Cellphone with Dial and Call Feature Design Prototype for Children with Autism Spectrum Disorder (ASD)

(Case Study: Behavior Therapy Center A+ Malang, East-Java)

A Product Design and Development of Communication Device for Special Needs Children with Ethnigraphic and Quality Function Development Method

Bayu D. Wicaksono and Sritomo W. Soebroto
Industrial Engineering, Industrial Technology Faculty, Institut Teknologi Sepuluh Nopember (ITS)
Jl. Arief Rahman Hakim, Surabaya 60111
E-mail: m.sritomo@ie.its.ac.id

***Abstract*— Autism Spectrum Disorder (ASD) is a term that used to explain neurological problems which affect mind, perception and concentration. The unfortunate condition of children with ASD lead more difficult to do long-distance communication, not only because of the lack of device that can be used exclusively by children with ASD (the physical as well as its interface), but also because of their general habits tends to destroy something in this case is a commercial cellphone.**

Identification of ASD children's habit will be conducted by distributing questionnaires and interviews of the parties which are well acquainted with their daily activities such as parents and school teachers. To validate the questionnaire, has also been conducted ethnographic video capture. The design of cell phone's prototype and dial & call software/application interface in it is done using the Quality Function Deployment (QFD) method as the results have been obtained from the collection of data on the habits of ASD children. In addition, there is also made a sound maker app.

The output of this research is a prototype of mobile product and features dial & call in it specifically designed for ASD children. Cellphone's prototype is a touchscreen phone with dial & call feature consists of 4 main buttons with different colors which are distinguished based on the people who plotted to the key, could be mother, father or other important people who can be contacted when needed (usually the babysitter). The use of this mobile phone is expected to alleviate the needs of so long distance communication between an autistic child with someone else he/she needed so it can lead them more to independencies to be able to survive in real world together with the sound maker.

Keywords*— Autism Spectrum Disorder; Cell Phone; GUI; HOQ; Ethnography*

I. INTRODUCTION

This section will explain about the background of the problem which became base of the research, research question, research objectives, scope of research which contains limitations and assumptions used in the research, also benefits that will be achieved in this research.

A. Research Background

It's no longer a secret that some people around are having special needs, whether given since their birth or starts at any time; including people with Autism Spectrum Disorder (ASD). Autism Spectrum Disorder is a term that is used to explain neurological problems/disorders which affect mind, perception and concentration. Nowadays, found on average the population of autism is 1 in 100 children, while the previous estimate was 1 in 150 children and older era people think autism is 1 in 500 children [1]. Other trigger factors of the increasing autism population such as quoted from Thedailygreen.com, Tuesday (6/10/2009) is an environment that has been exposed to mercury or other heavy metals, contaminated water, as well as the use of pesticides or antibiotics.

Figure 1. The Characteristic of People with Autism [2]

The estimated number of children with autism in Indonesia can reach 150-200 thousand people. The comparisons between men and women population was 2.6 - 4: 1, but girls which are affected will show more severe symptoms [3]. The characteristics of autism are shown in a very wide-ranged mapping, even the symptom or the problem shown by one sufferer to the others sometimes much different but still having the similar signs. Autism blocks, slow down or disturb signal from at least one sensory body parts so it will give trouble to

the sufferers' cognitive, verbal, behavior, communication and social interaction. The population data shown above indirectly tells that autistic children are no longer really minor in Indonesia population, so that, they should have the equal rights and life quality that typical development (TD) have, including ease of communication technologies. The unfortunate condition of children with ASD lead more difficult to do long-distances communication, not only because of the lack of long-distance communication tool that can be used exclusively by children with ASD (the physical as well as its interface), but also because of their general habits tends to destroy something in this case is a commercial cellphone. Cell telephones have become an almost universal communications tool. They achieved remarkably high levels of market penetration at a rapid pace, and are now the dominant technology for vocal communications and short message transmission [4] [5]. They are particularly popular among young people, who have been at the forefront of adoption of this new technology [6] [7] [5].

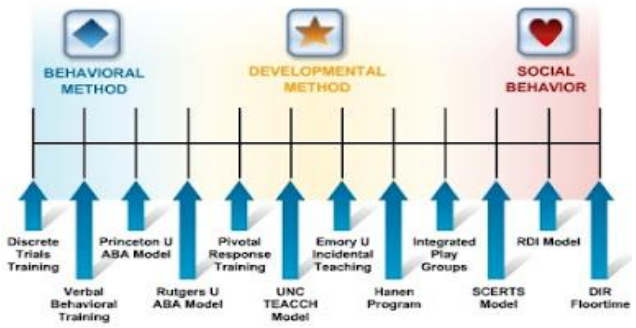

Figure 2. The method of Autism Children Development Teaching/Therapy [8]

Impairments in social and communicative reciprocity and in adaptive, flexible regulation of self and behaviors in individuals with ASD lead to significant difficulties in both social and life skills [9]. Whilst there is not complete agreement in the literature on the precise meaning of these terms, there is a general level of consensus [10]. Based on this consensus, will be used a working definition of social skills as relating to the facility of interacting with other people, and include skills such as appropriate communication, learning social norms, regulating one's own behaviour and understanding its impact on others, anger management and play. Many complaints about the difficulty occur with long distance communication needs of ASD children in certain conditions. Individuals with autism and limited speech are candidates for speech-generating devices (SGDs), but some individuals might experience difficulty in operating these devices. In the research was described the case of Steven, a children with autism who used an iPod-based SGD, but had difficulty activating the speech output feature of this device. His difficulties were initially interpreted as motor control problems, suggesting the need to abandon this technology, prescribe a different SGD, or adapt his existing device [11].

Fortunately, there are already been some methods to help developing skills of ASD children based on certain aspects. These methods have been applied in each special schools and therapy center differently. By these methods, with the help from the experts (teachers and therapists), it will be easier for the children with ASD to learn facilities and accept technology which the TD children get. To specify the object of the research, classification of children with autism done to get a group of ASD children who can be trained (trainable) and record certain activities teaching so that the function of the product's prototype will actually be used fully.

B. Research Question

Issue to be examined in this study is how to facilitate the needs of long-distance communication for children with autism with a specialized specification of the communication device.

C. Research Objectives

This research has two objectives. They are:

1. To develop a communication facility with the considerations of autistic behavior and phenomena during long-distance communication activity of children with ASD, experimental ethnographic data capture and usability factor;
2. To develop the independencies factor of ASD children to their close ones and to upgrade their communication skills through technology;
3. To know the differences between the types of ASDs which are tested on the product's prototype based on their communication skill improvement;

D. Benefits of Research

The benefit of this research is the creation of cellphone which can facilitate the long-distance communication need for children with autism together with their parents and anyone related to their daily life and also can develop their independencies or make closer to the lifestyle of normal ones.

E. Scope of Research

This section consists of two parts, which are the limitations and assumptions that bounds the research.

Limitations

These are the limitations of the research,

1. The object of the research is children with special needs specified to Autism Spectrum Disorder (ASD), but excluding those who have physical disabilities such as hearing, seeing, etc.;
2. The research will be done based on the autistic behavior of children and not considering their parents' parenting style;
3. The Questionnaires for getting the Voice of Customer (VOC) are distributed to the selected school/therapy for parents/family/teacher or another considerably the ASD children's close ones;
4. Product's prototype will only be tested on some of the ASD children which are students in "Pusat Terapi Perilaku A+" located at Jalan Blitar 2, Malang, East Java.

Assumptions

These are the assumption of the research,

1. There will be some minor help from people around the children with autism to be able to operate the specialized cellphone;
2. Children with autism need at least 2-4 days in a row to know about new thing for an adaptation and in this research specified to trainable ones;
3. Shape and color preferences of children with autism are very individual, there are no particular preferences related to the autistic condition.

II. LITERATURE STUDIES

This chapter presents the relevant theories used in this research. It consists of two sub-sections. The first section will discuss the theoretical frameworks which support this research. The second section will discuss the previous relevant work that will identify the research gap and determine this research's position and role.

A. Autism

Autism is a condition of someone since he/she was born or when reaching toddlers age phase, which make themselves can't have a normal communication or social relationship. Therefore, these children are excluded from the society and fall into a repetitive world of obsessive interests and activites.

According to a research [5], autism symptoms also include the disturbances in some aspects, which are:

1. Disturbance in verbal & nonverbal communication aspect;
2. Disturbance in social interaction aspects;
3. Disturbance in plays and actions aspects;
4. Disturbance in emotional and feeling aspects.

B. Cell Phone

Cell telephones have become an almost universal communications tool. They achieved remarkably high levels of market penetration at a rapid pace, and are now the dominant technology for vocal communications and short message transmission [4] [5]. They are particularly popular among young people, who have been at the forefront of adoption of this new technology [6] [7] [5]. A smartphone is a mobile phone built on a mobile computing platform, with more advanced computing ability and connectivity than a feature phone [12].

C. Ethnography

Ethnography (from Greek ἔθνος ethnos = folk/people and γράφω grapho = to write) is a qualitative research method aimed to learn and understand cultural phenomena which reflect the knowledge and system of meanings guiding the life of a cultural group [13]. The term ethnography has come to be equated with virtually any qualitative research project where the intent is to provide a detailed, in-depth description of everyday life and practice [14]. The use of the term "qualitative" is meant to distinguish this kind of social science research from more "quantitative" or statistically oriented research. The two approaches, i.e., quantitative and qualitative, while often complimentary, ultimately have different aims. Since the old days, the ethnographer will focus the attention on a community, selecting knowledgeable informants who know the activities of the community really well [15].

D. Quality Function Deployment Method

Quality Function Deployment is the process of converting customer demands into "quality characteristics" and develop a design quality to final product by systematically detailing the relationship between demand and its characteristics, starting with the quality of each functional component and extending the details of the quality of each parts and processes. Meanwhile, according to another definition, QFD is a systematic matrix based visual approach to designing products and services quality. Application of Quality Function Deployment method in the process of designing products and services begins with the formation of the product planning matrix or often referred to as the House of Quality (quality house).

E. Graphical User Interface & Integrated Development Environment

In computing systems, a graphical user interface (GUI, commonly pronounced gooey, source: http://dictionary.reference.com/browse/GUI) is a type of user interface that allows users to interact with electronic devices by using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and also office equipment. Integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of: a source code editor, build automation tools and also a debugger.

III. RESEARCH METHODOLOGY

This research conducted in eight stages which are introduction/preliminary stage, data collecting stage, implementation of ethnographic video capture and quality function deployment method, data processing stage, design stage, product testing stage, data analyse and interpretation stage, evaluation and conclusion and suggestions stage. The expected output of these stages will be a cellphone with dial and call feature specialized for children with ASD, standard hardware and software/application user manual, usability factors and human (with special needs) computer interaction

A. Introduction/Preliminary Stage

This stage is the beginning of the research. This introduction/preliminary stage consists of problems identification stage, literature studies, field studies and determination of research objectives.

Problem Identification Stage

In this stage, problems in the existing condition of research object will be identified and by then could be stated the research questions to be solved.

Literature Studies

This stage is conducted to obtain information and methods on how a cellphone with dial and call feature specialized for children with Autism Spectrum Disorder should be made. It consists of autism life and behavior study, Ethnographic video for data capture method, Quality Function Deployment to translate the voice of customer (autistic children's parent, teacher or therapists) become technical design aspects, cellphone and its operating systems studies.

B. Introduction/Preliminary Stage

This stage is the beginning of the research. This introduction/preliminary stage consists of problems identification stage, literature studies, field studies and determination of research objectives.

Problem Identification Stage

In this stage, problems in the existing condition of research object will be identified and by then could be stated the research questions to be solved.

Literature Studies

This stage is conducted to obtain information and methods on how a cellphone with dial and call feature specialized for children with Autism Spectrum Disorder should be made. It consists of autism life and behavior study, Ethnographic video for data capture method, Quality Function Deployment to translate the voice of customer (autistic children's parent, teacher or therapists) become technical design aspects, cellphone and its operating systems studies.

Field Studies

This stage is conducted to obtain information directly from the field – environtment of the autism children (house, school or teraphy center) – so it will be done by a direct observation.

Determination of Research Objectives

This stage is conducted so the problems/research questions could all be answered in the end of this research. The objectives of this research are to develop a communication facility with the considerations of autistic behavior and phenomena during long-distance communication activity of children with autism with their close ones, experimental etnographic data capture and usability factor.

C. Data Collecting Stage

After doing all the preparation stages, the next step is data collecting stage. The processes will be done in this data collecting stage is the questionaires gathering and interview with the experts (autistic children's teachers, teraphists, parents or family members).

D. Implementation Stage of Ethnographic Video Capture and QFD Method

After collecting all the data needed, the next steps are implementation stage of ethnographic video capture and QFD method. Data collected from the previous stage will become input and be considered in this implementation stage.

Implementation Stage of Ethnographic Video Capture

When the data through interviews and questionaires about how the cellphones for the autistic children should be made in the point of view of the autistic children's parents, teachers, teraphists, or family members are collected, the next step to do is collecting data through implementation of ethnographic video capture, so all the data about how the cellphones should be made in the point of view of the autistic children can be obtained.

Implementation Stage of Quality Function Deployment Method

When the data through interviews, questionaires and ethnographic video capture about how the cellphones for the autistic children should be made in both point of view are collected, the next step is to decipher what both sides want by using HOQ, also by adding some technical responses to meet the specifications needed of making the cellphones.

E. Data Processing Stage

After implementation process is ended, the next step is doing some processes to the data of the implementation result. Data received from the implementation stage are the product preferences from the translation of questionaires (voice of customer) filled by autistic children's parents, teachers, teraphists, or family members, and also some technical product aspects by looking at the autistic children behavior and preferences through the ethnographic video capture. Those two types of data will be processed in House of Quality (HOQ) to find the right specifications needed for the cellphone design.

F. Design Stage

This stage will be conducted by applying all the technical aspects caught from HOQ and interviews to the process of designing the prototype (hardware and software/application). Starting from the application/software, then the hardware can follow after it. There are some multiple-language IDEs that might be used to design the applications: such as Eclipse, ActiveState Komodo, IntelliJ IDEA, Oracle JDeveloper, recent versions of NetBeans, Microsoft Visual Studio, Genuitec MyEclipse, WinDev, and Xcode.

G. Product Testing Stage

This test will be conducted by asking a number of respondents (Autistic Children) to play the prototype of the cellphone and evaluate it by ethnographic video capture based on usability factor, in this stage, some scenarios will be executed. The result of this test will be evaluated using usability analysis. If the result shows inadequate usability, the prototype will be evaluated and if necessary it will be reconfigured. In this testing stage, help from the teachers or therapists are needed in order to translate what we want to get to become what the ASD children will do.

H. Data Analyze and Intrepretation Stage

This stage will be conducted by analyzing the existing condition of autistic children behavior (especially to the stuffs around them or even more specific, when they use cellphone), analyzing the exsisting cellphone specifications for normal user, analyzing the cellphone prototype specifications

specialized for children with ASD, and analyzing the result of usability testing to the children with ASD.

I. Conclusion and Suggestions Stage

After conducting all of the previous stage, a set of conclusion and suggestion will be generated. The conclusion will provide answer for the research question. The suggestion will provide advice in accordance to further development of this research.

III. PREVIOUS WORKS

This section will include the previous works of research done before this research worked as the background of doing this research whether in data support, method development, subject changing and so on.

A. Review of The Previous Works

In a study done, a personal digital assistant (PDA) with picture, auditory, and video prompts with voice over, was evaluated as a portable self-prompting device for students with autism spectrum disorder (ASD) by this mean is task managing activity for their independencies. The research done by Mechling is done only for self-prompting or can be considered as self-centered development of the ASD children, besides it still need help from others in operating it, if it's without help from others, the children are considerably in Asperger type not all type of ASD.

Research done by Thunberg in 2007, in the form of communication of four children with autistic spectrum disorder was investigated when they were supplied with a speech-generating device (SGD) in three different activities in their home environment: mealtime, story reading and ''sharing experiences of the preschool day''. An activity based communication analysis, in which collective and individual background factors for the activities were outlined, was used as a basis for the discussion of linguistic coding data derived from video recordings made before and during SGD intervention. They need to play role which can be say only for practice and it's only done in one same place which is as familiar as home, not a long-distance communication.

Yang et al in 2007 found that Graphical User Interface (GUI) for applications of Embedded Devices (ED) has been increasingly in demand. Rapid GUI development tools are being required more than ever. However, traditional way of GUI development for ED applications has some limitation in support of visual environment and blocks rapid development. However, In this paper, they only introduce a new mini visual IDE, called VY, which supports rapid development utilizing control library, and simulation of GUI which is used by TD people.

Another year 2007 research done by Bauminger et al described a pilot study for an intervention aimed at enhancing social skills in high functioning children with autism. They found initial evidences that the use of a social interaction and may lessen the repetitive behaviors typical of autism. These positive effects also appear to be transferred to other tasks following the intervention. They hypothesized that the effect is due to some unique characteristics of the interfaces used, in particular enforcing some tasks to be done together through the use of multiple-user GUI actions. Still, the media is a computer in which hardware not yet specialized for ASD children.

Meanwhile, the similar research done by Durkin in 2009 found that while young people have generally been at the forefront of the adoption and use of new communication technology little is known of uses by exceptional youth. This study compared cell phone use by a group of adolescents with Asperger Syndrome (n = 35) with that by a group of adolescents with typical development (n = 35). People with Asperger Syndrome tend to have limited ability to take part in reciprocal communication and weaker social motivation. Still, even if the communication technology had already been used by ASD , in this research it was only for the adolescents which are already been enough self-developed, and furthermore it's an Asperger not for all ASD because the technology has not been specified for ASD.

In the other research done by Reed in 2011, Children with autism spectrum disorder show deficits in social skills such as initiating conversation, responding in social situations, social problem-solving, and others. These deficits are targeted through the use of social skills interventions, some of which use a technology-based approach as a resource-efficient alternative to common forms of instruction but the development of the communication itself still in direct conversation not a long distance communication and the learning was through DVD or other similar media.

ACKNOWLEDGMENT

This research was still in progress and at the moment hasn't finished yet until the submission due date to participate in SEANES 2012, April 1st and also until the revise due date, May 25th.

REFERENCES

[1] BARARA, VERA FARAH. "Detik Health: 1 Dari 100 Anak Menderita Autis". can be accessed at http://health.detik.com/read/2009/10/06/150910/1216319/764/1-dari-100-anak-menderita-autis. Last accessed at 28th of March 2012, 20:00 WIB (2009).

[2] DISPLAYS FOR SCHOOLS, INC. Autism: Person with Autism May Posses The Following Characteristics in Various Combinations and in Varying Deegres of Severity. Can be accessed at http://www.displaysforschools.com/autism.html. Last accessed at 3rd of April 2012, 20:00 WIB (2005).

[3] YCHICENTER.ORG. Yayasan Cinta Harapan Indonesia – Autism Care Indonesia: "Jumlah Anak Autis Meningkat Pesat". Can be accessed at http://www.ychicenter.org/index.php?option=com_content&view=article&id=110:jumlah-anak-autis-meningkat-pesat. Last accessed at 28th of March 2012, 20:25 WIB (2012).

[4] HANSON, J. How cell phones and the Internet change the way we live, work, and play. Westport, CT: Praeger (2007).

[5] SRIVASTAVA, L. Mobile phones and the evolution of social behaviour. Behaviour & Information Technology, 24, page 111–129 (2005).

[6] KATZ, J. E., & AAKHUS, M. A. Perpetual contact: Mobile communication, private talk, public performance. Cambridge: Cambridge University Press (2002).

[7] LING, R. The Mobile Connection: The cell phone's impact on society. San Francisco: Morgan Kaufmann (2004).

[8] HAROLD, L. D. AutismPro - "Somewhat" Evidence Based Internet Autism Intervention or Not Evidence Based At All?. Can be accessed at http://www.wellsphere.com/autism-autism-spectrum-article/autismpro-somewhat-evidence-based-internet-autism-intervention-or-not-evidence-based-at-all/247010. Last accessed at 3rd of April 2012, 20:12 WIB (2008).

[9] HOWLIN, P. Autism and Asperger syndrome: Preparing for adulthood. London, UK: Routledge (2004). RAO, P. A., BEIDEL, D. C., & MURRAY, M. J. (2007). Social skills interventions for children with Asperger's syndrome or high-functioning Autism: a review and recommendations. Journal of Autism and Developmental Disorders.

[10] KAGOHARA, DEBORA M., MEER, LARAH VAN DER, ACHMADI, DONNA, GREEN, VANESSA A., O'REILLY, MARK F., MULLON, AUSTIN, LANCIONI, GIULIO E., LANG, RUSSELL, SIGAFOOS, JEFF. (2010). Behavioral Intervention Promotes Successful Use of an iPod-Based Communication Device by an Adolescent With Autism. Wellington, New Zealand: SAGE Publications. Can be accessed at http://ccs.sagepub.com/content/9/5/328.short. Last accessed at 28th of March 2012, 20:45 WIB.

[11] NUSCA, ANDREW. "Smartphone vs. feature phone arms race heats up; which did you buy?". ZDNet. Retrieved 2011-12-15. Can be accessed at http://www.zdnet.com/blog/gadgetreviews/smartphone-vs-feature-phone-arms-race-heats-up-which-did-you-buy/6836. Last accessed at 29th of March 2012, 21:12 WIB (2009).

[12] PHILIPSEN, G. Speaking Culturally: Explorations in Social Communication. Albany, New York: State University of New York Press (1992).

[13] HOEY, BRIAN A. Brianhoey.com: What is Ethnography. Can be accessed at http://www.brianhoey.com/General%20Site/general_defn-ethnography.htm. Last accessed at 29th of March 2012, 09:15 WIB (2011).

[14] GARSON, G. DAVID. "Ethnographic Research: Statnotes, from North Carolina State University, Public Administration Program". North Carolina: Faculty.chass.ncsu.edu. Can be accessed at http://faculty.chass.ncsu.edu/garson/PA765/ethno.htm. Last accessed at 29th of March 2012, 21:10 WIB (2008).