

# **A field validation of the ICT4D 3.0 framework in rural Sarawak Malaysia.**



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August 2018

## **Abstract**

Extensive research is done over the years in the field of Information Communication Technology for Development (ICT4D), the effort to bridge the digital divide between western countries and development countries. Recently an approach to ICT4D has been developed, in which users' needs are made central. This approach is named ICT4D 3.0. In this paper, a validation for this framework is presented. Validation is done in a field experiment, where three different use cases were set up. The use cases are situated in Sarawak Malaysia and build within a joint course between the Vrije Universiteit (VU) Amsterdam and the University Malaysia Sarawak (UNIMAS). The validation of the framework, will consider if the integrated collaborative, iterative and adaptive methodology is having an effect on the projects. From the three different projects, issues and success factors are described. Making use of a collaborative, iterative and adaptive methodology has a positive effect on the projects. Such as, the integration of the local context, implementing the suitable requirements and the usability of the systems. Therefore, this paper is concluding that the ICT4D 3.0 framework is suitable and recommended for ICT4D projects.

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## 1 Introduction

Over the past two decades the use of internet has increased significantly. For most people in the western world the internet nowadays is a self-evident approach for knowledge sharing. However, the internet is still inaccessible to most of the rural communities in the world. These communities are still depending on radio and mobile phones for communication. This divide in the use of ICTs is commonly attributed to illiteracy, poorly developed technological infrastructures, low incomes and difference in ethnicity [1], [2]. Information and Communication Technologies for Development (ICT4D) is the research field that deals with these types of problems, with the main goal to facilitate information and knowledge sharing in rural areas.

ICT4D projects are not always successful, failure of ICT4D projects can be summarized in three different categories: lack of sustainability, insufficient evaluation and lack of scalability [3]. After the cooperation with the developer the system should be complete and easy to maintain without the help of the developer. When ICT4D projects are not evaluated on lessons learned are not communicated to following projects, mistakes will be repeated and the quality of a new project will not improve. ICT4D projects focuses on small communities, therefore it is maybe difficult to scale up. Different frameworks are developed to prevent this kind of failure, within this paper different frameworks are described and analyzed.

The ICT4D 3.0 framework[2] is a method for development of ICT services in low resource development contexts. The framework is based from extensive sociotechnical field action research performed in West Africa (Ghana, Burkina Faso, Mali), where methodologies are created by the understanding of social and technical factors that influence the context of the development of ICT services. The framework is designed to address a set of concerns that arises from ICT4D, where people from the western world design a technology for a development country without knowing what exactly is happening in developing countries.

For this research, fieldwork was done in rural communities of Sarawak Malaysia, this state of Malaysia is one of the poorest states with the highest unemployment rates. In Sarawak, the state of ICT is below national level. One of the main reasons for this underdevelopment is that Sarawak has a large number of different ethnic groups, this division causes difficulty in policy implementations by the government[1]. Two third of the population of Sarawak is located in rural areas without access to ICTs facilities [4].

The ICT4D 3.0 framework is validated through different ICT4D use cases, in Sarawak. The use cases and prototypes were set up during an exchange course between the Vrije Universiteit (VU) Amsterdam and University Malaysia Sarawak (UNIMAS). During the course 'ICT4D in the field', carried out in May 2018, systematic use case and requirements analysis of the low-tech and low-resource context of rural communities in Sarawak was performed, by a group of students and researchers. At first, ethnographic research was done in form of field visits and interviews, to assemble the need of knowledge sharing between the local communities. Resulting from the field visits and interviews, different requirements and use cases were constructed. A validation of the framework will be made, considering the overall process of the development of the ICTs.

## 2 Research question

This section will describe the research question and the resulting sub-questions, the subsection will explain the ICT4D 3.0 framework. Out of the research question, two sub-questions can be formed.

*RQ: Is the ICT4D 3.0 methodology, suitable for designing, engineering and deploying ICTs in a rural context?*

*SQ1: Is the ICT4D 3.0 methodology a suitable method for the developers?*

*SQ2: Does the ICT4D 3.0 methodology leads to a sustainable solution for the end-users?*

To determine what 'suitable' is for engineering and deploying ICTs in a rural context, the ICT4D 3.0 framework should lead to a sustainable solution for the end-users, where goals and objectives are set by the local user. Furthermore, it should lead to a system or service that is desired by the end-users using iterative development cycles and be fully adapted within the local context. These characteristics are described as in the ICT4D 3.0 framework as a collaborative, iterative and adaptive methodology. These claims whether the ICT4D 3.0 framework is collaborative, iterative and adaptive will be validated during fieldwork in Sarawak Malaysia.

### 2.1 ICT4D 3.0 framework

Bon et al. [2] developed a the ICT4D 3.0 framework for development of ICT services in low resource development contexts. The framework is based from extensive sociotechnical field action research performed in West Africa (Ghana, Burkina Faso, Mali), where methodologies are created by the understanding of social and technical factors that influence the context of the development of ICT services. The framework is designed to address a set of concerns that arises from ICT4D, where people from the western world design a technology for a development country without knowing what exactly is happening in developing countries. The following image shows the model of the framework.

The framework consists of five components:

1. context analysis
2. needs assessment
3. use case & requirements analysis
4. sustainability assessment
5. developing, testing & deploying

Context analysis focus on the fact that the developers needs to spend sufficient time on becoming familiar with the context and the associated constraints and demands. Need assessment focuses on the end-users needs. After collecting user stories and business ideas, use case and requirement analysis need to be done. In means of developing mockup and prototypes in communication with local stakeholders (e.g. using a focus group), this will lead to revised end-users needs. Sustainability assessment describes that business-model studies need to be carried out, to continue the service beyond the first stages of the project. At last, developing, testing and deploying makes use of multiple development cycles where the end-users are involved.

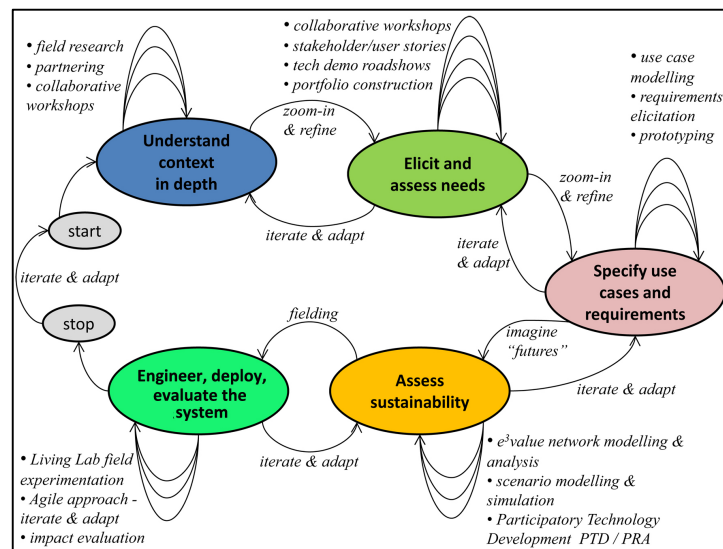


Figure 1: ICT4D 3.0 model

## 3 Method

This paper is based on a broad range of literature research combined with ethnographic research to validate the methodology formed for the field of ICT4D. This research makes use of the double

loop learning approach[5], where a validation of the framework is made by implications out of the findings of the fieldwork in Sarawak Malaysia.

### 3.1 Validity

Akkermans and Gordijn [6], suggest different categories of characterization of experimentation and empirical validation relevant to the field of Requirement Engineering. For this paper, the category field experiment is appropriate. Where the usefulness of the framework is validated under realistic field conditions. Akkermans and Gordijn, describe a checklist of review criteria, consisting of six different categorization of validity notions[6]:

“

- **Descriptive validity:** *do the data provide a truthful description of the situation or problem that is considered?*
- **Theoretical validity:** *are the employed theories or conceptual frameworks explicated and shown to be appropriate for the purpose?*
- **Interpretive validity:** *is the way in which all available data are mapped onto or interpreted in the employed theories or frameworks clear and adequate?*
- **Reasoning validity:** *are all steps in the reasoning sound and, in addition, consistent and coherent with other knowledge that we possess?*
- **Internal validity:** *are the claims made acceptable ‘beyond reasonable doubt’ within the situation or context (or sample) considered in the study?*
- **External validity:** *are any generalization claims that go beyond the studied situation sufficiently credible?*

”

Wieringa and Morah[7], describe two important questions for validation, considering the expected effects and expected value. “*What will be the effects of the artifact in a problem context? How well will these effects satisfy the criteria?*” Akkermans et al. [8] state too reduce problems in validity it has to include notion of adequacy and sustainability in the field. These researches towards validity will be taken in account for the evaluation of this research.

### 3.2 Method during field work

The Web alliance for Regreening in Africa<sup>1</sup> (W4RA) is an interdisciplinary network collaboration of scientists at the VU Amsterdam. The mission of W4RA is to support farmer-managed regreening activities by enhancing information, communication and knowledge sharing for rural development. The W4RA is researching and developing ICT4D technologies and methodologies in Africa to deliver useful voice services and web apps to rural communities. The W4RA visited UNIMAS in 2017, to expand research collaboration with UNIMAS in ICT4D.

For this research, the context is based on use cases for the ‘ICT for Development in the Field’ course. Interview and meeting were arranged to determine possible use cases for the course. The course is the first joint collaboration between the VU Amsterdam and the UNIMAS Faculty of Computer Science and Information Technology. The objectives<sup>2</sup> of the course are:

*““To make the next generation of information and computing scientists aware of the potential role of ICTs for the developing and emerging world, however (in contrast to a one-size-fits-all-approach) with a strong appreciation for the highly diverse and complex contexts, social-cultural factors and human needs that must be addressed.*

*To equip students with relevant field research and development methods and skills for ICTs in a rural community/developing region.*

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<sup>1</sup> [www.w4ra.org](http://www.w4ra.org)

<sup>2</sup> <https://www.vu.nl/nl/studiegids/2017-2018/master/g-j/information-sciences/index.aspx?view=module&origin=50978227x50766605&id=51571814>

*To acquire and reflect on the experience of carrying out a full cycle of a real-world software development project in the field, learning to be able to deal with unfamiliar and complex contexts, and to engage with real users with their own specific problems, needs and goals.””*

Ten students from the VU and eight students from UNIMAS, were divided into three different groups to encounter different use cases. As goal to develop a working prototype for the use cases in the field of Sarawak Malaysia. The students make use of the ICT4D 3.0 framework, within this paper the course is used to validate the framework during the process of an ICT4D project. The course makes use of the SCRUM methodology[9], where daily team meeting take place to discuss and work on the projects.

In cooperation with Dr. Cheah Wai Shiang of UNIMAS, context analysis and needs assessment is done to collect user requirements. Use cases were setup and prototypes will be developed for the cases. The different steps of the framework make use of value co-creation, where for every step the developer, local users and local business partners work together. To create new systems that are useful and meaningful for local users and profitable for local business partners[10]. Dr. Cheah Wai Shiang as a resident of Sarawak has the knowledge of the language and local communities. Together with the UNIMAS students, there are sufficient people who speak the local language. To perform interviews in multiple small focus groups. Furthermore, Dr. Cheah Wai Shiang has previous research experience within the field of ICT4D[11]. By being engaged within the complete process of the projects, issues and success factors can be identified for the validation of the ICT4D 3.0 framework.

To create an overview of the complete process, the projects are visualized using a timeline, where point of interest are visualized and described. Point of interest for the ICT4D projects are considered: requirement changes, new stakeholder or technique introduced, design changes and sustainability assessment. The timeline gives an oversight of the order of the different phases, insight is gained on which moment information is retrieved for the different phases.

### **3.3 Validating the framework**

The validation of the framework is done in two different steps. At first, answers to the review criteria of the different validity notions will be given. Out of the findings of the different projects, the different review criteria are answered. Considering the descriptive validity, theoretical validity, interpretive validity, reasoning validity, internal validity and external validity. Not all the validity criteria have to be satisfied to reassure the validity of the framework [6].

As second, the two questions described by Wieringa and Morah are specified. The expected effects and the expected value. Within this paper, the expected effects are considered the description of the framework, where the framework is described to have the following claims: collaborative, iterative and adaptive. The expected value are the findings out of the different projects corresponding to the three characteristics. The validation of the framework will lead to answers towards the research question and the resulting sub-questions.

## **4 Related work**

This section will explain previous research done for the field ICT4D, the section is divided in three subsections: web-based information systems, development frameworks & research methodologies and user engagement.

First of all, it is important to specify what is considered development in the field of ICT4D. A distinction of ICT for Development and ICT in a development country can be made. Where in ICT for development can be seen as any kind of development for a human being. Scholars have different perspectives for the definition of development. Considering the Sen capability approach, development is described as ‘an individual’s freedom to live the life he/she values, rather than economic growth’ [12]. According to Duncombe [13] ICT4D should aim at reducing poverty and not only by providing ICT to the rural poor. Here development is seen as pure economic growth, however Rothe [14] sees development in a different way and introduces the sustainable development



goals (SDGs) for conceptualizing development. The SDGs are 17 goals<sup>3</sup> appointed by the UN and gives a more wider perspective of the definition. This paper will take the definition of Rothe inconsideration.

#### **4.1 Web-based information systems**

The Raspberry Pi is a small computer, which offers a simple solution for knowledge sharing in a low-resource developing context. The device has a low cost and is easily portable, different systems are created with the Raspberry Pi. The first system that will be discussed is Library in a Box, it provides a solution to make the digital divide smaller. Reading materials for education can be made available, by connecting through the Wi-Fi of the Raspberry Pi with a device, such as a smartphone. Learning content can be loaded on a device without having any internet connection. Another system created on the Raspberry Pi is the Kasadaka<sup>4</sup>.

The Kasadaka is an ICT4D platform for knowledge sharing, it allows the development and deployment of information systems for the poor. Information sharing can be done in various ways, through voice-, SMS-based, visual or textual interfaces. The Kasadaka is built on a Raspberry Pi computer, it uses open source Linux based software and it uses a GSM dongle to connect to local GSM networks[15]. The GSM dongle makes it possible for the users of the system to retrieve or create information, by calling the Kasadaka with their mobile phones. The voice interface of the Kasadaka system is an interesting feature, to provide an information sharing service in a communities' own language. This can be a useful function for developing countries, where there is a low literacy rate. Baart (2017) developed a Voice Service Development Kit for the Kasadaka, which enables the development of voice-services in any language for users without having much programming experience and small knowledge of the underlying technologies[16].

The eBario project was setup by a group of researchers from the University Malaysia Sarawak (UNIMAS) to introduce ICTs to a remote community in Bario, Sarawak [17]. With the goal to facilitate opportunities for social development, introducing the Smart School application and a community telecentre set up. A telecentre to provide full internet and World Wide Web connectivity. The results of a survey conducted with the local people in Bario, concluded that the Bario community is ready and enthusiastic for ICT improvements. Where the current communication resources exist of radio and radiotelephone. In Bario there was no basic infrastructure for ICTs, new implementations and telecommunication are expensive and of limited availability. The eBario has brought many advantages to the community, it changed the lives of the people in the community to be connected to information and where people using the internet[18].

#### **4.2 Development frameworks & research methodologies**

ICT4D 1.0 was consisting out of telecentre projects to provide text-based information via the internet to poor communities. This period is summarized as a complete failure []. ICT4D 2.0 was proposed, to lay more attention on application and business model innovations. However, there are still some issues with ICT4D 2.0 such as: the notion of true innovation, support to self-organization of local communities and true participation of end-users. Bon and Akkermans propose an alternative approach for ICT4D projects labeled as ICT4D 3.0, where the needs of the user are considered the most important. Based on three principals: goals and objectives are set by the local user, co-creation and technologies are fully adapted to the context.

Over the years multiple frameworks and methodologies are designed for ICT4D, within this section different frameworks and methodologies will be described. Where earlier methodologies lack the ability to be adaptive, because of a linear approach. This linear way of thinking has been proven to be cause failure in ICT4D projects[19]. The frameworks that are discussed in this paper all maintain an agile way of development. Agile software development has different practices, who share common characteristics, using iterative development with a focus on interaction and communication [20]. Frequent used techniques are extreme programming and SCRUM. Dijkers et al. [21] investigated how agile software development is contributing to the success of ICT4D

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<sup>3</sup> <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

<sup>4</sup> [www.kasadaka.com](http://www.kasadaka.com)

projects. They describe four critical success factors that need to be fulfilled for ICT4D projects before an agile method can work. The project needs to be demand-driven, relevant skills must be built and trained, a cultural understanding must be developed and trust must be built.

#### *4.2.1 Other frameworks*

Doerflinger and Dearden [22] discuss a methodology DRAMATICS, “DistRibuted Agile Methodology Addressing Technical Ictd in Commercial Settings”. The methodology uses an iterative, action research approach which is adapted and redefined over several projects in retail and agricultural supply chain sectors in Africa. The methodology brings a focus on establishing a core team and long-term business relationships in development regions. The core team includes four key roles: project leader, local change manager, local contact and internal software developer.

Ferrario et al. [23] introduces Speedplay an agile and iterative development framework for software development, using approaches from social sciences like action research and participatory design. The framework consists of four phases: prepare, design, build and sustain. The first phase prepare is using qualitative research methods for gaining the user requirements. The second phase aims to visualize design systems that addresses user needs. The build phase makes use of short development cycles, where stakeholders and end-users are involved in every step of the process to refine the user requirements. The last phase focus on planning for future development for the system by finding a partnership to support long-term development and the deployment of the prototypes. The project has been built on experiences with ICT projects with communities and has been evaluated on three different projects.

Haiking and Duncombe takes a critical approach towards participation and community empowerment in ICT4D projects[24]. Using different ICT4D projects to create a framework that takes success factors and issues into consideration. However, the described framework is not tested in a real-world situation. The framework has a similar structure as the frameworks discussed above, however there is a greater focus on sustainability and planning of the ICT4D projects.

#### *4.2.2 Differences and resemblance of the frameworks*

Keijndener et al. [3] have performed a literature research regarding the previous frameworks. The paper states that the above frameworks all share a similar structure, focusing on context, team building and iterative design. Most of the frameworks share similar phases, they all start with a preparation or understanding phase, to identify stakeholders and environmental factors. The second phase is requirements gathering, with this phase the research team should discover what the needs are of the local community. The third phase is the design phase, a design will be formulated using user interface drawings, prototypes and human centered design techniques to perform requirement analysis. After the requirement analysis, clear requirements can be formulated. The fourth phase will be sustainability assessment, mainly focusing on financial sustainability. The fifth and final phase is the development phase, using iterative development by closely involving the end-users in the development process.

The frameworks discussed above are all using agile methods for software development, where every phase is an iterative phase by using input of the stakeholders and end users. The different frameworks all explain the importance of a local partnership and building a good relationship with the local stakeholders and community. An apparent difference between the frameworks are the descriptions of the sustainability of the projects. The framework by Doerflinger and Dearden does not take the sustainability within the framework, only for the evaluation of DRAMATICS they explore financial sustainability, level of adoption and discusses plans for scaling up. The level of adoption is presented in the form of a percentages of the end-users who adopted the system. In the contrary, the framework of Haiking and Duncombe lays a high focus on sustainability from the start to prevent failure. The frameworks discuss different factors to see a project as sustainable.

Financial sustainability, refers to the economic value for towards the stakeholders involved at a ICT4D project. Most frameworks consider this the most important factor for sustainability, a high financial sustainability points towards an important positive factor for scalability [23]. The ICT4D 3.0 framework makes use of the e3value methodology [25] to assess the sustainability of a project. The e3value methodology, gives a better understanding of the business value of e-commerce projects for stakeholders involved in a project. The methodology exists out of modeling concepts to



present which parties exchange things of economic value. The exchange of things of economic value is modelled through value ports, where actors exchange value for value. The profitability can be evaluated for each actor involved.

The framework by Ferrario et al. is not laying focus on financial sustainability, it describes more the need for a wider partnership for future system deployment and the need for sharing the system technical understanding. Technological sustainability is the manner where a technology can exist for a longer period of time without large shifts in the use of hardware or software. An important factor for technological sustainability is the technological dependency of the projects, local stakeholders should not be dependent on the developing team. The technical understanding of the system should be shared with the local stakeholders.

Social sustainability, is the way of embedding a technology where it will be accepted and used by the local communities [23]. Not only if the technology will be used by the community, but the technology should be useful to at least one of the stakeholders, where the technologies are able to supply relevant content. To provide social sustainability, all the frameworks starts with an understanding and requirements gathering phase to determine the local context and needs. However, this is not described as social sustainability in the different frameworks. Institutional sustainability is related to social sustainability, ICT for development projects needs to be accepted by the political actors in the concerned countries [26].

According to Keijndener et al. there are issues regarding the fact that the sustainability and scalability are seen as one term in the literature. their focus lays on scalability and describes multiple factors regarding to the scalability of a ICT4D project. The main challenge for the scalability of a project is not the size or reach, but to keep it sustained over a longer period [3]. The frameworks describe a step for the preparation to scale up the projects, ICT4D 3.0 framework is not discussing scalability.

#### **4.3 User engagement**

Important within ICT4D projects is the way of engaging with the stakeholders and end-users, because the quality of relationships and the expectations at the beginning of the project are critical to the outcome and impact of the project [27]. The Afrocentric research methodologies: focusses on the engagement with different communities, the proposed research method describes 5 different research criteria, for research where the human behavior is a factor. These following criteria will be taken into account for research performed for this paper.

1. Ukweli(truth): the experiences of the community members have the authority in determining what is true. Truth has to be grounded in the experiences of the community, experiences influences the kind of research/ topic and how the data is interpreted.
2. Kujitoo (devoted): It requires that the researcher takes in consideration of how knowledge is structured, so the knowledge can easily be retrieved by the community.
3. Utulivu (justice): it requires that the researcher needs to avoid creating, exaggerating or sustaining division between or within communities.
4. Ujamaa (familyhood): the need for recognition and maintenance of the community.
5. Uhaki(harmony): the research should be fair to all participants in the research, the researcher should aim for the encouragement and maintenance of harmonious relationship between groups in the communities.

### **5 Field research**

The use case that are used to validate the frameworks exist from the ICT4D course. For these use cases prototypes were made, using Web-based information system techniques. These prototypes are based on co-creation, where in communication with the local community, a full understanding of the end-user's needs is incorporated. Two different kind of Web-based Information systems were taken in to consideration for developing the prototype: smartphone application and a prototype that makes use of the Kasadaka system. The Kasadaka is a tool for knowledge sharing that is enabled by a voice service. The systematic use case and requirements analysis as well as the prototype were developed using the methodologies described in the ICT4D 3.0 [28].

## 5.1 Context analysis and need assessment

Performing field visits and interviews, the context analysis and the need assessment was determined. Context analysis will be done to get a better picture of the situation in rural Sarawak. Where information is needed on different kinds of subjects, for example on: literacy rate, technological infrastructure, ICTs usages (e.g. level of smartphone use) and purchasing power of the end-user[2]. The need assessment will arise mainly in communication with the local community, to build requirements for the use cases. At first, some interview and meeting were done to identify the situation and have an insight of possible use cases for the ICT4D course. At the start of the ICT4D course more interviews were executed by the different groups of students, to obtain a more detailed description of the context and needs of the local community.

A semi structured interview (appendix A) with the director of the institute of Borneo studies, gave insight in the 'general' context of Sarawak. The institute has collected a lot of data, all over Sarawak focussed on villages. The 'general' context is described in the following section.

### 5.1.1 General context Sarawak

Within Sarawak, every local community has a community leader. Out of different interviews with ISIT and Institute of Borneo studies they point out that it is very important to have a good relationship and approval of the community leader before starting any project in the community. The state of Sarawak has over 40 different kind of languages, where Bahasa Malay is the main languages. The large amount of languages is due to the many different ethnic groups within Sarawak, the Iban is the largest group containing about 30% of the population.

The Institute of Borneo studies did a lot of research and collect information of many communities in Borneo. The main concern the director of the institute, describes is the education. The unemployment rate in Sarawak is 3.0% and the literacy rate 73% (Appendix A). Villages are dealing with a low infrastructure, where schools are difficult to assess and there is a low internet coverage.

The government of Malaysia is highly investing in telecentres to provide internet to rural Sarawak, because the communities are very new to the connection people are not aware of the possibilities of the internet. The overall use of smartphones is high in Sarawak.

### 5.1.2 Agricultural department, banana chips factory and contract farmers

A meeting with the agricultural department of Sarawak, local farmers and CEO of the factor was arranged to decide if there is a possible use case for the ICT4D course. Within the first meeting, a lot of information was shared about the role of the actors, the process of banana farming and the problems/concerns the different actors faces (appendix B). The factory is asking for more bananas because the demand of banana chips is high, there is one kind of banana used to make the chips the 'Pisang Sekaki'. The agricultural department is currently trying to find more contract farmers to meet the demands of the factory. It became clear all actors had different interest and different needs for improving the process of banana farming. Where the CEO of the factory had a big interest in providing the farmers with knowledge about banana farming, for example the amount of fertilizer to use, what is the right time for harvest and how to deal with certain situations. The agricultural department had a strong interest the amount of harvest, the waste percentages and the amount of acre of farmland owned by the farmer. This interest occurs from the fact that the agricultural department is investing in new contract farmers by supplying fertilizer, tissue culture and chemicals. The agricultural department wants to have a better overview of their investment. A second meeting was arranged that was more focused on the farmers.

One group of students of the ICT4D course focused on the farmers problem statement, equipped with the knowledge gained from the previous interview, these students had three more interviews to verify the findings and to describe challenges within the scope of banana farming. The following challenges became clear. First of all, there is a lack of coordination between all actors, leading to inconsistencies in supply and demand, and too much waste. There is a lack of knowledge and supply of the seedlings using a tissue culture method. At last, the factory receives bananas of poor quality, there is a lack of knowledge on how to grow bananas properly, the types of disease and how

to handle these, and the know-how of building canals against floods.

Further findings from the interviews were that all farmers are low-literate or literate, the ICT-literacy among the farmers was divided. Some of the farmers had no experience with smartphones and could only make phone calls, other farmers have android smartphones and are able to operate and understand smartphone technologies.

### 5.1.3 *Kampung Pinggan Jaya*

The village Pinggan Jaya is used for context analyses and need assessment, to determine possible use cases for the ICT4D course. The village is chosen because of the long-term collaboration with UNIMAS. The village is located 30 minutes from the centre of Kuching, it has around 700 inhabitants. The road infrastructure towards the village is good, however the network coverage is poorly. Only one spot in the village, located at the jetty has a proper internet coverage.

After the first visit to the village, while meeting the community leader and several women of the village (appendix D). The community was informed over the coming project and first insights about the context and problems the community faces were made. The inhabitants of the village can be divided in three different groups for possible use cases. The woman group, teenagers and primary school children. With the start of the ICT4D course a second visit was made to the village, the students were divided to interview the different groups of the community. To have more focused interviews for context analysis and need assessment.

The most women from the women group, are housewives, the women are selling local products on the side, using Facebook, WhatsApp and a website to promote their products by adding their phone numbers. At the second interview with the women group, eight women were available for questions. Five of the eight women had a business or were involved in a business, selling or producing products. The products ranged from chips and Malaysian cookies, gula apong, traditional clothes, handcraft and vegetables. Gula apong is a local sugar product, produced from the Nipa palm tree. The women are interested in expanding their businesses. Most of the production of the products are in demand, orders are received via SMS, WhatsApp, calls, or visits. The advertisement is done via WhatsApp, Facebook and by word of mouth. The biggest problem the women encounter in their businesses is the connectivity to the internet for selling their products.

The teenagers are mentioned that they face some serious problem, using drugs and dropping out of school. The interest of the teenagers is dancing, every year the teenagers from the village perform a dance at the cultural village of Sarawak. At the start of the interview with the teenagers we were able to talk to the dancing teacher, he plays a major role in the well-being of the teenagers. For the teenagers, it is difficult to share their dancing videos because of the poor internet connection in the village. Currently the dancing teacher is downloading all the dancing materials to show to the teenagers in his salon.

The main concern of the women in the village is the education of their children. The school is located on a 30 minutes walking distance from the village. The school is not performing well therefore it is losing funding from the government. About year ago, Malaysia introduced a new system for the primary schools. Where answers on homework assignments needs to be found on the internet. The school and the village do not have any decent internet connection, this is causing problems for the children. Most of the households are not earning enough to pay for all the required books, where the internet is a solution to still find the materials the children need to learn. For the interview within the ICT4D course, the children were divided in three different groups for the interview, two groups with children between the age of 10 and 12 and the third group with children between the age of 7 and 9. The groups consisted around five children. The children were asked to draw pictures or write down their hobbies, their favorite fictional character and their aspirations for the future to get a better understanding of the interest from the children. The children have different views on which subject they find the most difficult. However, according to the parents the children are facing the biggest problems with English and Math. Currently the children do not have much offline material available to be stimulated to engage in educational activities after school.

The biggest problem that arises from the interview with the different groups is the lack of internet in the village. All group faces their own problems due to the poor connectivity to the internet.

#### 5.1.4 Gula apong

During a visit with the agricultural department for the context analysis and need assessment with the banana farmers, a new possible use case was brought to light by a expert in the field from the Engineering Department of UNIMAS. A meeting was set up with the Ministry of Industrial and Entrepreneurial Development Sarawak (MIED), to hear the needs of the ministry. The MIED wants to monitor the producers of gula apong, currently there is no good overview of the amount of gula apong producers and their location. It is the wish of the MIED is to develop a system that will collect data about the gula apong production in Sarawak. The data the MIED is interest in is the names of the producers, the number of trees, the size of their farm and the amount of gula apong produced.

The context was determined by talking to gula apong producers in kampung Pinggan Jaya and a visit to a gula apong producer in Asajaya. The producers work together with their families, who helps with transporting, packaging and selling the product. Currently gula apong is sold for 8 ringgits<sup>5</sup> per kilogram, the production is time consuming and labor intensive. Often the products are sold to middlemen, who buys the products from the producers and resell it to the final customer.

## 5.2 The use case selection

Out of the first two phases of the process the context analysis and need assessment, insight is gained in the problems the stakeholders involved faces. From these broad problem descriptions, a list of more specific use cases is made. Eleven possible user stories are described in the table below, to decide which use cases to pursue the cases are mapped on the ease of implementation and their impact. These decisions were made during a workshop of the ICT4D course, where the level of execution and impact are discussed by the students and professors.

<i>Use cases</i>	<i>Description</i>
<b>Banana farmers</b>	
Coordination of demand/supply	Oversight for the agricultural department of the number of trees, harvest and fertilizer.
Quality control	Control on diseases and quality of the bananas.
Knowledge sharing	How to grow bananas? New farmers lack the know-how.
<b>Teenagers</b>	Teenagers of kampung Pinggan Jaya
Internet access for social media support	It is difficult for the teenagers to exchange dancing videos, to improve their social visibility.
Knowledge sharing	Providing content for dance classes
<b>Gula apong</b>	Gula apong
Coordinate demand/ supply	Get rid of middle man and make a better price for gula apong
<b>Children</b>	Children of kampung Pinggan Jaya
Homework	Offline content to answer assignment questions without querying the internet
Learn English	Help the children to improve their English
Math Game	Help the children to improve their math
<b>Women group</b>	Women group of kampung Pinggan Jaya
Access to the internet	Selling products
Advertise products	Help with the advertisement of the products

Table 1: User stories

For all the focus groups located in the village Pinggan Jaya, the main problem is the poor internet connectivity. All the groups will profit if there is a better internet connection in the village, this case is mapped with the highest impact and is relatively easy to implement. A router is placed in the

<sup>5</sup> 1 MYR = 0.214389 Euro <https://www.xe.com/currencyconverter/convert/>

village as a trial solution for the problem. However, due to the fact that payment is needed for the internet on the SIM card, the router is currently not running because of the lack of funding.

The other use case that are chosen are considering the ease of implementation and impact, are helping the children to improve their English, the coordination of demand and supply of bananas and the coordination of demand and supply gula apong. The students of the ICT4D course are divided in three groups to continue the process of the development of prototypes for the use cases.

### **5.3 The use cases and prototypes**

The use cases are constructed by the student with use of a pragmatic format for use cases and requirements description[29], to give a clear understanding of the use cases and requirements. The format exists of 11 steps with guidelines for development of information architectures. The three use cases that are selected with their developed prototypes are described briefly in the following section.

Depending on the on the context and need assessment, it can be determined which kind of prototype can be build. Considering the two Web-based information systems used: smartphone/web application and the Kasadaka system.

#### **5.3.1 *Coordination of demand and supply of bananas***

The demand for bananas is very high for the production of banana chips, currently the amount of banana supplied by contract farmers is limited. The agriculture department is helping the factory to meet this demand by recruiting new farmers with land, the department will provide plant tissue culture, fertilizer and chemicals to the farmers. Because the agriculture department is investing in the farmers it is necessary for the department to have an overview of the data of the contract farmers. Currently there is a lack in the communication between the different actors. Three different actors play a role in this case with different concerns, the contract farmer, department of Agriculture and the banana chip factory.

The prototype [30] made by the ICT4D students is a data collection system for the contract farmers, to support the communication and coordination for the banana chips production. To help the agricultural department with information to monitor and control the contract farmers. The following requirements for a system became clear after the interviews with the contract farmers, agricultural department and an expert in the field. The number of planted trees per yield, the weight of the harvested bananas per yield and whether the farmer used fertilizer, should be entered by the farmers. The contract farmers use their smartphone to enter the data, this data should be recorded every month from the farmers. The agricultural department needs an overview of the all the farm data and the factory needs to be able to see the farmers data and enter data about the purchase. The application should be easy to use, implemented with English and Bahasa Malay language.

The prototype is a simple web application build on a Django framework, with three different interfaces. One for the agricultural department and one for the banana chip factory, an online web application accessible in an internet browser. The third interface is for the contract farmers as a mobile web application accessible through a mobile browser. The application interfaces are hosted on Heruko, it can also be hosted on another hosting service that supports python.

The agricultural department can form new user accounts for the farmers with their personal information, such like username, location total number of trees, number of harvested bananas and fertilizer use. The agricultural department will have interface with an overview of all the collected data. The interface for the factory is very similar to the one of agricultural department, there is an extra page to collect information of how many bananas are bought from the farmers. With this information, the waste percentages can be calculated using the number of bananas harvest and the number of bananas bought. Using the farmers interface, the farmer can update the personal information every month.

#### **5.3.2 *Coordination of demand and supply gula apong***

This use case [31] was introduced by the MIED, their interest lays in creating an overview of gula apong farmers, to renovate the gula apong production and get rid of the middlemen. The MIED wants to bring the producers on the map by collecting data of the production. Such as, names of the

producers, the number of trees, the size of their farm and the amount of gula among produced. The following actors play a role in the gula among use case: gula among producers, gula among customers, the middlemen, the MIED and an administrator. The main goal of the system is to organize the production in Sarawak, connecting buyers and sellers and to encourage a farmer cooperative.

The system is a mobile application to increase the visibility of gula among producers. The application is written in Ionic 1 and Cordova framework, the application can be run on multiple platforms with the same source code. Gula among customers are provided with a list of producers with their stock and contact details. The application consists of three different interfaces, one for the producers, the second for the MIED and at last one for the gula among customers. The main features of the application: the application is offline accessible the information is saved in databases, location and area of the farm can be tracked, the number of trees and the amount of gula among produced can be registered.

The interface for the gula producers allows them to enter information about the amount of gula among produced every week, the number of trees and the size of their farms. The size of the farm can be estimated using GPS points, while the producer is walking around his farm. The producers have an overview of the amount of gula among produced and of their customers. The government is promising property to the gula among producers if they regularly use the application and contribute with data about their businesses. The MIED will be provided with an overview of the data stored by the farmers, to give insight in the producers, their production and their farms. The information is visualized in the form of a graph. The stock is provided to the customers, so the customers can easily find the producer who meets their demands.

### 5.3.3 *Help children to improve their English*

This use case [32] has as goal to help the children of the kampung with English. The Library in a Box build on the Raspberry Pi (related work), provides a good solution to for presenting an application to the children without having an internet connection. During the ICT4D project a new important part of context was presented by Dr. Cheah Wai Shiang and the village leader, they have a small project to create a study spot in the village leader's house. The study spot will be equipped with a number of OLPC XO-4 laptops<sup>6</sup>, where the kids are able to learn how to use a laptop and learn different skills. These laptops are made for the one laptop per child (OLPC) program. As mission to provide the world's poorest kids with education, by providing them with a low cost and low powered laptop.

The OLPCs and the Library in a Box will be a good way for presenting an application within the context of the village. Currently the Library in a Box contains some learning games, however user testing showed the children lost their interest in the games quickly.

Multiple actors play a role in this use case, the children are the most important stakeholders in this case, the children want to improve their English. UNIMAS is involved by providing OLPCs and creating a study spot. The women of the kampung are involved with their children and the community leader's daughter is working closely with UNIMAS.

The prototype that is developed is a web application, where the database is hosted on the Raspberry Pi. The children will make use of the OLPC XO's to make a connection to the Raspberry Pi and access the content of the application, besides it is possible to connect a smartphone or laptop to the Raspberry Pi to open the application in a web browser. The application provides a possibility to learn English in a playful way. By reading comic strips and answering quiz questions about the comic strip to unlock new chapters, if the questions are correctly answered. The interest of what kind of comic strip the children likes was gained with the first interview with the children. The application has the intention that the children will gain reading comprehension skills and increase the children's vocabulary. The children first need to login with their own username, in this way personal scores can be stored. The content of the application can be easily edited to fit context or needs of the users, the content of the chapters can be changed and the question and answers of the quizzes.

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<sup>6</sup> [http://wiki.laptop.org/go/The\\_OLPC\\_Wiki](http://wiki.laptop.org/go/The_OLPC_Wiki)



## 5.4 Interview and meetings

This part will discuss the important interviews and meeting before and after the ICT4D course, with a description of findings during the research, such as complications within the process.

### **Meeting agricultural department**

25/04/2018: At the first meeting at the agricultural department the stakeholders for a possible use case were introduced. An expert in the field from the agricultural department, the CEO of the banana chip factory and some contract farmers. All the actors shared their vision of the current problems in the production and coordination of the banana chips. Knowledge of banana farming is shared.

### **Interview institute of Borneo studies**

30/04/2018: Insight is gained in the general context of Sarawak.

### **Meeting kampung Pinggan Jaya**

04/05/2018: The project is introduced to the village leader and women of the kampung, the first context and need assessment is discovered. The village is divided in three groups for further research, children, women group and teenagers.

### **Interview ISITI**

7/05/2018: Interview with prof. Nara, knowledge about telecentres and information about the practices of the Institute of Social Informatics and Technological Innovations (ISITI).

### **Meeting farmers agricultural department Asajaya**

1/06/2018: Farmers are introduced to the project and a planning is made for future visits. New knowledge for banana farming is introduced.

### **Second meeting kampung Pinggan Jaya**

2/06/2018: Inform further plans of the ICT4D course, meeting women group.

### **Interview dr. Cheah Wai Shiang**

8/8/2018: Short interview on the future prospects for the build prototypes. Considering the banana and the gula apong case. Both applications need further enhancement in order to suit real deployment. Currently students of UNIMAS are working on the application for the coordination of bananas. There is still no study spot created where the children can make use of the English learning application.

### 5.4.1 Findings

The first appointments were easily made, however over the course of the project some difficulties were faced. For example, it was not possible to get an appointment with the teachers of the kampung Pinggan Jaya due to a long holiday. Moreover, many public holidays are celebrated within in the state of Sarawak. During the second meeting with the kampung Pinggan Jaya, it was difficult to gain information of the women group. Because the meeting was held with 20 women and the village leader, the voice of the daughter of the village leader was strong and not much personal information of the women was gained.

Out of the interviews with ISITI and the Institute of Borneo studies, it became clear how important it is to develop a good relationship with the village leader is.

Considering the last interview with dr. Cheah Wai Shiang, about the future prospects of the applications, it appears that the sustainability of the projects is still uncertain. A positive factor is that the currently the students of UNIMAS are developing the application further for the coordination of bananas.

## 5.5 Interviews and meetings for the use cases

This section, present a timeline visualizing the information gained considering the different phases of the framework, over the course of the three different use cases.

### 5.5.1 Banana farming

- a. Interview agricultural department, contract farmers and expert in the field.

**Context analysis:** Information about the relationship between agricultural department, contract farmers and the factory. Information about the smartphone use of the farmers, process of

planting and harvesting. Information of the type of services the agricultural department provides to the contract farmers.

**Need assessment:** No issues described by the farmers, where technology could help. Flooding stated as the biggest issue. The agricultural department described they lacked a means of tracking activities between farmer and factory and they lacked information of the current processes. The field expert gave a more detailed description of the challenges the process is facing (section 4.1.2).

**Financial sustainability:** financial information of how factory is paying the farmers, government determines the price of bananas and how the agricultural department is investing in the contract farmers.

- b. Visit to factory, interview with the CEO of the factory.

**Context analysis:** more details of how the contract farmers work for the factory.

**Need assessment:** The factory is unable to coordinate the supply of the bananas with their demand and processing capacity. Another concern of the factory was the quality of the bananas, the CEO wishes for a knowledge system to provide training to the farmers.

- c. Use case selection:

Continue with use case for the coordination of demand and supply of bananas

- d. Presentation of the project plan.

**New requirements?** Comment of an employee of UNIMAS, who raised the question if farmers are able to provide the number of trees and hectares of land by their own. The employee suggested to upload pictures of the trees using satellite photographs.

- e. Meeting expert in the field

**New requirements:** No division into areas, just in different yields, monthly data entry, amount fertilizer not important

- f. Presenting prototype to expert in the field and fertilizer company.

**Context Analysis:** New stakeholder introduced, the company that provides fertilizer to the company.

**Need assessment:** Fertilizer company acquires the same need as the factory, where knowledge should be brought to the farmer. By cause of the lack the know-how of the contract farmers.

Findings: Information about financial sustainability gained in one of the first meetings, the contract farmers declare they do not face any problems, expect for flooding. Questions arise for the social sustainability, will the farmer be motivated to use the system? Moreover, the amount of fertilizer seemed important, however in a later meeting it this requirement was changed. At last, in a late state of the project a new stake holder is introduces. Because of the time limit of the project, no end-user testing is done.

### 5.5.2 *Gula apong*

- I. Interview women kampung Pinggan Jaya

**Context analysis:** by talking to women who produce gula apong, more insight is gained.

**Need assessment:** businesswoman like to expand their business.

- II. Interview Gula Apong farmer in Asajaya:

**Context analysis:** more insight in the process of the gula apong production.

**Financial sustainability:** by gaining information about the market prices.

- III. Interview Ministry and expert in the field

**Need assessment:** discovering the needs for a possible system

- IV. Use case selection:

Continue with the use case for the coordination of demand and supply gula apong

- V. Interview expert in the field:

**New actors introduced:** buyers and resident director

**Sustainability:** farmers are promised land if they keep supplying gula apong through customers using the app.

**Requirements:** GPS locations is important factor for data entry.

- VI. Interview ‘application developer’:  
**Introduction new technique:** application<sup>7</sup> for farmers in Mali, easily indicate the area their farm by the number of trees and GPS coordinates.
- VII. Cycle 1 prototype, Interview gula apong producer  
**New needs/requirements:** not only the GPS coordinates of the farm are interesting, but the size of the farm is of interest too to the Ministry. Know who the regular customers are. An overview of the producers who produce regularly, so that they know who deserves to receive land
- VIII. Feedback MIED:  
**New requirements:** Asked for more features, possible to deploy it on Android, make entry field for the size of the farm, asked for an addition to the buyer interface,  
**Sustainability:** want to use the application for more farming products and they want to download the application as soon as possible.

Findings: Stakeholder had already clear idea how a system should look like, more time would result in a useful buyer interface.

#### 5.5.3 Children group

1. Interview kampung Pinggan Jaya  
**Context analysis:** Interviews with the children of the village gave insight in the interest, ambitions and problems of the children.  
**Need assessment:** the children are mainly facing problems with English and math
2. Decide on which use cases to proceed  
Continue with the use case to help the children improve their English
3. Meeting with the parents of kampung Pinggan Jaya  
**Context analysis:** Introduction of the one laptop per child program, UNIMAS and the community leader are planning to create a study spot at the village.
4. First cycle of implementation and deployment  
**New requirements:** Living lab with the children of kampung Pinggan Jaya, the first version of the application was tested. The pages of the comic strips were too long before the quiz started, the children lost their concentration on the text. Furthermore, the question at the end of the chapter was a bit too difficult for the children to understand.
5. Second cycle of implementation and deployment  
**New requirement:** After implementing the new requirements into the system, a second evaluation was carried out. This time the children remembered the order of the correct answers, this has led to an implementation where the order of the questions was shuffled.

Findings: the user testing was useful for the system, pitfalls in the system were fast discovered.

### 5.6 The findings of the projects

This section gives a summary of the findings out of the fieldwork performed during the different projects.

A good relationship with stakeholders is crucial, so there is a good trust for each other that is important for the quality of the information. The use of a local partner is important, where local partners and end-users be more open and honest [22]. To gain good relationships with local partners and end-users it is important to respect the different culture. Planning is an important factor, where in this case in Sarawak many different kinds of public holidays are celebrated. Within this research many appointments needed to be delayed due to public holidays. A new stakeholder was introduced late in the process of the project, this can be the result of a poor context analysis. Considering the context of the end-users, where many of the locals have access to a smartphone or own a smartphone, the Kasadaka does not bring a relevant solution for the constructed use cases.

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<sup>7</sup> <https://w4ra.org/2014/01/31/mr-jiri-a-new-app-for-evaluation-of-on-farm-trees/#tc-comment-title>

During the briefing towards local stakeholders by presenting the plans for the systems, new requirements and needs arises. For all the projects the sustainability is uncertain, this can be the reason of an insufficient sustainability assessment and also due to the time limit of the project. With more time, the prototypes could be developed further for deployment. Sustainability for the projects are reassured by the fact that all projects are developed as open source software, and UNIMAS students will continue the projects in the future. Some questions arise taking the social sustainability into account: Will farmers accept the application and actually provide the data to the application for the factory and the agricultural department? Furthermore, promises made during the gula apong case, where the government is promising land to the gula apong producers. Is an important reason for the social sustainability to use the system for the producers, however such promises are quite big, and should be written down into a contract. Now it can just be a false promise from the government.

Another aspect of the lack of time resulted in that one of the projects could not be tested with real end users. As shown in the English learning application, the testing with end-users gave good view what should change in their design. Due to the fact that the applications are not deployed yet, no evaluation can be made. Whether the applications have any impact to the local communities, whether the applications are socially accepted and the level of adoption.

## 6 Discussion

The following subsections will answer whether the projects are influenced by using a collaborative, iterative and adaptive approach. The validation subsection gives an answer to the research question and describes the validation criteria discussed in section 3.1 and 3.3.

### 6.1 Collaborative

To gain information for the different phases of the framework, collaborative workshops were performed. Out of these workshops a lot of information is collected about the context, needs and sustainability for the use cases. However, it is difficult to say that the goals and objectives are set by the local user. In the cases of the banana and gula apong production, the agricultural department had a strong voice in the problems the sector is facing. Where the farmers/producers themselves did not encounter any problems. The collaboration together with UNIMAS was beneficial towards the different projects, were for example dr. Cheah Wai Shiang had a good relationship with the community leader of the kampung Pinggan Jaya. This resulted in a smooth collaboration with the community, where we as researchers were welcomed and where the local community was open in sharing information. The collaboration with UNIMAS resulted as well in the use of other techniques, such as Library in a Box for the children group use case, that was presented by the dean of the computer science faculty of UNIMAS.

### 6.2 Iterative

A timeline is created (figure 2) to visualize, when information is gained considering the different phases of the framework. All projects were using an iterative approach where findings were done and the consequences for the system were presented to the stakeholders in several steps. This resulted in an evaluation of needs and requirements. It shows how important the use of iterative development is, because in many cases new needs and requirements were introduced.

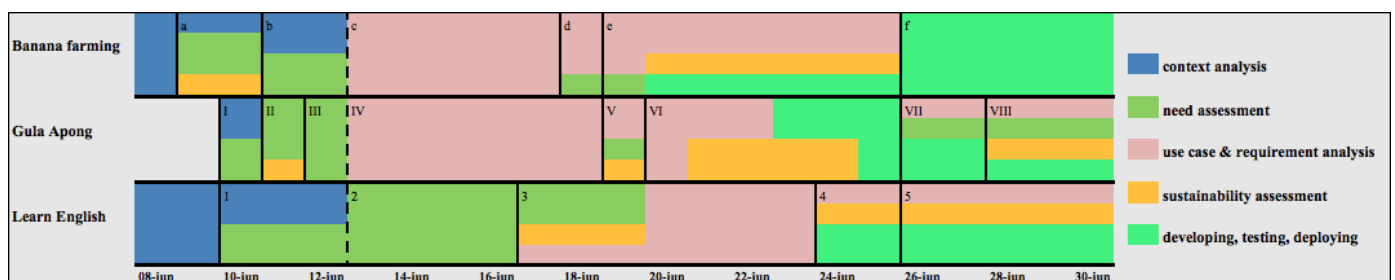


Figure 2: Timeline

The colors of the timeline correspond to the different phases of the ICT4D 3.0 framework, the points in time refers to field visits, focus groups, interviews and points of interests for the ICT4D in the field projects. The 'surface' of the different collard areas direct to the amount of information is given for the different phases. For example, when there is information gained about factors for the financial sustainability a part of the date will be colored yellow. The first thing that catches the eyes is that the phases are performed using an iterative way, and definitely not using a linear approach.

### **6.3 Adaptive**

Out of the iterative steps that were followed during the projects, new needs and requirements were adapted within the systems. Another way to see the adaptability, is the use of the development in open source software. It makes it possible that everybody interested could expand the projects. Moreover, the use case to help the children improve their English is adaptive in the means of using iterative development cycles. Where the software is adapted towards the needs of the children. The systems are adaptive towards the context by making use of offline functionalities, due to the poor internet connection. Another example for that the projects made use of an adaptive approach is, were new needs and requirements were introduced in the meetings with stakeholders the systems adapted these new requirements in the system design.

The ICT4D 3.0 framework is designed by employing use cases in West Africa. It can be stated that the framework is adaptive to a complete different context, in this case for Sarawak Malaysia.

### **6.4 Validation**

To answer the research question: *Is the ICT4D 3.0 methodology, suitable for designing, engineering and deploying ICTs in a rural context?* It can be concluded that the three different claims (collaborative, iterative, adaptive) of the ICT4D 3.0 framework occurs using the framework and has a positive effect of carrying out an ICT4D project. Because the claims are occurring and resulting in a positive effect, it can be concluded that the ICT4D 3.0 methodology is suitable for design, engineering and deploying ICTs in a rural context. Therefore, the first sub-question can be answered where it is a suitable methodology for the developers. However, currently it cannot be answered if the framework resulted in a sustainable solution for the end-users, because none of the projects are actually in use at the moment. The other frameworks as mentioned in section 4.2 have a similar way of looking to ICT4D projects. The ICT4D 3.0 framework is the most complete described framework.

#### **6.4.1 Validation criteria**

The framework delivers a clear description of the proposed method for developing ICTs, mostly all success, failures can be found back in the description of the framework (descriptive validity). Other than for planning, no other factors outside of the framework are necessary to explain the findings (internal validity). The theory of the framework is based on extensive sociotechnical field action research carried out in West Africa, where context and needs are very different in Sarawak Malaysia. No problems were faced of using the framework (theoretical validity). The sustainability is reassured by the means of the use of open ended software and local engagement (external validity).

### **6.5 Strong and weak points of the framework**

This section will describe the strong and the weak point that were faced during the validation of the framework. The last subsection describes some recommendations for making use of the ICT4D 3.0 framework.

#### **6.5.1 Strong points**

By making use of the collaborative, iterative and adoptive methodology the projects resulted in a clear description of the local context and the needs/requirements the stakeholders are depending on.

The framework is made to help with concerns that are raised during ICT projects within development regions. These concerns are: local needs unknown, context unknown, significant levels of low literacy, availability of crucial technology and infrastructure, low purchasing power of end users, lacking understanding of ICT possibilities, mismatch between donor sponsor goals and

‘beneficiary’ end-users and sustainability concerns. By making use of the framework during the projects, information is gained about these concerns. That provides the developer with the knowledge what kind of system is suitable for the situation.

#### **6.5.2 Weak points**

The time factor or a planning of time is not mentioned in the framework, this lack of time appears to be crucial for the deployment of the projects.

#### **6.5.3 Recommendations**

The main problem of the project was the lack of time, where in the end the projects were not yet ready for deployment. However, this is not the fault of the framework. The notion of planning could be integrated in the framework, where it is important to reassure there will be enough time for the whole development process. This time element is not caused by insufficient capacity on the side of the project team. To get a proper overview of context, needs and sustainability the intended end-users need enough time to realise what is happening, and what is expected of them. This time/planning factor is essential for development projects, to gain social sustainability.

Looking at the timeline as pictured in section 5.2, future ICT4D projects have to be aware of the fact that the steps as described will not appear strictly in the described order. In the start of the project context, needs and sustainability will arise in an early stage of the project. In terms of validity this has no impact on the framework, because the different subjects have to be researched in the project and it is not depending on specific order.

To gain good relationships with local partners and end-users it is important to gain trust with the local people, therefore it is important lay an extra focus on this aspect. The framework could make use of the Afrocentric research methodologies (section 2.4), to created awareness of the importance of respect towards new cultures.

### **6.6 Further discussion points**

The frameworks discussed within this paper are validated using the use cases of the ICT4D course, three different use cases are taken in to account. It gives a good insight that the different phases are using an Agile way of development. However, the reliance on this small number of projects is a weakness for the analysis. Using a much bigger number of projects for the analysis could give a more reliable result. All steps of the framework were followed, the findings as described show that the steps deliver a complete context analysis and need assessment for all three projects. With the following remarks, considering the banana project one stakeholder was left out at the beginning of the project. Due to time limits, this stakeholder is not yet involved, this is due to a limited context analysis. A better timing and planning could have avoided this problem, where planning is not explicitly mentioned in the framework.

The question arises if the contract farmers have the motivation to use the system, this point is a part of social sustainability. Currently the system is not deployed yet and cannot be tested on this aspect. If a problem arises were the farmer are not willing to use the system, this will be referring back to a poor context analysis and need assessment. Where the framework clearly describes the importance of these phases. Trustworthiness of promises made by stakeholders, refers back to the establishment of a good partnership with the end-users and stakeholders involved. Success in sustainability is established by the usage of open source software delivers the possibility for local continuation of the project. The importance of the use case and requirement analysis phase became clear. Where for every project new requirements and needs were introduced, during meeting with the stakeholders.

During the process, it was clear that the project had to take all the steps as described within the ICT4D 3.0 framework. We did not encounter any steps that were obsolete in the process. This means that working with the ICT4D 3.0 framework is valid and to be recommended.

For the use cases used in this paper, we were lucky to have a connection to stakeholders that where involved in the communities. Because it is time consuming when engaging with new communities without other stakeholders already involved with the community. At first, to gain a good relationship



with the community and have a more complex understanding of the social and technical environments.

The selection of the use cases (section 5.2) is based on the ease of implementation and impact a possible system has. However, these decisions are made during a discussion with the professors and students involved with the ICT4D course, the decisions are based on assumptions and there is not really a scientifically ground to it.

The form of research of this paper can be classified as bungee research [21], where engineers form a foreign country perform a short field visit to study a problem. Following field visits are conducted to test their solutions. Dearden and Tucker states such research could increase dependency on external support. However, the projects described within this research made use of people who are already involved with the community for a long time. Furthermore, the students of UNIMAS are continuing the projects. To avoid unethical research, it is really necessary to focus on the sustainability of the projects.

Considering the sustainable development goals(SDGs) discussed at the start of the related work section, the question arises if the prototypes developed during the ICT4D course are considered '4Development'. The application for the children to learn English clearly is covered by the SDGs, under quality of education. For the gula among application will be covered by decent work and economic growth, because the gula among producers with a relatively low income will be provided with land and more customers using the application. The same could be said for the banana farmers, however during field visits at the banana farms it became clear that the banana farmers already have an economic wellbeing.

An interesting point is the difference between, ICT4D or software development in western countries. Where agile methods are a useful method for both, the main difference lays in the community engagement, due to the different cultures. Where complete different context and needs are found. Another big difference is the financial sustainability where in development countries funding is often a donor that pays for the cost. However, donor funding will end at some point where the service needs to be able to continue without this funding.

## **7 Conclusion & Future work**

Within this paper the process of the development of ICT4D projects is closely followed, detailed description of the process is given. Three use cases and prototypes were constructed by student of the VU and UNIMAS, using the ICT4D 3.0 framework described. Insight in the context and need of a local community in Sarawak Malaysia is described. The timeline created as an oversight of the projects clearly indicate that there is an agile way of development and that a linear approach is ineffective. Findings of failure and success factors are described of the overall project, these finding are seen as the result of using the framework. and are verified by using the detailed description of the framework. The framework has a complete description of the success and issues faced, by being involved with the three different projects. The framework reaches the goal to support with concerns faced in developing regions and emerging countries, therefore it can be used as a useful tool for developing ICTs in such places. Compared with the other frameworks, the ICT4D 3.0 framework is the most complete and elaborated framework. Where the use of collaborative, iterative and adaptive methodologies are an important approach for carrying out ICT4D projects.

The only addition that can be made towards the framework is the notion of planning, for a better time management. As well as integrating the Afrocentric research methodology to focus on respect and trust with the local community.

## **8 Acknowledgements**

I want to thank UNIMAS, Dr. Cheah Wai Shiang, W4RA team and the students of the ICT4D course for welcoming me at the university in Sarawak Malaysia and for supporting me during my research.

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## 10 Appendix

### A. Interview institute of Borneo studies

Date: 30/04/2018

Location: Kota Samarahan, Say café

Duration: 40 minutes

Names: Director Assoc Prof. Dr. Shahren Ahmad Zaidi Adruce  
Research officer Abg Mohd Heikal B. Abg Othman

Institute of Borne studies

Get to understand what they exactly do.

Studies all over Borneo focus on history, geography, demographics. Helping with the preservation of indigenous knowledge, community based industries, tourism and technology an ICT related issues.

Education is considered the biggest problem, government funding for schools will increase when a school is performing good, however school funding will decrease when a school is performing poorly. This will result in a bigger divide in schools that are performing good and bad. School in rural areas have a poor infrastructure considering technology and road. Literacy rate of Sarawak is 73%

Results of the new telecentres gives concern for internet safety, children are able to access any kind of content there is no protection for the children to what content their exposed to. Bringing internet to communities who never had internet, need for training to create awareness of the possibilities of the world wide web.

It is important to have a good relationship with the village leader; the village leader is the one who decided what is happening in the village. Because of some previous complications the Institute of Borne studies, find it uncomfortable to work with the village Pinang Jaya.

## **B. Meeting Agricultural department**

Names: expert in the field Prof. Ibrahim Mohammad Sawawi, CEO factory Tho Tze Bing

Location: Pejabat Pertanian kota samarahan

Date: 25/04/2018

Duration: 60 minutes

The demand for bananas is very high for the production of banana chips, currently the amount of banana supplied by contract farmers is limited. The goal of the banana chip factory is to produce five tons of bananas a day. The agriculture department will help the factory to meet this demand by recruiting new farmers with land, the department will provide plant tissue culture, fertilizer and chemicals to the farmers. However, most farmers do not have the specific knowledge of banana farming. The agriculture department is investing in the farmers and the factory, therefore it is necessary for the department to have an overview of the amount of produced banana.

Three different actors play a role in this cases with different concerns, the contract farmer, department of Agriculture and the banana chip factory.

The contract farmer needs knowledge of banana farming, for example:

- First importance is what kind of ground is the farmer working on: type of soil, flat or hilly.
- Timing of planting and fertilizing
- Right time for harvest

Department of Agriculture:

- When are the bananas ready?
- The amount of bananas
- Waste percentage
- Amount acres of land

Banana chip factory:

- Knowledge for the farmers
- Fertilizer (needs standard formula)
- Flooding is a big problem
- Will take all the bananas for producing
- 

*Banana knowledge:*

Department:

- 100+ hectares of land
- 30 farmers involved
- factory has 30 hectares of land, for backup
- plan to extend with 48 hectares, thus more farmers

planting:

- 1 hectare 40 tons of banana
- 600 plants per hectare
- 1 bunch of bananas 15 to 30kg
- after planting 8 to 10 months to harvest, following harvest 5 to 6 months

- +- 2.5 years, 5 times harvest, time for restart. Cut everything down, process ground, plant seeds.
- 1 months 400g fertilizer

factory:

- banana chips shelf-life is more than a year

### **C. Meeting farmers**

Date: 1/06/2018

Location: Pejabat Pertanian Asajaya

Duration: 60 minutes

#### *Context farmers*

Low internet connection sometimes even problem with 2G connection.

Spoke with 8 farmers some of them do not have a smartphone, however their kids do own smartphones. Most application on smartphone is WhatsApp. Had a feeling of a low ICT literacy of the farmers.

Currently new farmers are trained by the agricultural department, where the agricultural department visits the land of the farmer and explain the process of farming step by step.

Pathology *department* - disease expert (offers website for disease treatment) wimic sarawaknet.gov *#cannot find*

Wimics (weed, insect, micro-organism collection Sarawak) database software, which has reduced the time for diagnosis of field problems on many crops. It can also be used to record disease and pests occurrence, which provides valuable information for pest management as well as serve as a reference for future global trade, he said.

Farmers supply directly to the factory without the knowledge of the agricultural department

Question of the farmers:

Why only bananas?

How do we use an application?

### **D. Meeting kampung Pinggan Jaya**

Location: kampung Pinggan Jaya

Duration: 45 minutes

Date: 04/05/2018

The village is located 30 minutes from the center of Kuching, it has around 700 inhabitants. The road infrastructure towards the village is good, however the network coverage is poorly. Only one spot in the village, located at the jetty has internet coverage. Most woman of the village are housewives and the man are working in factories or as laborers around the village, with a salary of 1000rm a month (around 230€). The women are selling handicraft products and gula apong on the side, using Facebook, WhatsApp and a website to promote their products by adding their phone numbers. Gula apong is a local sugar product, produced from the Nipa palm tree.

### *General context*

- Most of the people in the village owns a smartphone
- Everybody speaks Malay
- Everybody is Muslim
- Internet connection at only one location of the village
- WhatsApp most used App

### *Education for Primary scholars*

The main concern of the village is the education of the children going to the primary school. The school is located 30 minutes walking from the village, the school is not performing good. Accordingly, it is losing funding from the government. About year ago, Malaysia introduced a new system for the primary schools. Where answers on homework assignments needs to be found on the internet. The school and the village do not have any internet connection, so this is causing problems for the children. Most of the households are not earning enough to pay for all the required books, where the internet is a solution to still find the materials the children need to learn.

### *General info*

Actors: Kids, Parents and Teachers

### *The women group*

The women group is asking for support to sell their products online, the products consist of handicrafts and gula apong. Currently the women are selling their products using WhatsApp or SMS

The products range from:

Pastries

Gula apong

Handicrafts

Clothes

### *The teenagers*

Every year the teenagers from the village perform a dance at the cultural village of Sarawak. Every year a different dance is performed, from one of the 26 ethnic groups of Sarawak. For each ethnic group, there are different dances and different clothes to wear. The teenagers need to figure out themselves what the dance is and which clothes to wear.