"> <li>• Cognitive abilities; the child does not yet know numbers, colors, and letters; he can match some pictures with original things and can point to objects that he wants.</li> <li>• Visual ability; the child can see the picture inside normal size.</li> <li>• Motor skills: the child is capable of using his right hand</li> </ul>	<ul style="list-style-type: none"> <li>• Settings: at home and school</li> <li>• Target: child, mother, teacher, and people nearest child</li> </ul>



### 3. Validation of AAC System plans by Expert Members

The results of the program formulation validation involved several experts, namely Mrs. DS, the Putra Hanjuang SLBS teacher who taught MZ subjects, and Mr. MH as the program development expert. The validation results led to suggestions for revising the system design program so that it becomes a complete design. Matters related to the revision are as follows:

#### Putra Hanjuang SLBS Teacher

- a. Please pay attention to the selection of symbols so they do not cause misunderstandings for the child and other people who become the child's communication partners.
- b. No need to use lots of symbols that will confuse children later. Just use the symbols that children use most often. which are activities or objects that often exist in children's daily lives because children's vocabulary is minimal.
- c. if the AAC system is used in the form of an application, consider whether you have to use additional components, such as gadget supports, because the child has motor difficulties.

#### The Program Development Expert

- a. Adding facilities to add image and sound symbol icons so that if one day a child does not understand the symbol in question or already has knowledge of new symbols, parents and teachers can add it themselves.
- b. Adding facilities so parents and teachers can find out children's progress in using the AAC system and their communication skills.

### Discussion

According to the [Department of Communication](#) (2018), communication is essential for us as social beings. Communication can be done using various verbal and non-verbal approaches, such as gestures, eye contact symbols, and facial expressions ([Department of Communication, 2018](#)). But not everyone can communicate with him in general. Some of them, especially children with cerebral palsy, experience difficulties communicating as a pathway for the physical and motor damage they experience. Cerebral palsy is a motor disorder located in the nerve center of the brain. Children with cerebral palsy cannot perform everyday activities such as walking, walking, or talking due to physical, motor, and intelligence disturbances ([Irfan et al., 2022](#)).

Conditions in the field found children with cerebral palsy who had difficulty communicating. They have the right to be able to communicate their needs and permissions and have the right to be understood by others. Children with cerebral palsy must learn to express themselves, share experiences with others, and express their desires. Children with cerebral palsy can use augmentative and alternative communication systems to develop their communication skills. According to Pennington (in [Smith & Hustad, 2015](#)), For

children with cerebral palsy, incorporating AAC is one aspect of a more significant focus on supporting and developing a child's full range of communication skills.

The AAC system is created for those who need adaptive speaking and/or writing assistance because their gestures, spoken and/or written communications are temporarily or permanently inadequate to meet all their communication needs. Assessment of someone with complex communication needs, one of which is a child with cerebral palsy, is very important to develop appropriate alternative and augmentative communication systems. Some of these individuals may be able to produce several utterances that need to be improved to meet their different communication needs (Beukelman & Mirenda, 2013).

AAC aims to provide individuals with independent communication and maximize their abilities and opportunities to participate successfully in everyday environments (Coyne, 2016). So that the preparation of AAC must be based on the results of an assessment of children's communication skills and other aspects that affect children's communication skills as modalities for the development of the AAC system, namely aspects of cognitive, motoric, and language. Beukelman & Mirenda (2013) provide points that must be considered in the assessment of the development of the AAC system:

1. The senses (i.e., vision, hearing, touch, smell, and taste).
2. Physical abilities (e.g., vocalization, orientation, mobility, and agility).
3. Physical and mental health (including medication).
4. Intellectual abilities (e.g., alertness, attention span, comprehension & understanding, receptive and expressive language, memory, and executive functions).
5. Literacy skills (i.e., reading, writing, and arithmetic).
6. Daily living activities include social skills and the ability to make choices.
7. Social networks.
8. Contexts or environments (e.g., Where the person lives, works, goes to school, and socializes).
9. Personality, personal preferences, and priorities (e.g., likes, dislikes)
10. Emotional support needs.
11. Self-advocacy skills (including self-esteem and assertiveness)
12. Personal history and plans or aspirations.
13. Previous intervention and support strategies.

Beukelman & Mirenda (2013) also add some questions to consider about how someone with a complex communication need can do the following:

1. Say yes and no.
2. Make sense of their environment by drawing on a variety of cues (e.g., sights, sounds, smells, touch, or taste).
3. Understand what is happening around them, and both participate in and influence those events in a positive way.
4. Communicate in everyday settings.
5. Engage the attention of others, including naming people of particular significance
6. effectively signal a protest or rejection of something or someone

7. Request an object, an action, assistance, or information
8. Express preferences and/or make choices
9. Express emotion in response to various situations
10. comment or express an opinion on issues of importance to them

According to [Blackstone & Berg \(2013\)](#), The preparation of the AAC system needs to consider the following: 1) What are the children's communication needs? 2) Is the AAC system based on the child's abilities? 3) How do children use the system? AAC, 4) How are the child's cognitive and visual abilities? Based on the child's profile, draw up a program design for the AAC system, which is expected to transform into concrete media to help children communicate. This is to the research results from [Dewi et al \(2019\)](#), who developed AAC mid-tech for children with cerebral palsy. And has been proven effective in improving the communication skills of children with cerebral palsy. Based on this theory, the design of the AAC system program was prepared based on the results of the child's assessment. Teachers and media experts then validated the program design compiled. The results of the validation provide a revision for the program including: a) Pay attention to the selection of symbols, so that they do not cause misunderstandings for both the child and other people who become the child's communication partners; b) No need to use lots of symbols that will confuse children later, just use the symbols that children use most often. which are activities or objects that often exist in children's daily lives, because children's vocabulary is very limited; c) If the AAC system is used in the form of an application, consider whether you have to use additional components such as gadget supports, because the child have motor difficulties; d) Adding facilities to add image and sound symbol icons so that if one day a child does not understand the symbol in question or already has knowledge of new symbols, parents and teachers can add it themselves; e) Adding facilities so parents and teachers can find out children's progress in using AAC system and his communication skills. The program that has been revised from the results of the validation is as follows:

**Table 2.** program that has been revised from the results of the validation

Need Communication Child	Possible AAC System	Method Use System AAC	Ability Cognitive & Visual	Settings and Goals
<ul style="list-style-type: none"> <li>• The child or subject needs media to help him communicate, even if not verbally. This matter because a child's way of communicate</li> </ul>	<ul style="list-style-type: none"> <li>• AAC system with help using symbol system in the form of an image that represents the word to be communicate</li> </ul>	<ul style="list-style-type: none"> <li>• The child gets access to AAC systems by pressing the icon, a symbol of communication. That icon pressed will give</li> </ul>	<ul style="list-style-type: none"> <li>• Cognitive abilities; the child does not yet know numbers, colors, and letters; he can match some pictures with original things and can point to objects that he wants.</li> <li>• Visual ability; the</li> </ul>	<ul style="list-style-type: none"> <li>• Settings: at home and school</li> <li>• Target: child, mother, teacher, and people nearest child</li> </ul>

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ing is with very limited gestured	<p>ted by the child</p> <ul style="list-style-type: none"> <li>• AAC application-based so that it can be accessed with phones/tablets. It will</li> <li>• be equipped with other components in the form of a stand and a table that can be installed on a child's wheelchair so that children can access it more easily</li> <li>• AAC system Contents: -Profile (child image) -Desire: want, don't want, and are -Activity: eating, drinking, urinating, defecating. Sleep. -Condition: Freezing, Heat, and pain.</li> <li>• The application will have a feature that facilitates teachers and</li> </ul>	sound output.	<p>child can see the picture inside normal size.</p> <ul style="list-style-type: none"> <li>• Motor skills: the child is capable of using his right hand</li> </ul>
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parents to be able to remove and add communication symbols so that they adjust to the progress and decline of children's communication abilities while using the AAC system.

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#### D. Conclusion

This study aims to develop a program design for the augmentative and alternative (AAC) system based on the analysis of findings in the field, namely the profile of children and the theory of the development of the AAC system. Subjects with cerebral palsy have difficulty communicating their desires apart from their physical barriers. The results of the assessment show that children also experience barriers in their language and cognitive aspects which is the cause of children's difficulties in communicating. Children communicate by pointing, nodding, and shaking their heads. Only some things children want can be immediately understood by those closest to them. So it is necessary to have assistive media, namely alternative and augmentative communication systems.

The implications of this research are presented theoretically and practically. Theoretically, this research shows that the AAC system is a media or application that can help individuals with complex communication needs to communicate with the modalities of their communication approach. The AAC system must be developed based on assessing children's communication skills. Practically, practitioners such as teachers and media experts can use this research to compile an AAC system before it becomes a media that can help children with complex communication needs, especially children with cerebral palsy, communicate.

Suggestions for researchers so that they can further develop the AAC system program formulation into a complete AAC media so that subjects can use it and be tested for its effectiveness.

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