Utrecht University

Situational Method Engineering for ICT4D

Performing Impact Assessments for Educational Programs

Master's thesis Business Informatics

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Abstract

Since the rise of ICTs, also the role ICTs play in supporting development initiatives has grown. Since then, the term ICT4D has been adapted in the field of development programs which are IT-based. This study focuses on the domain of ICT4D in the educational domain. In developing countries there exists a large digital divide between persons that have access to ICTs and information, and individuals that do not. Next to accessibility issues, there is often a lack of skill to handle with these ICTs in the most optimal way. In order to support the development of education in these developing countries, many western organisations made attempts to implement ICT projects. However, in order to confirm if an educational development project has an impact on its target community, an evaluation must be performed in the form of an impact assessment. It is discussed that there are too few studies that focus on the evaluation of ICT4D projects. Performing an impact assessment is a non-trivial process. Hence, a method is required. In order to develop a method that seeks to achieve a wide applicability and a means to anticipate to novel developments, situational method engineering can be applied. Therefore, this study proposes a situational method for the performance of an impact assessment on ICT4D programs in the field of education in order to contribute to the current landscape of evaluation methods. The proposed impact assessment method is situational, meaning that the method is adaptable to a specific development project in the domain of education. This is done by selecting relevant method fragments. Each method fragment consists of a set of metrics which are used as input for the impact evaluation. The benefit of this is that the method is generalisable to other educational development projects. The proposed impact assessment method is validated through focus groups. After that, the method is implemented in a real-world development context in West-Africa in the form of a pilot study. Based on the implementation, results from the pilot study are drafted and the treatment is evaluated upon.

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Chapter 1

Problem Statement

Development is primarily perceived as the extent to which a country grows economically, and the identification of approaches to make economic systems of developing countries more effective (Unwin & Unwin, 2009). However, Unwin and Unwin (2009) mention that the economic growth of a developing country is only one perspective of development. For example, participation and empowerment in effective development practices are also of great importance to take into account when development is discussed (Unwin & Unwin, 2009). Furthermore, Information & Communication Technology (ICT) can play a large role in the economic growth of a country, and the application of ICTs is not limited to commercial organisations (Colle & Roman, 2003; Unwin & Unwin, 2009). ICTs are used to create, store, and manipulate information, which can be applied to support the development of a country (Sachin, Rajashekar, & Ramesh, 2018). Moreover, it is also important to map the accessibility of information, especially in the field of education (Unwin & Unwin, 2009). Raiti (2006) states that the quality of education can be increased by programs that focus on information and communication technology for development (ICT4D), which is an important aspect of development. Furthermore, Psacharopoulos and Woodhall (1993) describe that the investment in education is a key element of the development process in a country. They mention that education enhances the skills, knowledge, attitudes, and motivation which are necessary for both economic and social development, which is confirmed by Shizha and Kariwo (2012).

This study is focused on the domain of ICT4D. More specifically, this study focuses on ICT4D in the educational domain. Since the rise of ICTs, also the role ICTs play in supporting development initiatives has grown (Marais, 2015). Since then, the term ICT4D has been adapted in the field of development programs which are IT-based. ICTs are not merely used as a tool for development, but more as a platform for development (Heeks, 2008). Information technologies can help in a wide range of development challenges, with one of them being education (Colle & Roman, 2003). Colle and Roman (2003) mention that digital technologies can be used to improve education, training, and other development issues by education institutions in Africa to be more powerful.

In developing countries there exists a large digital divide between persons that have access to ICTs and information, and individuals that do not (Shrestha, Moore, & Abdelnour-Nocera, 2010). Shrestha et al. (2010) mention that next to accessibility issues, there is often a lack of skill to handle with these ICTs in the most optimal way. This is partly caused by the fact that there is not an appropriate infrastructure. Especially in rural areas, proper ICT and internet connection is often limited. In urban areas, where such an infrastructure is in place, it is still inferior to the service in developed countries (Shrestha et al., 2010). There are various attempts by western organisations to implement ICT

projects in developing countries. However, often these ICT projects end in failure and a wastage of resources (Pade-Khene & Sewry, 2012). Dolence and Norris (1995) mention that a transformation process as described here can be obstructed by the lack of suited models and best-practices.

Furthermore, Heeks (2009) mentions that there are too few studies that focus on the evaluation of ICT4D. He states that this is a topic that is "much talked about but hardly ever seen (Heeks, 2009)". Latchem (2018) also describes that there is a great call for comprehensive data, both qualitative and quantitative, which displays the quality of the outcomes of development programs and their impact upon individuals, communities, and economies. Next to that, Zawacki-Richter and Anderson (2014) underlined this need for research on long-term impact of development projects focussing on education. There are various studies that conclude that the scope of the existing impact assessments of ICTs in developing countries was too narrow (Gomez & Pather, 2012; Kozma, 2005). Existing impact assessment methods often focus on tangible elements of ICT that are easy to measure, but Gomez and Pather (2012) argue that this is not sufficient. Moreover, they state that it is more important to focus on the intangible aspects of ICT, such as empowerment, self-esteem and social cohesion. Most of the currently existing assessments have the focus on economic growth, and other important factors such as the empowerment, social fabric, and development of education are left out (Gomez & Pather, 2012).

In the domain of ICT4D, a distinction is made between an outcome assessment and an impact assessment. Pade-Khene and Sewry (2011) describe that an outcome assessment has the aims to evaluate the direct outputs of a project. An impact assessment however, is described as having the aim to evaluate long-term effects of a project, focused on a target community and the wider community (Pade-Khene & Sewry, 2011). Studies that do focus on the impact of ICT on education are often limited since they only conduct a correlation analysis (Kozma, 2005). For example, Kozma (2005) describes the study of Wenglinsky (1998), which performed a correlation analysis between the numbers of computers used and the scores that were achieved in a math test. The study reported that positive correlations were found, which means that the factors are associated to each other. However, no causal relation can be concluded from the variables that are measured. Moreover, sustainability is an important subject within the field of ICT4D. Many development initiatives encounter difficulties trying to pursue their goals in a sustainable manner (Marais, 2015). Economic development tends to move at the same pace as the use of natural resources. Marais (2015) describes that ICTs play a large role in decoupling these two factors. The goal is to apply ICTs in such a way that the use of resources does not increase when the economy develops.

Heeks and Alemayehu (2009) composed a compendium of various frameworks and methods for the performance of an impact assessment. A wide variety of methods and frameworks is given, but all are designed for a specific purpose. There is a lack of an impact assessment method that is exhaustive in every subject. A possible explanation for this is that every specific project is in need of a method conform the project characteristics. However, many existing impact assessments only focus on a specific set of those characteristics, thus failing to display a thorough representation of the entire impact of a project. Often, methods are striving to standardise evaluation practices (e.g., the guidelines of Ciaghi,

Villafiorita, and Dalvit (2014)). However, next to the increasement of uniformity, rigidness and a wide applicability, administering standardisation in a method engineering process also has disadvantages. For instance, standardisation prevents a method to anticipate to new developments in a flexible manner (Harmsen, Ernst, & Twente, 1997). In order to consort with this issue, situational method engineering can be applied. Situational method engineering is defined by van Slooten and Hodes (1996) as "adapting a methodology to the needs of a particular project". Situational method engineering is the process of creating a method for a specific situation (Henderson-Sellers & Ralyté, 2010).

Current literature shows that education plays an important role in the development of a country (Psacharopoulos & Woodhall, 1993). However, in order to determine whether an educational development project has an impact on its target community, an evaluation must be performed in the form of an impact assessment. As mentioned before, there are too few studies that focus on the evaluation of ICT4D projects, and existing methods for the performance of an impact assessment often focus on a specific set of characteristics, leaving other critical elements out of scope (Heeks, 2009). Standardisation of evaluation practices has the benefit to create a wide applicability, but has difficulties with anticipating on novel developments in a flexible manner. To the best of our knowledge, in current literature no method is identified that pursues both objectives. In order to develop a method that does seek to achieve a wide applicability and a means to anticipate to novel developments, situational method engineering can be applied. Therefore, this study strives to contribute to the current landscape of evaluation methods by designing a situational method for the performance of an impact assessment on ICT4D programs in the field of education.

The remaining of this thesis is divided over eight chapters. In Chapter 2 the research plan that is drafted for this study is discussed. The research questions are explained, the research environment is sketched, and the research method is described. In Chapter 3, relevant literature is studied in the form of an exploratory literature review, supplemented with a systematic literature review. Also, two expert interviews are performed and discussed in this chapter. Section 2.3.2 describes the design of a novel situational impact assessment method. First, the process of requirements elicitation is described, whereafter the method design is discussed. Then, the novel designed impact assessment is validated through focus groups, which is explained in Section 2.3.3. Furthermore, Section 2.3.4 describes the implementation of the novel method in a real-world context. After that, this implementation is evaluated on in Section 2.3.5. Then, the limitations and threats to validity of the research are discussed in Chapter 8. Lastly, the research is concluded in Chapter 9, where the research questions are answered. Furthermore, this chapter describes the implications of the research, and opportunities for future research are discussed.

Chapter 2

Design Science Applied to Situational Method Engineering

A research plan is drafted for this study in order to carry out the research in a structured manner. First, the research questions are defined and the research environment is described. After that, the research method is discussed.

2.1 Research Questions

For this study, various research questions are drafted. The main research question is defined as follows:

MRQ *What situational method can be designed to perform impact assessments on ICT4D programs in the educational domain?*

The main goal of this research is to design a situational method, which can be applied in the process of evaluating educational programs in developing countries. This is done based on the sub research questions that are defined below.

In order to answer the main research question, the following sub-research questions are defined:

SRQ1 *What is the current state-of-the-art of impact assessments within the domain of ICT4D?*

The goal of this research question is to sketch the current landscape of impact assessments within the domain of ICT-based development projects. In order to answer this research question, an exhaustive literature review is performed.

SRQ2 *Which metrics can be used for performing an impact assessment?*

The goal of this research question is to identify relevant metrics for the performance of an impact assessment. There already exist a wide range of impact assessment methods and frameworks. For most assessments, a set of metrics is used to measure impact. Furthermore, novel metrics can be identified in other relevant literature.

SRQ3 *How to methodologically perform impact assessments of educational ICT4D programs?*

This research question is drafted in order to conduct research about how impact assessments of educational ICT4D programs should be performed. A list of metrics that are used to measure impact is defined, based on literature that is found for previous research questions. Furthermore, in order to validate the value of the defined metrics expert interviews are conducted. These expert interviews can possibly help with extending the list with novel identified metrics. After that, the final goal of this research is effectuated: the design of a novel situational method for the performance of impact assessments in the educational domain.

SRQ4 *How to validate a novel developed situational impact assessment method?*

The goal of this research question is to validate the situational method that is developed. This is done by means of focus groups with experts in various subjects, such as development projects, impact assessments, and pedagogical knowledge. The results of the validation might contribute to a novel iteration in the method development process, resulting in an improved method design.

SRQ5 *How to evaluate the implementation of a novel developed situational impact assessment method?*

This research question is drafted with the goal of evaluating the implementation of the novel developed method. The evaluation is performed in collaboration with the project manager of the development project within Maxim Nyansa. With the evaluation, it is investigated what effects the implementation has on the development project, and it is sought to find out how these effects are caused. Furthermore, it is analysed if the effects contribute to the stakeholder goals. The results of the evaluation might contribute to a novel iteration in the method development process, resulting in an improved method design.

All the sub-research questions (SRQs) that are described above are used in order to answer the main research question (MRQ). In Section 2.3 the methodology that is used to answer each research question is defined.

2.2 Research Environment

This research is performed as a Master's Thesis project for the Master Business Informatics at Utrecht University. The research is carried out in collabouration with Maxim Nyansa IT Solutions, which is a non-governmental organisation (NGO). Maxim Nyansa is located in Accra, the capital of Ghana. Climbing The Right Tree is a Dutch partner organisation of Maxim Nyansa, which is located in Veenendaal. The mission of Maxim Nyansa is to create career opportunities for young people in Africa with the use of information technology (Maxim Nyansa IT Solutions, 2020).

At Maxim Nyansa, there is a focus on three of the seventeen sustainable development goals (SDG) stated by the United Nations (2016): Sustainable development goal 4, 8 & 12.

Sustainable Development Goal 4:

"Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." (United Nations, 2016)

SDG 4 is supported by providing financial support in order to improve the quality of education. This is done by equipping West-African schools with computers and computer labs, together with training in IT skills.

Sustainable Development Goal 8:

"Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." (United Nations, 2016)

Furthermore, Maxim Nyansa organises training programs for young IT professionals from an underprivileged background, which supports SDG 8.

Sustainable Development Goal 12:

"Ensure sustainable consumption and production patterns." (United Nations, 2016)

SDG 12 is supported by Maxim Nyansa since the foundation actively promotes the reuse of European hardware in local schools in West-Africa.

Initially, part of the research plan was to travel to the Maxim Nyansa office in Accra, Ghana. However, unfortunately these plans were cancelled due to the global crisis regarding the COVID-19 virus outbreak. Several changes to the research plan and method were necessary in order to cope with this crisis. In Section 2.3 the initial research plan is described, supplemented with the changes that are made in order to carry out the research in line with safety measures worldwide.

2.3 Research Method

The goal of this study is to design a method for performing an impact assessment on ICT4D programs in the field of education. The Design Science methodology of Wieringa (2014) is used for this. The Design Science methodology includes a five-step engineering cycle: (1) problem investigation, (2) treatment design, (3) treatment validation, (4) treatment implementation, and (5) implementation evaluation (Wieringa, 2014). These steps are used in order to divide the research into different phases, aiming to answer the research questions stated earlier. Figure 2.1 displays the Engineering Cycle of Wieringa (2014), adapted to this research. It has to be mentioned that the phases in the engineering cycle are part of an iterative process. Furthermore, Wieringa (2014) describes that the problem investigation phase and the implementation evaluation phase are somewhat similar. At the end of the cycle, the implementation evaluation serves as a new problem investigation phase, whereafter a new iteration through the cycle can be started. However, in Figure 2.1 the implementation evaluation phase and the problem investigation phase are modelled separately in order to provide a more organised overview of the research. For each research question, various research methods are applied. An overview of the research methods for each research question is given in Table 2.1.

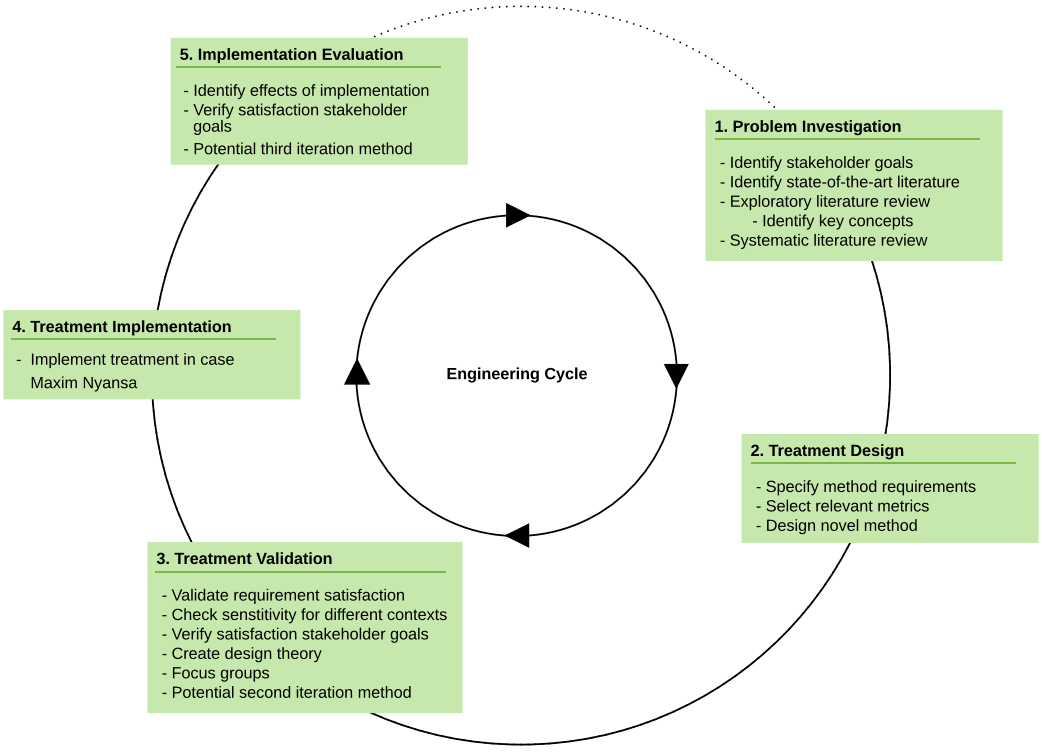

Figure 2.1: Engineering cycle adapted from Wieringa (2014)

Table 2.1: Research methods per research question

MRQ	**SRQ1**	Literature review Expert interviews
	SRQ2	Literature review Expert interviews
	SRQ3	Literature review Method engineering
	SRQ4	Focus group / Expert workshop
	SRQ5	Stakeholder interviews

In the following sections, each phase is discussed. After that, a process deliverable diagram (PDD) is provided, visualising all the steps that are taken in this research. Lastly, the validity of the proposed research method is evaluated.

2.3.1 Problem Investigation

In order to answer the first sub research question (SRQ1), the current landscape of impact assessments is sketched. This is done by conducting a systematic literature review. However, before an extensive literature review is conducted, first an exploratory literature review is performed. The goal of this exploratory literature review is to identify the key concepts that are relevant for this research. Both the exploratory and the systematic literature reviews are divided over three main subjects: impact assessments, digital learning transformation, and method engineering. Based on the concepts that are identified in the exploratory review, an extensive systematic literature review is conducted in order to learn about the state-of-the-art of impact assessments in the field of education and ICT4D. There are various interests for conducting this literature review. The first goal of this literature research is to identify metrics that can be used to measure impact, which are used to answer SRQ2. For this, various existing impact assessment methods are analysed. Next to the identification of these metrics, also the way they can be measured and the level of importance can be extracted. The second goal is to capture information on how to methodologically perform impact assessments (SRQ3). To answer this research question, literature will be analysed to gather information about the existing methods and best practices of conducting impact assessments. The approach that is used for conducting the literature review is discussed in Section 2.4. Furthermore, experts on performing impact assessments and experts in the field of digital transformation process (in the educational domain) are interviewed in order to gain knowledge supplementary to the found literature.

Initially, the research method contained a case study. This case study had the goal of identifying the needs, possibilities, and restrictions in performing an impact assessment in the educational domain within a developing country. The goal was to visit different types of schools in Ghana. In Ghana, there exist multiple types of schools. A distinction

can be made between rural and urban schools. Furthermore, there are public and private schools. For each type of school, there are situations where the Maxim Nyansa foundation (or other equal organisations) have performed a project, and schools where no such project took place. An overview of the different school situations is given in Table 2.2.

Table 2.2: Classification of schools in Ghana

	Rural	**Urban**
Public	No project / ICT Project	No project / ICT Project
Private	No project / ICT Project	No project / ICT Project

In order to create a correct representation of the educational system in Ghana, at least two schools of each type should be visited. However, due to the worldwide crisis concerning the COVID-19 pandemic, it was not possible to travel to Ghana. Therefore, the case study as proposed could not be carried out. Therefore, the decision is made to construct the method solely on the literature research and the expert interviews. Since the literature research is conducted in an exhaustive manner, the amount of information that is gathered is sufficient for the research to continue. In order to collect information on the needs, possibilities, and restrictions in performing an impact assessment in developing countries, various stakeholder interviews are performed.

2.3.2 Treatment design

In order to answer the main research question (MRQ), a treatment is designed in the form of a situational method. Despite the fact that situational method engineering is mostly focused on the development of methods for software engineering, this research strives to adopt the approaches of the method engineering domain for the goal of developing a novel situational impact assessment method for the educational domain in the field of ICT4D. Information and knowledge that is gained through the problem investigation phase is used in order to develop a novel situational method.

First, the requirements for the design artifact are drafted. Furthermore, during the problem investigation phase, various metrics are identified that are used to measure impact. Next to that, various approaches for the performance of an impact assessment are found. A selection of these metrics and approaches is made, which are used to design a novel situational method. A method base is created in order to store existing method fragments. Furthermore, novel method fragments can be designed and stored in the method base. Moreover, novel metrics can be defined based on the expert interviews and brainstorm sessions with stakeholders. In order to eventually apply the novel situational method, various types of data are required. Therefore, it is crucial to know whether the data that is necessary to perform the impact assessment is available. Therefore, the data that is necessary for the novel method is identified based on the selection of metrics. After that, the availability of the data is investigated.

The method is described using the Process Deliverable Diagram (PDD), as described by van de Weerd and Brinkkemper (2009). The PDD modelling technique is used to model activities and artifacts of processes. A PDD model consists of two integrated diagrams: a process diagram and a deliverable diagram. The process diagram is constructed based on a UML activity diagram, and the deliverable diagram is based on the UML class diagram (van de Weerd & Brinkkemper, 2009). The process diagram contains all the activities that take place when performing the method. Each activity can result in a deliverable, which are displayed as concepts. Each activity and concept is explained in additional activity- and concept tables. After the treatment is designed, the validity of the treatment design is checked as proposed by (Wieringa, 2014).

2.3.3 Treatment validation

After the design of the situational method, it is necessary to validate the treatment. This is done to justify that the treatment contributes to the stakeholder goals (Wieringa, 2014). Wieringa (2014) also describes that in this stage no implementation is in place which can be used in order to check if the stakeholder goals are met. However, a prediction can be made based on a design theory, to see what will happen when the treatment is implemented. Therefore, in order to validate the treatment a design theory is created, as proposed by Wieringa (2014). Next to that, the method evaluation model proposed by Moody (2003) is applied, which takes the actual efficacy, the perceived efficacy, and the adoption of the method in practice into account. Furthermore, experts are interviewed in two focus groups to collect their perspective and opinion on the novel developed method.

2.3.4 Treatment implementation

After the validation of the treatment is concluded, the treatment is implemented. The case for this implementation are the ICT4D projects of the Maxim Nyansa foundation. For the implementation of the method (i.e., the actual performance of an impact assessment) various types of data need to be collected. Data is gathered in two forms: qualitative and quantitative. Qualitative data is gathered through interviews with stakeholders of the educational system in Ghana (e.g., students, teachers, policymakers). Due to the COVID-19 crisis, collecting data from stakeholders as mentioned here can be challenging. The goal is perform this part of the research as intended. However, since the situation around the global pandemic is changing every day and no real prediction can be made on how the situation further develops, it is difficult to predict the possibilities in conducting these type of interviews. Communication technologies and/or internet access might not be available for all stakeholders. Furthermore, the Maxim Nyansa foundation is planning to perform an audit on their project implementations. While performing this audit, a checklist is used, which is adjusted for the purpose of this study. That checklist serves as a survey, which is sent to every school that received an implementation of the Maxim Nyansa foundation in the past. In that way, quantitative data is gathered about different schools where a project of the Maxim Nyansa foundation took place. In order to do a correct comparison, the same data is gathered about schools where no such ICT project is implemented.

2.3.5 Implementation evaluation

Lastly, the treatment implementation is evaluated. With this evaluation, it is investigated how successful the implementation has been, as described by Wieringa (2014). The effects of the implementation are identified and it is verified if the stakeholder goals are met. At the end of this phase it can be concluded that some alterations have to be made in the design of the novel method, and therefore can result in a novel iteration through the engineering cycle (Wieringa, 2014).

2.3.6 Overview Research Method

As mentioned before, the research is divided over different phases. Each phase consists of various processes with their corresponding deliverables. These processes and deliverables are visualised within their respecting phases in a PDD, shown in Figure 2.2.

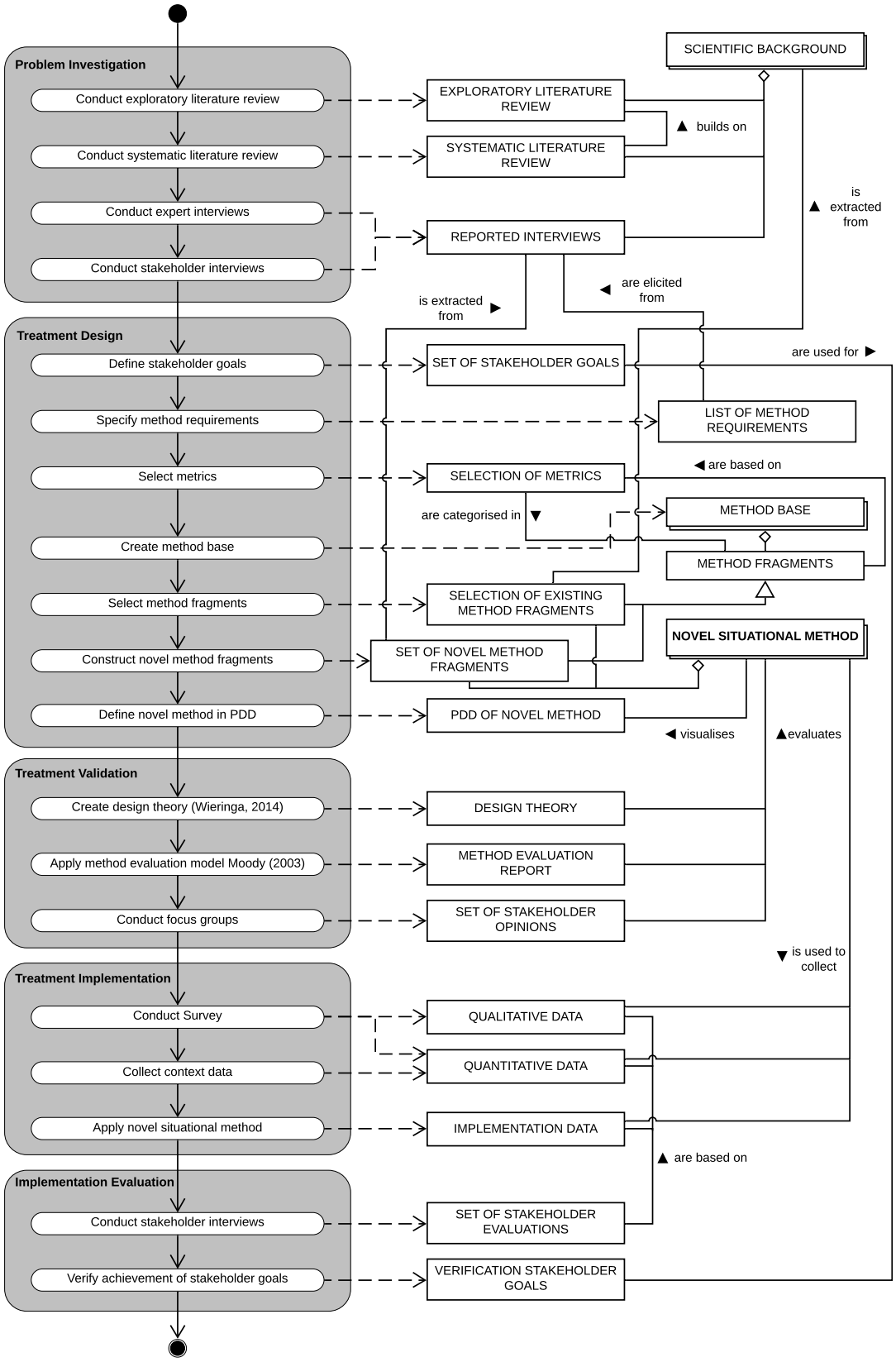

Figure 2.2: Process deliverable diagram of the research method

2.3.7 Research Method Evaluation

To verify that the research method as described above is well suited for this research, and that the threats to validity are minimised, a research method evaluation is performed, based on the threats of validity for research defined by Yin (2002). Yin (2002) proposes four tests in order to check the quality of a research. These tests consider (1) *construct validity*, (2) *internal validity*, (3) *external validity*, and (4) *reliability*.

1. **Construct validity**: This research uses various types of sources for evidence. First, background information is gathered through an extensive literature review. Furthermore, this information is supplemented with expert knowledge through interviews. Existing impact assessment methods and frameworks are analysed, thus applying the concept of method triangulation. Furthermore, information is gathered from multiple perspectives. For example, in order to define method fragments for the novel situational method, sources from the educational domain, even as sources from the impact assessment domain are consulted. Therefore, it can be stated that theory triangulation is applied. Also, with the implementation of the novel method, there is made use of quantitative data which is obtained from local organisations. Also, a survey is used in order to collect data from local stakeholders. Furthermore, it is aimed to establish a chain of evidence by reporting every step of the research process in this thesis. In this way, an external observer is able to reproduce the study.

2. **Internal validity**: is indirectly relevant for this research, since the goal of the novel situational method, which is to be developed, has the goal to prove impact based on a selection of metrics. It is of great importance that the novel method does not conclude an incorrect causal relationship between the practices of a development project and changes in the target environment. To fulfil this goal, as many perspectives as possible are taken into account. For example, a development project might not be the only project that has an influence on the target environment. Other external factors, such as possible other development projects, should be taken into account when an impact is determined.

3. **External validity**: This involves the generalisability of a study (Yin, 2002). This research is aiming to design a situational method for the educational domain. Taking this in consideration, it will be difficult to generalise the novel method, so that it can be applied in other domains. For example, if a situational impact assessment method is designed for the agricultural sector, various different factors should be taken into account. However, the research method proposed here could in general be applied to other domains. Different types of sources should be approached in different domains.

4. **Reliability**: If a later investigator would carry out the research in the same way as described in this thesis, the results may not necessarily be the same. Overall, the structure of the research results will be similar, but some deviations may occur. This is the case, since development in developing countries is pursued. Therefore, other factors, which are not taken into account in this research, might become more relevant in the future. However, if the research is carried out in the same moment in time, results should be similar.

2.4 Literature Research Protocol

The approach that is used for the literature research is based on theory from Webster and Watson (2002). Webster and Watson (2002) recommend to use a structured approach in order to determine the sources for the literature review. Jesson, Matheson, and Lacey (2011) discuss that a traditional (scoping) review is suitable in order to gain a broad understanding of a topic. Next to that, such an exploratory review provides the opportunity to create a big picture of the field of study, whereas a systematic literature review suits a narrow focus (Jesson et al., 2011). In this research, first an exploratory literature review is performed. After that, a systematic literature review is carried out in order to gain a more comprehensive understanding of the topic, as proposed by Jesson et al. (2011).

An exploratory literature review is conducted in order to identify common concepts in the domain of impact assessments and education in ICT4D. The approach of Webster and Watson (2002) entails three initial steps:

1. Search for major contributions in leading journals
2. Review citations for the previously selected sources
3. Use Web of Science[1] for the identification of citing the previously selected key articles

The first step ensures that the most important publications in the domain are taken into account. The major contributions of a research field are most likely to be found in leading journals. Then, scanning the table of contents of these journals might also be useful to find publications that were not found by the previously selected keywords (Webster & Watson, 2002). The second step denotes the snowball method. This method refers to the usage of the reference list of a paper to identify other papers of relevance (Wohlin, 2014). The third step includes a reversed approach to search for publications that have cited the selected paper. Webster and Watson (2002) mention that a relatively complete set of relevant literature can be collected by using this approach. They suggest that the review is finalised when no new concepts can be found in the set of publications. By conducting an exploratory literature review general concepts and key terms are identified, striving to create a thorough basis of concepts to be used as a starting point for the systematic literature review. It is chosen to perform this exploratory review to minimise the possibility that important concepts are forgotten or missed. Furthermore, Jesson et al. (2011) mention that in the beginning of a research there might not be sufficient working knowledge on the topic. Therefore, they recommend to start with a traditional literature review in order to identify relevant concepts of the topic.

While performing the exploratory literature review an overview of all the relevant concepts is created, which is used as a foundation for a systematic literature review as proposed by Jesson et al. (2011). An overview is created based on the concept matrix proposed by Webster and Watson (2002). This matrix is helpful for the identification of the importance of the concepts in the domain, and the identification and validation of gaps in the literature.

After that, a systematic literature review is performed. It is chosen to perform a systematic literature review instead of continuing a traditional literature review, since a systematic

[1] www.webofscience.com

review is a more suitable method when the aim is to minimise the bias of the study (Jesson et al., 2011; B. Kitchenham, 2004). Furthermore, since this study is carried out in aid of the Maxim Nyansa foundation, a systematic literature review preserves the risk of consulting too many biased influences.

The systematic literature review is performed based on a pre-defined search strategy, as proposed by B. Kitchenham (2004). This makes sure that a researcher bias is prevented (B. Kitchenham, 2004). The goal of the systematic literature review is to congregate background information in order to position this new research. B. Kitchenham (2004) supports that a systematic literature review is suitable for this goal. Systematic literature reviews are more time consuming than traditional reviews, but they do have the advantage of providing more information on a broader scope (Jesson et al., 2011; B. Kitchenham, 2004). Although a systematic literature review has the characteristic of documenting the search strategy in advance, the systematic literature review in this research does allow some deviation from these predefined search queries, which is normally only done with traditional literature reviews (Jesson et al., 2011). Since this research aims to design a novel method, it might occur that new insights originate during the literature review process. Furthermore, while performing the literature review, also some interviews are conducted. These interviews can also bring up new elements that are not considered before.

Based on the guidelines of B. Kitchenham (2004) a search protocol is defined for the systematic review. This search protocol contains search queries that are build on the concepts found in the exploratory literature review in Section 3.1. The exploratory literature review is divided in three sections of interest: impact assessments, digital learning transformation, and method engineering. For every subject, a list of key concepts is identified. Therefore, the systematic literature review is also mainly divided in the same equal subjects as the exploratory literature review. In Table 2.3 the search protocol for the systematic literature review is found. The first query is altered from the original one. The concept of "impact assessment" is added to the query in order to specify the scope in a better way. *Google Scholar* is the only database that is approached for this systematic literature review. One might argue that this is too limited for an exhaustive systematic literature review. However, the study of Gehanno, Rollin, and Darmoni (2013) provides evidence that Google Scholar has a coverage of 100% for results.

Table 2.3: Systematic literature review: search protocol

		Description
Queries	Impact assessments	1. "Impact assessment" AND "ICT4D" AND ("Sustainability" OR "Readiness" OR "Availability" OR "Uptake" OR "Impact" OR "Effectiveness" OR "Efficiency" OR "Scalability" OR "Evaluation" OR "Costs & benefit")
	Digital Learning Transformation	2. "Learning transformation" AND "Developing countries" AND ("E-learning" OR "Teaching and learning technologies" OR "E-readiness" OR "Blended learning" OR "Higher education")
	Method engineering	3. "Method engineering" AND "Situational method" AND ("Meta-modelling" OR "Method fragment" OR "Method chunk" OR "Method assembly" OR "PDD")
Databases		Google Scholar
Inclusion Criteria		1. Research is within the scope of this study
Exclusion Criteria		1. Research is a duplicate of another result 2. Research is an older version of another result 3. Research is in a foreign language without proficiency 4. Research has no clear scientific method 5. Source is solely a patent or citation

The queries that are constructed consist of an elaborate selection of concepts. This is done so that a wide and exhaustive literature review can be carried out. Using a large set of concepts results in hits that cover the entire spectrum of the subjects, which are needed for this study. However, using large queries results in many hits as a consequence. It is not possible to analyse all the query results. Therefore Jesson et al. (2011) propose that the keywords for the query should be refined in an iterative procedure. This is not done for this research, since such a procedure would narrow down the results of the literature research and therefore would fall short the purpose of the study. The literature review is assessed as completed when no new sources are found, or when the reviewer judges that a high level of saturation is reached (Okoli & Schabram, 2010). Performing an exhaustive literature review is a time consuming task. Since there is only limited time for the literature review, the decision is made to complete the literature review after a saturation of information is identified. Therefore, not all results that are found with the queries could be analysed.

At the end of the literature review, a semantic net is created containing all the key concepts that are identified during the review. With this semantic net, also the relations between the key concepts are mapped, thus creating a structured overview of the literature.

Chapter 3

Investigating Impact Assessments, Digital Learning Transformation & Method Engineering

This chapter comprises of a literature review consisting of two parts. First an exploratory literature review is performed. After that, a systematic literature review is carried out.

3.1 Exploratory Literature Review

In this exploratory literature review, current literature is analysed in order to identify relevant concepts for the scope of this study. As described in the previous chapter, literature is investigated about the three main subjects of the research. First, literature about the procedures of conducting impact assessments is consulted. Secondly, literature on digital learning transformation is analysed. Lastly, literature is searched on the subject of method engineering (ME). For all three subjects, literature is consulted within the domain of ICT4D, and literature that might not have a direct link with development projects. Both type of sources might be resourceful for this research. At the end of every subsection a table is shown, comprising a selected set of relevant key concepts for the subject, which are later used to draft the search queries for the systematic literature review.

3.1.1 Impact Assessments

In current literature, there are various approaches and frameworks for the guidance of an impact assessment. Some of these approaches have a wide scope, and others have a much narrower scope. For example, Cmte. on Guidelines & Principles for SIA (1995) focuses on the measurement of social impact of projects in general. Mthoko and Khene (2015); Osah, Pade-Khene, and Foster (2014); Pade-Khene and Sewry (2012) discuss the assessment of impact in ICT4D for rural areas. There are various domains for which an impact assessment can be performed. For example, environmental impact assessments (EIA) focus on nature and environmental change caused by human actions (Morgan, 2012; Heeks & Alemayehu, 2009). Furthermore, health impact assessments (HIA) concentrate on elements that have an influence on the health of the population (Kemm, 2000; Heeks & Alemayehu, 2009). Impact assessments in the third category are called social impact assessments (SIA). Social impact is defined as "the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society" (Cmte. on Guidelines & Principles for SIA, 1995). Although the focus on social impact is defined

in a broad sense here, Pade-Khene and Sewry (2012) mention that most evaluations in the ICT4D domain focus solely on assessing the greater element of impact. However, they also emphasize that it is of great importance to make use of interdependent assessments when conducting an impact assessment. Furthermore, a social impact is defined by Franks (2012) as something that is experienced or felt, that is caused by an action (or the lack of an action). This experience might be real, but can also be perceived in some way by an individual, a social group, or an economic unit (Franks, 2012). Various assessments should be performed throughout the life of a project in order to thoroughly analyse the impact a project has on its environment (Pade-Khene & Sewry, 2012). Next to that, Franks (2012) supports this by stating that an SIA should be an iterative process across the life cycle of developments, rather than one activity. Franks (2012) describes that the goal of an SIA is to monitor, report, evaluate, review, and proactively respond to change. SIAs can be used to identify key issues of projects, from the perspective of the environment that is potentially impacted (Franks, 2012). Moreover, an SIA can be used in order to predict and anticipate change (Franks, 2012).

Cmte. on Guidelines & Principles for SIA (1995) presents a framework that can be used when conducting SIAs. The framework denotes various factors that are taken into account when assessing impact. First, one can distinguish between impacts that are desirable and impacts that are undesirable (Cmte. on Guidelines & Principles for SIA, 1995). A project might have a negative impact on a specific environment, but a project might also bring opportunities (Franks, 2012). Furthermore, an impact can be very different in scale. For example, an action might cause the creation of ten new jobs, or a thousand new jobs (Cmte. on Guidelines & Principles for SIA, 1995). Then, the concept of time or duration is taken into account. Some impacts might be of short duration, whereas some impacts might have a long-term effect. Cmte. on Guidelines & Principles for SIA (1995) also mentions that some communities might even recover their old ways rather quickly after the source of change is removed.

Next to that, Cmte. on Guidelines & Principles for SIA (1995) describes that social impacts can differ in their intensity or severity. It is also mentioned that the intensity or severity of the impact is relative to the project of measurement. The impact of a specific unit can be more severe in one project environment than in the other. For example, if fifty litres of water is diseased in a developing country, it has a way higher impact than if fifty litres of water is lost in a developed country. Lastly, Cmte. on Guidelines & Principles for SIA (1995) refers to the difference in impact of complementing projects. The effects of two (or more) projects can be cumulative or mutually counter-balancing. The various concepts that are described above are not definitions of two states, meaning there are not only two options (e.g., being desirable or not desirable). What is described above are extremes, with a range of values between them.

Furthermore, Cmte. on Guidelines & Principles for SIA (1995) states that the social equity of impacts should also be taken into account. The impact of a project may be different for each individual or community. Heeks and Alemayehu (2009) describe that an impact assessment for ICT4D is based around six main questions: Why?, For whom?, What?, How? (1), When?, and How? (2). An overview and specification of these questions is given in Table 3.1.

Table 3.1: Six questions on which impact assessments for ICT4D are based (Heeks & Alemayehu, 2009)

Why?	What is the rationale for impact assessment?
For whom?	Who is the intended audience for the impact assessment?
What?	What is to be measured?
How? (1)	How are the selected indicators to be measured?
When?	At what point in the ICT4D project lifecycle are indicators to be measured?
How? (2)	How are impact assessments results to be reported, disseminated and used?

Furthermore, Heeks and Alemayehu (2009) proposed an ICT4D value chain, as a guiding model to understand the basis for assessing ICT4D projects. This model is divided over four targets for assessment: readiness, availability, uptake, and impact. Readiness refers to an e-readiness assessment, which measures if a specific environment or target audience is ready for an ICT4D implementation. E-readiness is further discussed in Section 3.1.2. During the process of an ICT4D project, various tangible intermediate deliverables are created. Availability refers to who can access these deliverables. Then, uptake refers to the extent in which the deliverables are actually used. Lastly, impact is about assessing the actual impact of the project. Impact is divided over three sub-elements, being *outputs*, *outcomes*, and *development impacts*. Outputs refer to micro-level behavioural changes, outcomes refer to the specific costs and benefits, and development impacts address the contribution to broader development goals, as mentioned in Section 2.2(Heeks & Alemayehu, 2009).

Cmte. on Guidelines & Principles for SIA (1995) describes that before a probable impact of development can be predicted, the past behaviour of individuals and communities should be understood. These behaviours are affected by the actions that are taken by organisations or changes in policy. If the goal is to make a prediction of the impact of a specific project, it is common practice to study the effects of the project in another environment first (if available) (Cmte. on Guidelines & Principles for SIA, 1995). In other words, in order to predict an impact before the implementation of a project, it is recommended to look at the impact of a similar project in a similar community. Cmte. on Guidelines & Principles for SIA (1995) also discusses the measurement of the dynamic complex quality of social impacts. This entails the change of the impact of a project over a period of time. In order to measure this, it is described that one solution could be to measure the impact over various points in time, including the initial and final state of the project. A framework is proposed, called the Social Impact Assessment (SIA) Framework, which takes these various points in time into account. This framework is useful for the measurement of impact over time, since it stimulates frequent monitoring, which provides the monitoring of short-term impacts (Cmte. on Guidelines & Principles for SIA, 1995).

Furthermore, various sources are found that describe methods or frameworks, or case studies, for the performance of an impact assessment (Alampay, 2006; Ballantyne, 2004; Chesterton, 2004; Heeks & Alemayehu, 2009; Mchombu, 1995; Parkinson & Ramirez, 2007). These different methods and frameworks are further analysed in Section 3.2. In various of these studies, variables for the assessment of impact are identified (Alampay, 2006; Chesterton, 2004; Cmte. on Guidelines & Principles for SIA, 1995; Mchombu, 1995; Parkinson & Ramirez, 2007), which are also discussed in this section.

Throughout the exploratory literature review on the subject of impact assessments, various key concepts are identified. An overview of these key concepts is given in Table 3.2. In this matrix, it is visualised which concepts are discussed in which source, in order to visualise the importance of these concepts in relevant literature. The concepts displayed in this table are used for the creation of a search query for the systematic literature review in Section 3.2.

Table 3.2: Impact assessments: key concepts

Reference	ICT4D	Sustainability	Readiness	Availability	Uptake	Impact	Effectiveness	Efficiency	Scalability	Evaluation	Costs & Benefit
Alampay (2006)	■		■		■	■		■			■
Ballantyne (2004)	■	■	■	■						■	■
Chesterton (2004)		■	■	■	■	■	■	■		■	
Cmte. on Guidelines & Principles for SIA (1995)						■				■	■
Franks (2012)		■				■				■	■
Heeks and Alemayehu (2009)	■	■	■	■	■	■	■	■	■	■	■
Kemm (2000)						■				■	
Kumar (2004)	■	■		■		■			■	■	■
Morgan (2012)		■				■	■			■	■
Mchombu (1995)		■		■		■	■			■	■
Mthoko and Khene (2015)	■	■	■	■	■	■	■	■	■	■	
Osah et al. (2014)	■	■	■	■		■	■	■	■	■	■
Pade-Khene and Sewry (2012)	■	■	■	■	■	■	■	■	■	■	■
Parkinson and Ramirez (2007)	■	■		■		■				■	

3.1.2 Digital Learning Transformation

The use of ICTs have had already effects in various factors of society. One of the sectors that is impacted by this development is the education sector (Sife, Lwoga, & Sanga, 2007). One concept that is widely adopted in the field of education and learning transformation is *e-learning*. A definition of e-learning that is given by Sife et al. (2007) is "the use of ICTs to enhance and support teaching and learning processes". Therefore, the term e-learning entails all the ICTs that are used in an educational environment with the purpose of improving the learning environment for both the teachers and the students, and therefore the concept of e-learning has emerged as an important educational tool (Nisperos, 2014). Thus, e-learning enables to provide learning experiences to be delivered by a wide range of electronic technologies (Sife et al., 2007). The term e-learning is used in a broad manner. E-learning can be very minimal (e.g., accessing course documents online) or complete (e.g.,

following an entire learning program online)(Sife et al., 2007). Sife et al. (2007) denote that e-learning has become essential to complement the traditional way of teaching. Various goals that can be achieved after implementation of e-learning, as described by Alamin and Elgabar (2014), are a higher quality of education, reaching a higher level of students, reducing costs, and reaching a higher level of student satisfaction. Sife et al. (2007) describe that there are various pedagogical and socio-economic factors that have directed the adoption of e-learning in higher education institutions. Factors that are mentioned are: greater access to information, improvement of communication, synchronous learning, increased cooperation and collaboration, cost-effectiveness, pedagogical improvement, virtual experiences, and graphic representations. Dolence and Norris (1995) describes that a transformation process can be divided in four sub-processes:

1. Realigning higher education with the Information Age.
2. Redesigning higher education to achieve this realigned vision.
3. Redefining the roles and responsibilities within realigned, redesigned higher education.
4. Re-engineering organisational processes to achieve dramatically higher productivity and quality.

Although the description of Dolence and Norris (1995) is dated at the moment of writing this thesis, it is assumed that the division in the four sub-processes is still relevant, especially for developing countries, where the digital transformation is not that advanced as in western countries.

Sife et al. (2007) also appoint the impact that e-learning can have on educational processes. They give the example of Microsoft PowerPoint, which is claimed to have a small impact on learning and teaching strategies. However, virtual learning environments are described to be able to have a large effect on the same learning and teaching strategies. Nisperos (2014) describes that any university that would not adopt this the use of ICTs in their educational programs would considered to be at a disadvantage to universities which do adopt this. In most cases, e-learning and traditional education is combined. If this is the case, the term *blended learning* is used (Salmon, 2014). The impact of online learning is increasing on a global level. Blended learning is being applied in higher educational institutions that otherwise had a traditional form. In those cases, online activities replace between 20% and 80% of the classroom activities (Miller et al., 2013).

Sife et al. (2007) explains that there are also various challenges that universities in developing countries face when implementing e-learning systems. African universities are expected to play a principal role in developing Africa's participation in the field of ICT. However, these universities are not able to fulfil such a leading role, since the information structure of African universities is of poor quality of development (Sife et al., 2007). Salmon (2014) describes that even the most traditional institutions can perform a transformational change, provided that the right circumstances are present. However, many higher educational institutions have a high resistance to organisational change (Salmon, 2014). Furthermore, there is a poor systematic approach to ICT implementation in most organisations, the attitude towards ICTs is often of negative nature, and administrative and technical support is often lacking (Sife et al., 2007). Next to that, many educational institutions have the tendency to use ICTs to replicate traditional practices, which leads

to a failure of ICT implementation (Sife et al., 2007). Moreover, in most organisations the development of staff towards the implementation of ICTs is poor. Lastly, Sife et al. (2007) mentions that there is often a lack of financial resources to fully implement ICTs and handle the challenges that are mentioned. Furthermore, technology cannot transform learning by itself. This can only be done in cooperation with various social and economic factors (Warschauer, 2007).

Nisperos (2014) describes that before technology-enabled education is implemented, barriers and obstacles need to be identified. In that way, potential challenges that arise can be addressed beforehand. Such identification of potential challenges is called an *e-learning readiness assessment*. There are various studies that propose a framework or approach to do an e-readiness assessment (Kaur & Zoraini Wati, 2004; Nisperos, 2014). An e-readiness assessment is described as critical, since such an assessment can provide key information about whether an institution is capable and ready to implement an e-learning program (Nisperos, 2014). E-readiness is the ability of a learner to make use of e-learning resources in order to improve the quality of learning (Kaur & Zoraini Wati, 2004).

Despite the fact that the majority of the literature is positive about the learning transformation trend, there are also publications that are sceptic (Guri-Rosenblit, 2006; Njenga & Fourie, 2010). Njenga and Fourie (2010) describe that the speed at which technology is advancing is too quick for educational research to keep up with. There is no time to study the impact of the new technologies on the educational system (Njenga & Fourie, 2010).

Throughout this section, various concepts are identified in the field of digital learning transformation. An overview of these subjects in combination with their sources is given in Table 3.3. There is a wide range of concepts that are used, which are not included in the table. However, the concepts that are included in the table are the concepts that are assumed to be most valuable for this research.

Table 3.3: Digital learning transformation: key concepts

Reference	Learning Transformation	E-learning	Developing countries	Teaching and learning technologies	E-readiness	Blended learning	Higher Education
Alamin and Elgabar (2014)	■	■	■		■		
Guri-Rosenblit (2006)		■		■	■	■	■
Kaur and Zoraini Wati (2004)		■		■	■		
Miller et al. (2013)	■	■		■		■	
Nisperos (2014)		■		■	■		
Njenga and Fourie (2010)	■	■		■	■	■	■
Salmon (2014)				■		■	
Sife et al. (2007)	■	■	■	■			
Warschauer (2007)	■			■			

3.1.3 Method Engineering

Saeki (2003) describes ME as a discipline for the exploration of techniques to create project specific methods. ter Hofstede and Verhoef (1997) add to this that methods are not only constructed, but also adapted. The term *method* can be described as an approach to perform a systems development project, based on a specific way of thinking (Brinkkemper, 1996). Brinkkemper (1996) mentions that a method consists of directions and rules which are structured in a systematic way. In most cases, methods are described in textbooks or manuals in the form of step-wise instructions (Brinkkemper, 1996). Every development activity results in a (sub)product, which are called deliverables (Brinkkemper, 1996). Brinkkemper (1996) proposed a framework for the development of methods and tools for information systems development. It is assumed that the development process of an information system development method is structured in a similar fashion as the development process of a method for performing impact assessments. Brinkkemper (1996) discusses the term *method engineering*, which refers to "the engineering discipline to design, construct and adapt methods, techniques and tools for the development of information systems". (Brinkkemper, 1996) also mentions that the term ME has many similarities with equal development concepts in other research areas.

Furthermore, Brinkkemper (1996) describes the use of situational methods, which is a method that is adjusted to a specific situations of a project. Often, existing methods are too general to be applied for a specific project, and therefore do not fit in every situation (Cossentino, Gaglio, Henderson-Sellers, & Seidita, 2006). Situational method engineering (SME) is a well fitted solutions to this problem (van de Weerd & Brinkkemper, 2009). With SME, optimised methods are designed with reusing parts of already existing methods (Brinkkemper, 1996; van de Weerd & Brinkkemper, 2009; Ralyté, Deneckère, & Rolland, 2003; ter Hofstede & Verhoef, 1997). Saeki (2003) uses a technique called *method assembly* in order to design a new project-specific method. With this technique, various meaningful parts of existing methods are used in the creation of a new method. Therefore, various standardised methods are required, which are called *meta-methods* (Brinkkemper, 1996). Next to that, if a situational method is created, there is made use of several building blocks of other methods. These building blocks are called *method fragments*, which can be separated in *product fragments* and *process fragments* (Brinkkemper, 1996; Harmsen, Brinkkemper, & Oei, 1994). Product fragments represent the structure of the products, which can be linked to the deliverables in the PDD notation of van de Weerd and Brinkkemper (2009) as mentioned before in Section 2.3.4. Products can be in the form of deliverables, documents, models, or diagrams (Harmsen et al., 1994). Also the process fragments are linked to the processes in the PDD notation of van de Weerd and Brinkkemper (2009). Process fragments represent activities that need to be performed in order to have a product fragment as output (Harmsen et al., 1994). These method fragments can be retrieved from a *method-base*(Brinkkemper, 1996; ter Hofstede & Verhoef, 1997; Harmsen et al., 1994). The concept of meta-modelling is also widely used in the field of SME (Brinkkemper, Saeki, & Harmsen, 1998).

In contrast to using method fragments, Ralyté (2004) describes the use of *method chunks* instead. A method chunk is considered to be an autonomous component of a method (Ralyté, 2004). It has to be mentioned, that an entire method is also considered to be

a method chunk. However, a method chunk as part of a method has a lower level of granularity than a method chunk as part of a method as a whole, which has the highest level of granularity (Ralyté, 2004). According to Ralyté (2004) a method chunk consists of a process part, called a *guidelines*, and a product part. A guideline prescribes the process of producing the product, and the product part denotes the product to be delivered (Ralyté, 2004). Furthermore, each guideline has an *interface*, which describes the conditions of its applicability (Ralyté, 2004). The interface is defined by a situation and an intention. The situation refers to the input of the method chunk, and an intention describes the engineering goal that is to be achieved (Ralyté, 2004).

The key concepts that are identified for the method engineering subject are found in Table 3.4. It can be observed when performing a traditional literature research on the subject of ME, is that there is a wide agreement in the use of terms and concepts. There are a few deflections of the main trends, but there is no great clash of perspectives. In the systematic literature review, the concepts identified above are taken as basis for the search query.

Table 3.4: Method engineering: key concepts

Reference	Method Engineering	Situational Method	Meta-modelling	Method fragment	Method Chunk	Method Assembly	PDD
Brinkkemper (1996)	■	■	■	■		■	■
Brinkkemper et al. (1998)	■	■	■	■		■	
Cossentino et al. (2006)	■	■	■	■	■		
Harmsen et al. (1994)	■	■	■	■		■	
Ralyté et al. (2003)	■	■	■	■		■	
Ralyté (2004)	■	■	■		■		
Saeki (2003)	■		■	■		■	
ter Hofstede and Verhoef (1997)	■	■	■	■			
van de Weerd and Brinkkemper (2009)	■	■	■	■		■	■

3.2 Systematic Literature Review

In this systematic literature review, current literature is analysed to find information that can serve as a foundation for this research. For this systematic literature review, the literature research protocol as described in Section 2.4 is followed. Similar to the exploratory literature review, the section is divided over three subjects: Impact assessments, digital learning transformation, and method engineering.

3.2.1 Impact Assessments

A lot of capital is invested in ICT4D projects. However, there is not enough research on the effectiveness of these projects (Heeks & Alemayehu, 2009). Heeks and Alemayehu (2009) mentions that too few impact assessment projects are carried out, which has mainly two reasons. There can be a lack of motivation from the local governments. Next to that, there is often not enough knowledge on how to perform an impact assessment. Furthermore, Latchem (2018) describes that most evaluations on impact are uni-dimensional. Latchem (2018) gives the example that evaluation methods may take the educational gains into account, but do not consider the costs. Furthermore, success may be reported, but the failures and reasons for these failures are not described.

Heeks and Alemayehu (2009) created a classification of overall impact of ICT4D projects. Five categories are defined:

1. Total failure
2. Largely unsuccessful
3. Partial success/partial failure
4. Largely successful
5. Total success

A project is classified as a (1) *total failure* in three cases: when a project is never implemented, when the project is implemented but is thereafter directly discarded, or when the project was implemented but none of its goals are attained. A project is denoted as (2) *largely unsuccessful* if some project goals are achieved, but that most major stakeholder goals are not reached or undesirable goals are the result. Furthermore, a (3) *partial success/partial failure* project is a project where some major goals are achieved, but still some of the goals are never met. Also, some results that are achieved might be undesirable. A project is classified as (4) *largely successful* when most stakeholder groups reached there goals, and no results were undesirable. Lastly, a project is denoted as a (5) *total success* if the project reached all stakeholder goals and no undesirable results were found as an outcome.

ICT4D projects can be evaluated from three different perspectives, being Macro, Meso, and Micro (Ashraf, Swatman, & Hanisch, 2008). Evaluations on the Macro level are mostly carried out by funding programmes. The Meso level refers to evaluations done by project teams from organisations, and the Micro level describes evaluations done by communities which are directly impacted by the project. The Micro level is user-oriented, and Ashraf et al. (2008) mention that it is important to also take these types of evaluations into account, so that individual recipients can experience the full benefits of an ICT4D initiative.

Heeks and Alemayehu (2009) wrote a working paper which contains a compendium of impact assessment methods and frameworks. In this paper, a collection of multiple methods and frameworks is given, and range from generic methods to very specific method. The categories that Heeks and Alemayehu (2009) describe are the following:

- **Generic**: Methods or frameworks that can be used for every impact assessment of development projects.
- **Discipline-Specific**: methods or frameworks for impact assessments that are focused on a specific academic discipline.
- **Issue-Specific**: Impact assessment methods or frameworks that are focused on a specific development goal or issue.
- **Application-Specific**: Impact assessment methods or frameworks that are centered around one specific ICT4D technology.
- **Method-Specific**: Impact assessment methods or frameworks that are focused on what specific form of data-gathering.
- **Sector-Specific**: Methods or frameworks for impact assessments that are focused on only one development sector.

In this literature review, an overview and description of various impact assessment methods and frameworks will be given. Most of the following methods and frameworks are found in the compendium paper of Heeks and Alemayehu (2009).

Cost-Benefit Analysis

The Cost-Benefit Analysis (CBA) takes a closer look at the costs and the benefits of a development project. It is a framework that provides a manner for assessment based on data analysis (Heeks & Alemayehu, 2009). The framework can be classified within the *generic* category. Heeks and Alemayehu (2009) describes that the CBA is mainly used to assess the financial sustainability and cost-effectiveness of a project. For example, the worth of an ICT4D project is determined based on the *net present value*, the *discounted cash flow*, and the *breakeven point*. Heeks and Alemayehu (2009) defines the following two basic elements for a CBA: *cost item identification and valuation* and *benefit item identficiation and valuation*, which provide the foundation for a comparison of the costs and benefits of a project. Furthermore, if there is an interest in future costs and benefits, it can be considered to take *discount rate* and specific *decision rules* into account. The main downside of the CBA is that it only takes financial performance of an ICT4D project into account.

Four sets of costs need to be taken into account (Depover & Orivel, 2013):

1. The design and production of courses and course material.
2. The distribution of the programme.
3. The reception by the learners.
4. System administration.

With the reception by the learners is meant in what form the students receive the learning experience. This can be face-to-face, but also through ICTs (Depover & Orivel, 2013). Latchem (2018) also describes that it may be difficult to express all benefits in monetary terms, since not all results have to cause immediate effects. Moreover, it may also be

a challenging task to measure the influence of other factors on an increased output or earnings (Latchem, 2018).

Project Goals

Heeks and Alemayehu (2009) also describe an impact assessment framework which assesses the project against the goals of the stakeholders. The framework is very easy and concise. It consists of four steps:

1. Identify project goals
2. Identify indicators to measure goal achievement
3. Identify appropriate methods to measure indicators
4. Measure indicators and assess goal achievement

An example of this framework in practice is the study of Ballantyne (2004). In this research, the goals of the project are clearly stated. In this research, next to the goals of the project, also the performance on a broader development goal is stated.

Communications-for-Development

This framework is based on communication from the perspective of an ICT4D project towards the change of individual behaviour (Heeks & Alemayehu, 2009). The framework works as follows: A specific context is observed. This can be a political, economic, sociocultural, technological or legal context. Then different types of communication are applied. After that, the differences of behaviour within the context are monitored. The goal of such a type of impact assessment is to analyse if the communication of information can change the behaviour of the recipients of the project. The change in behaviour can lead to broader development impacts (Heeks & Alemayehu, 2009).

Chesterton (2004) applied the framework in four different contexts. The evaluations in the research of Chesterton (2004) focused on short term outcomes in these contexts. The framework that is used here is evaluating on the following criteria:

- Relevance for the context
- Effectiveness
  - Reaching intended audience
  - Meeting project objectives
- Efficiency of implementation (expenses vs outcomes)
- Capacity for expansion
- Sustainability

The evaluation of Chesterton (2004) utilises various evaluation outcome questions on multiple subjects. First, the *reach* of the project was evaluated. In order to evaluate on this, questions are asked about the geographic areas in which the communication was carried out, and what the size of the target population was for example. Furthermore, the profile of the reached population is sketched. Next to that, *awareness and knowledge* is another subject that is taken into account. For example, a question is asked about how much knowledge is gained by the target population. Next to that, further demographics of these populations are analysed. *Life skills practices* is another subject that is discussed. This

subject focuses on the change of behaviour on the communication of the development project. For example, the study of Chesterton (2004) compares the behaviour between different sample groups: groups that are exposed to the development project, and groups that are not. After that, the evaluation tries to identify what the reasons for the behaviour change are. For each of the subjects mentioned above, evaluation outcome questions are defined. These questions are answered in order to complete the evaluation. Various types of data are used in the study of Chesterton (2004). For example, focus groups are used to gain qualitative data and surveys are used in order to acquire quantitative data.

Capabilities Framework

The capabilities framework, as described by Heeks and Alemayehu (2009), evaluates an ICT based development project on how the ICTs contribute to freedom and empowerment. The framework focuses on individual freedoms, or capabilities, which are defined as the goals or values that an individual finds important. A *capability* is something that an individual is free to do. The things that are achieved by these capabilities are named *functionings* (Heeks & Alemayehu, 2009). Heeks and Alemayehu (2009) defines five areas of capabilities: economic, political, social, informational, and security.

The study of Alampay (2006) used the capability framework for an evaluation within the ICT4D domain. The evaluation of Alampay (2006) assesses the implementation outcome of the universal access to ICT. In this study, it is researched the extend to which individuals have access to ICTs. Next to that, the demographics of these people are analysed. Furthermore, it is investigated what the reasons are that the ICTs are used. Moreover, it is studied what effect it has on individuals when they have access to ICTs, and what change they are going through if the access to ICTs is taken away. This is done by assessing the results of surveys.

Alampay (2006) performed the evaluation based on the capabilities approach as described by Heeks and Alemayehu (2009). First, individual differences of the population are analysed, based on the following five factors: age, income, gender, skills/education, and location. Then it is investigated to what extent individuals of these population have knowledge to use ICTs and actual access to ICT (capabilities), and to what extent the ICTs are actual used (realised functionings). In other words, it investigated whether individuals actually have the skills to perform certain tasks with the use of ICTs, or if they are in need of assistance. Next to that, it was assessed what the barriers of using ICTs are. Participants were asked what prevented them from using ICTs in their daily lives. Furthermore, the study of Alampay (2006) assessed to what extent individuals have access to ICTs. A difference is made between, ownership, access, and use. Ownership means that an individual actually has the ICT in possession. Access is defined as the option to use the ICT, being made available by another. Use is defined as an individual actually using an ICT (Alampay, 2006).

Livelihoods Framework

Another framework that is described by Heeks and Alemayehu (2009) is the livelihoods framework (or Sustainable Livelihoods Framework (Adato & Meinzen-Dick, 2002; Parkinson & Ramirez, 2007)). The framework is used to assess the impact of ICTs on indi-

viduals and communities. Heeks and Alemayehu (2009) mentions that the framework is not focused specifically on one type of impact assessment. The framework is used to get an overview of the entire perspective of a development project. Therefore, Heeks and Alemayehu (2009) recommend to use this framework as an overarching framework, with another specific framework as a supplement. The livelihoods framework is often used for the planning and assessment of development projects (Parkinson & Ramirez, 2007). The livelihoods framework is mostly a conceptual framework that can be used to analyse the cause of poverty, the access to resources and livelihood activities, and the relationship between relevant factors (Adato & Meinzen-Dick, 2002). Furthermore, Adato and Meinzen-Dick (2002) also mention that the framework can be used to assess and prioritize interventions.

The framework is constructed of six elements: *vulnerability context*, *assets*, *structures*, *processes*, *strategies*, and *outcomes* (Heeks & Alemayehu, 2009; Adato & Meinzen-Dick, 2002). The starting point of the framework is the vulnerability context. This represents the context in which people operate (Adato & Meinzen-Dick, 2002), and shapes peoples lives (Heeks & Alemayehu, 2009). The vulnerability context can be in the form of shocks, trends, and seasonality (Heeks & Alemayehu, 2009). In most cases these are defined as negative influences, but this is not always the case. The vulnerability context is a subjective personal assessment of things that make the individual vulnerable to external contexts (Adato & Meinzen-Dick, 2002). These are taken into account, since a perceived vulnerability can also influence the livelihood strategy (Adato & Meinzen-Dick, 2002).

After that, the focus is drawn on the assets. Assets can be seen as livelihood wealth indicators, but are not limited to classic factors like monetary wealth (Adato & Meinzen-Dick, 2002). The assets can come in five different types: human capital, natural capital, financial capital, physical capital, and social capital (Heeks & Alemayehu, 2009; Adato & Meinzen-Dick, 2002). Adato and Meinzen-Dick (2002) describe that the assets interact with policies, institutions, and processes. In that way, the choices of livelihood strategies can be made. After that, the livelihood outcomes can be concluded. Adato and Meinzen-Dick (2002) states however that the livelihood outcomes are not by definition the end result of the assessment, but can be used as input for a future asset base. The structures and processes refer to institutions and organisations that have influence on the vulnerability context, by providing laws and policies (Heeks & Alemayehu, 2009; Adato & Meinzen-Dick, 2002).

As mentioned earlier, the results of the framework are not specific. The framework provides a holistic view on how a project can have an impact on the livelihood of an individual. Adato and Meinzen-Dick (2002) mention that by applying this framework, a more substantiated decision can be made on more narrow and specific assessment method. Parkinson and Ramirez (2007) state that the framework is particularly useful for young projects, since it provides the opportunity to assess probably future impacts at community level.

Information Economics

The information economics framework focuses on the analysis of commerce or trade businesses (Heeks & Alemayehu, 2009). An important aspect of this framework is that it takes the information failures around transactions into account. Heeks and Alemayehu

(2009) described these information failures in five categories: information absence, information quality, information uncertainty, information asymmetry, and information cost. *Information absence* refers to the unavailability of key information that are needed for development actors. The *information quality* category describes that the key information is available, but that the information is of poor quality. *Information uncertainty* refers to the uncertainty about the quality of the key information. Furthermore, *information asymmetry* describes that not all development actors have the same amount of key information available. And lastly, *information cost* means that key information is only obtainable against high costs (Heeks & Alemayehu, 2009).

The information failures that are described above are used in order to assess the impact of ICTs. It is used in order to assess to what extent the ICTs change the information characteristics of transactions (Heeks & Alemayehu, 2009). After that, the framework provides the opportunity to evaluate on the changes to a transaction process, the changes to structural characteristics, and the changes to market development characteristics (Heeks & Alemayehu, 2009). Heeks and Alemayehu (2009) mention however, that some characteristics cannot be altered by implementing ICTs. There are other factors that can affect these. Heeks and Alemayehu (2009) describe trust, reputation, and cultural norms as examples.

Information Mapping Framework

Next to the information economics framework, another framework focused on the information needs exists, named the Information Mapping Framework. The Information Mapping Framework has the goal of mapping the information needs of communities against ICT4D information impacts (Heeks & Alemayehu, 2009). The framework is primarily based on information delivery, carried out by developing projects. The framework seeks to identify information requirements of a community, before an ICT4D intervention is implemented. After these information requirements are identified, the ICT4D project is carried out. Then, the framework is used to assess if the ICT4D project contributes in meeting the requirements that are identified earlier (Heeks & Alemayehu, 2009). Heeks and Alemayehu (2009) describe three approaches to identify the information needs:

- Using a baseline survey prior to the intervention. Then, the results of the survey function as input for the ICT4D intervention. After that, the results of the survey can be mapped against the actual results of the ICT4D project after the intervention.
- Using two phases, where the first phase consists of the identification of the information needs. The needs that are identified are defined as anticipated benefits of the intervention, and therefore as indicators which are used to measure the actual impact. The impact assessment is carried out in the second phase. Then, the information needs are mapped against the impact indicators and results.
- Using a generic set of information needs or conducting interviews in order to use retrospective data. This is helpful if the intervention is already carried out, and no other possibility is available to identify information needs prior to the ICT4D intervention. Furthermore, ongoing information needs can be identified.

Heeks and Alemayehu (2009) describe that the information needs can be identified with both a bottom-up and top-down approach. Furthermore, Heeks and Alemayehu (2009)

denote various criteria which can be used to assess the information needs with the framework: completeness, accuracy, relevance, timeliness, and appropriateness of presentation. The identified information needs and the assessment criteria are used to create a matrix. In this way, it is possible to develop an clear overview of which information needs are impacted or not (Heeks & Alemayehu, 2009). Mchombu (1995) applied the information mappings framework in the context of rural development in various African countries, being Malawi, Botswana, and Tanzania. Mchombu (1995) first identified the information needs in various villages in the countries mentioned above. After that, the anticipated benefits and the services and products that can contribute to these are defined. Mchombu (1995) underlines that the information mapping framework is a suitable approach to identify gaps in information in developing countries.

Critical Outcome and Impact Themes

In the study of Mthoko and Khene (2015) an impact assessment framework is proposed which consists of three components: evaluation guidelines, critical themes of rural ICT4D outcome and impact assessments, and previous domains of evaluation. The framework focuses primarily on rural ICT4D programmes. Previous domains of evaluation can be baseline data, needs assessments, programme theory assessments, and process assessments (Mthoko & Khene, 2015). It has to be mentioned that there is an overlap in the five themes, which are defined are as follows (Mthoko & Khene, 2015):

- **Strategic Value.** This theme consists of the identification of capabilities which are needed in order to construct and maintain a sustainable ICT4D programme. Moreover, the impact of such capabilities is of importance for the strategic value of such a programme (Mthoko & Khene, 2015). With a strategic value, it is determined what the value of the programme is in order to achieve the development goals that are desired (Mthoko & Khene, 2015).
- **Most Significant Change.** The theme of most significant change aims to identify various types of information from the recipients of a programme. The goal of this theme is to let recipients of the ICT4D programme reflect on the changes that are made within a community, caused by the programme. Therefore, all stakeholders should be asked for their experiences of changes, without using predetermined indicators (Mthoko & Khene, 2015).
- **Empowerment.** The theme of empowerment refers to two factors: agency and opportunity structure. The agency of a person or community is defined as the dependency on assets or capital. Opportunity structure refers to the external context where an individual lives, works, and makes decisions (Mthoko & Khene, 2015). These two factors are used to assess the impact of a programme, since empowerment is described as expanding the capabilities of individuals or communities. If these capabilities are expanded by an ICT4D programme, empowerment grows, as does the impact of the programme.
- **Livelihoods.** The livelihood of an individual is affected by the external environment. Mthoko and Khene (2015) states that the livelihood theme focuses on how ICTs are influencing the livelihood of a person, by assessing the impact a programme has on the external environment a person lives in (Mthoko & Khene, 2015).
- **Sustainability.**. Lastly, the sustainability theme has the goal to determine in which

way an ICT4D programme is contributing to sustainable development (Mthoko & Khene, 2015). Mthoko and Khene (2015) states that no focus should be placed on the sustainability of the ICT4D programme, but on the outputs, outcomes, and impacts of a programme. For example. indicators can be used in order assess whether the results of the programme will be long-term. Furthermore, it should be assessed if the programme can be generalised and replicated (Mthoko & Khene, 2015).

Outcome Mapping

The outcome mapping approach is used to plan, monitor and evaluate social change initiatives (Earl, Sinha, & Smith, 2013). Outcome mapping provides guidelines which can be used to identify a desired change. The results of a project are measured by reflecting on the change of behaviour, actions and relationships of individuals or communities that are affected by the specific project. There are twelve steps within the outcome mapping approach. However, Earl et al. (2013) state that it is not necessary to go through all the twelve steps in order to make effective use of the outcome mapping approach. The twelve steps are divided over three stages: Intentional Design, Outcome & Performance Monitoring, and Evaluation Planning (Earl, Carden, & Smutylo, 2001). The first stage helps to answer four questions (Earl et al., 2001):

- What is the vision of the programme?
- Who are the boundary partners of the programme?
- What are the changes that are being sought?
- How will the programme contribute in achieving these changes?

The second stage focuses at monitoring the program and its process towards the achievement of the changes that are defined earlier (Earl et al., 2001). The third stage is used to identify evaluation priorities and developing an evaluation plan (Earl et al., 2001). Within every stage, various steps are taken (Earl et al., 2001, 2013):

Intentional Design

1. Vision
2. Mission
3. Boundary Partners
4. Outcome Challenges
5. Progress Markers
6. Strategy Maps
7. Organisational Practices

Outcome & Performance Monitoring

8. Monitoring Priorities
9. Outcome Journals
10. Strategy Journal
11. Performance Journal

Evaluation Planning

12. Evaluation Plan

Since this literature review is focused at identifying impact assessment methods, and not method in order to plan and monitor the process, the steps are not described in detail. The steps are described in a very elaborate manner in the work of Earl et al. (2001). However, the outcome mapping approach can be useful in the design of a novel impact assessment method and planning an evaluation with the steps described above.

Theory of Change

A theory of change is described as a process mapping methodology, which defines a sequence of events that lead to an outcome that is desired (Connell & Klem, 2000). It can be also viewed as a reflective process which can be used to explore why a specific change happens, and how it happened (Li & Thomas, 2019). Li and Thomas (2019) describe that a theory of change is typically constructed of the following basic elements:

1. Long-term goals
2. Context for the change initiatives
3. The change-bringing interventions
4. Intermediate goals and their relationships
5. Assumptions which explain the process of change
6. Indicators that are used to measure success at every intermediate goal
7. Narrative summary

Li and Thomas (2019) state that a theory of change is well suited to use for an impact assessment in the ICT4D domain, since it describes how a project is contributing to its development goals. Li and Thomas (2019) has adopted theory of change as a generic framework for an impact assessment purpose in the ICT4D domain. The seven elements mentioned earlier are used as basis for the evaluation method, but do not necessarily be carried out in this fixed order (Li & Thomas, 2019). It is described that *long-term goals* should be clearly stated, and should be associated with project-based goals that are achievable. Long-term goals should not be stated as micro-level behavioural changes, but they should be related to higher level development goals (Li & Thomas, 2019). An example that Li and Thomas (2019) mention is the alignment with the Sustainable Development Goals, defined by the United Nations (2016).

Next, the *context* for the change initiatives should be clearly described. This includes the problem statement, and all social, political and economic conditions surrounding the problem space. Furthermore, the different actors that can have an influence on a change should be described (Li & Thomas, 2019). Furthermore, the change-bringing *interventions* should be stated, meaning the solutions which are designed in order to achieve the goals. Also, the process of change, in the form of the *intermediate goals*, should be described. Li and Thomas (2019) mention that the outcome of this step is usually in the form of a pathway map, which provides a visual representation of the logic model of the theory of change. Then, the *assumptions* which explain the process of change should be made. These assumptions should describe how an ICT4D project would lead to the long-term goals.

Furthermore, *indicators* need to be developed in order to measure which outcome has occurred (Li & Thomas, 2019). These indicators support testing the outcome of a project.

So, after defining the indicators, a research plan needs to be written to operationalise the indicators in the project context (Li & Thomas, 2019). Lastly, a narrative summary should be written in order to explain the change pathway map and underlying assumptions. Such a summary can help with conveying the elements of the theory of change to stakeholders (Li & Thomas, 2019).

3.2.2 Digital Learning Transformation

The adoption of novel learning methods is important for education institutions, since this results in students being more employable, innovative, and creative (Florjančič, 2019). ICTs are used to introduce new learning methods. ICTs are often described as computers. However, Sachin et al. (2018) describe that ICTs includes various types of informational media, such as handheld devices, television, radio, and print. Furthermore, ICTs can also come in the form of communication technologies as telephones and networks (Sachin et al., 2018). Florjančič (2019) mentions that the digitisation of a society is changing learning resources, and therefore the way education is practiced and experienced. Furthermore, using different learning technologies results in a more varied learning environment, and students are more likely to be motivated (Florjančič, 2019). The study of Inamdar and Rotti (2004) shows that learners support the statement that training in computer skills integrated in their studies does improve their skills. In that way, they are more trained to find and use the correct information to solve problems in a quick an efficient manner (Inamdar & Rotti, 2004).

The digital divide is one of the many gaps between developed countries and developing countries (Pakistan, 2011). The digital divide is defined by Salinas (2003) as the disparity between individuals or communities who can make use of ICTs to enhance the quality of life and those who cannot. Developing countries manifest a rapid growth of higher education systems, with grow rates between 40% to 90% (Raanan, 2016). However, Raanan (2016) also mentions that the budget for higher education did not grow accordingly, which thus contributes to an even larger digital divide. Sachin et al. (2018) describes that education is one of the most powerful instruments used to fight poverty. However, many children, especially in developing countries, do not have access to quality education (Sachin et al., 2018). They have limited access to ICTs, which are described by Sachin et al. (2018) as the key driver for the improvement of the educational and economic prospects of a country. Moreover, since there is little access to these ICTs, the knowledge gap is amplified even more (Sachin et al., 2018). Pakistan (2011) focuses on e-learning, which can be used to close the digital divide. Developed countries have been using e-learning and digital platforms for educational purposes since the 1980s. Since then, massive improvements have been made on these systems. However Pakistan (2011) describes that developing countries had just started projects on ICT infrastructure development around 2010s. These developments are mentioned to be the first step towards the transformation to e-learning (Pakistan, 2011). However, the study also concludes that the pace of development is too slow. Many people have access to a computer in development countries. It has to be mentioned however, that individuals in developing countries that have access to a computer, cannot use the full potential of that computer most of the time. The cause of this is that there is to little training and often there is no reliable internet infrastructure (Pakistan, 2011).

Students in many developing countries lack the proper knowledge and skills they need to compete in the global workforce. Those developing countries are not able to provide the appropriate education to teach that knowledge and skills (Sharma & Rathore, 2011). Next to that, Sharma and Rathore (2011) mention that a lot of students are not able to receive the training to improve those skills or gain new knowledge because they live far away from university campuses. E-learning provides the opportunity for individuals in rural areas to take advantage of the same resources as individuals that can physically go to school. Therefore, e-learning can provide a cost-effective solution in education, also to the geographic gap (Sharma & Rathore, 2011). Most development programmes that focus on education have the same goals. The main goals are to empower and develop capacities in individuals and communities. Next to that, programmes strive to reduce the inequality and poverty by enabling lifelong learning (Latchem, 2018). Next to the fact that educational opportunities are increased, these programmes are also inspiring others to contribute in the meeting of the Sustainable Development Goals of the United Nations (2016).

According to Maribe and Twum-Darko (2015), technology in education plays a vital role in globalising challenges. Technology in education has the ability to change and shape educational systems in order to carry out practices in the most effective manner. Maribe and Twum-Darko (2015) states that the integration of ICT in education is significant because it has the potential to change the education environment in a positive manner. Next to that, ICT in education can act as an effective tool for classroom management (Maribe & Twum-Darko, 2015).

Learning management systems (LMS) (e.g., Blackboard) are an important factor for academic institutions (Al-Busaidi, 2013). An LMS provides opportunities to use various tools in supporting educational processes, such as content development, discussion management, group work, student tracking, communication, and various administrative tools. An LMS or another e-learning platform is expensive in development (Al-Busaidi, 2013). Al-Busaidi (2013) describes that many academic institutions are too intimidated to transform their educational system to a system that is entirely in the form of e-learning. However, the benefits of e-learning are often recognized. Therefore, e-learning technologies or LMS tools are often adopted for blended learning, especially in the initial phase of adoption. E-learning can be defined in several ways, ranging from the use of an online platform for all interactions between educators and learners, to the use of technology to only deliver a small amount of education material online (Al-Busaidi, 2013). A full adoption of e-learning is valuable, especially for distance education (Al-Busaidi, 2013). However, an LMS is often used in combination with traditional education, resulting in a blended learning environment(Al-Busaidi, 2013). Blended learning is defined by A. Kitchenham (2011) as courses which are delivered both online and in face-to-face environments. Blended learning provides the opportunity to strengthen the face-to-face learning environment, by designing the course itself. Within the design process, various e-learning methods can be implemented (Al-Busaidi, 2013).

The study of Al-Busaidi (2013) has the goal of assessing e-learning acceptance by considering the characteristics of learners. These characteristics are: self-efficacy, technology experience, and personal innovativeness. Moreover, the study also assess the adoption

of LMS of learners, based on the perceived ease of use, perceived usefulness, and satisfaction. *Self-efficacy* is defined as a self-assessment of the ability to use computer skills with the objective to complete educational tasks (Al-Busaidi, 2013). Al-Busaidi (2013) describes that this is an important element, since an individual is more likely to feel a sense of control over technology when there is a high level of self efficacy. The *technology experience* is a factor which describes the level of experience an individual has with (a specific type of) technology. This element also takes the skills and abilities towards of the individual towards the technology into account (Al-Busaidi, 2013). Al-Busaidi (2013) also mentions that an individual is more likely to continue using the technology if there is a higher level of experience. *Personal innovativeness* is an element which describes the extent to which an individual experiments with the new technology. Al-Busaidi (2013) states that a person is more likely to identify the usefulness of the technology, when a higher level of personal innovativeness is present, since they are accustomed to the system more quickly. Moreover, the study of (?, ?) used an online questionnaire to collect the data for the research, based on determinants stated earlier.

A relevant example of the need for distance learning is described by A. Kitchenham (2011). A. Kitchenham (2011) describes a population that is widely spread across a country. There is not enough financial support to provide university courses for all small populations across the country. However, there is a need for higher education in these areas. If ICTs are available for these rural areas, distance learning can be used in order to provide the opportunity to educate. In that way, even individuals that are not located in large cities can have access to the educational system. However, another problem in many developing countries is that there is often a lack of internet access, especially in rural areas. There are also shortcomings of full e-learning. Milovanović et al. (2010) describe that the main shortcomings are concern the lack of human interaction. It is described that human interaction is a critical factor in education. Therefore, Milovanović et al. (2010) mention that traditional classrooms cannot be replaced in its entirety. Not all education is suitable to be transferred in a digital manner. Next to that, it is more complicated to teach soft skills over an internet connection (Milovanović et al., 2010).

Quality assessment

The study of Hanh, Nga, Loan, and Viet (2019) describes that continuous quality assessment is a factor of great importance in the educational context. However, quality assurance in higher education is described as an issue by Santally, Rajabalee, Sungkur, Maudarbocus, and Greller (2020). Quality assessments can be used to find strengths and weaknesses in the programs and processes of education institutions (Hanh et al., 2019). Quality assurance is therefore an important factor to take into account, especially in the educational domain in developing countries, since this can contribute to a growing economy (Hanh et al., 2019). A definition of quality assurance, given by Hanh et al. (2019, p. 650), is: "*... the assurance of the organisation that the product or service it provides meets acceptable quality standards*".

Hanh et al. (2019) describe that the labour market is the external environment that is forming one of the goals for education institutions. Education institutions aim to reach a quality of their education programs to be optimal for students to satisfy the labour

market. Next to satisfying the job market, Hanh et al. (2019) mentions that educational institutions need to focus on improving the personality and intellectual ability of graduates in order to assure quality. Maturity models are overall valuable tools to check whether an educational institution performs the same as similar other institutions. In that way, benchmarking can be applied (Santally et al., 2020).

Traditionally, quality assurance is focused on the inputs of education (Latchem, 2018). With inputs, the planning, provision, and resources are implied. However, Latchem (2018) describes that funding bodies are more interested in the outputs, outcomes and impact of programmes. Outputs are described as short-term, outcomes are defined as medium-term results, and the impact of a programme is considered to be long-term (Latchem, 2018). Moreover, Latchem (2018) mentions that the evaluation of programmes should be built in at the start of the programmes.

Sustainable Learning

Sustainability is an important factor of education. In order to achieve lifelong learning, sustainable measures are necessary to be taken within the educational context. Davies and West-Burnham (2003) describe that sustainability within education is achieved, when there is a focus on implementing practices in sustainable forms. This is done through educational development, leadership, and innovation (Davies & West-Burnham, 2003). Stepanyan, Littlejohn, and Margaryan (2010) discuss sustainability in e-learning, and identified three operational domains: Resource management, educational attainment, and professional development and innovation. These are reasoned to be the three fundamental domains in an sustainable educational system Figure 3.1. Resource management refers to the resources deemed necessary in order to design e-learning in a successful manner, and focuses mainly on taking cost-effective measures to make education sustainable (Stepanyan et al., 2010). Stepanyan et al. (2010) describe issues as staff time and costs of technology. Furthermore it is explained that digital sources are cheaper to share and reuse, which is already contributing to the goal of sustainability. Furthermore, economies of scale and economies of scope are an important factor in improving the sustainability of education, which are used to increase the diversity of education services (Stepanyan et al., 2010). Morris (2008) reasons that economies of scale and economies of scope are contributing to sustainability in education by reducing costs and improving quality. Educational attainment refers to the effectiveness and quality of e-learning, which includes the following indicators: students satisfaction, learner support, student attainment, and achievement (Stepanyan et al.,

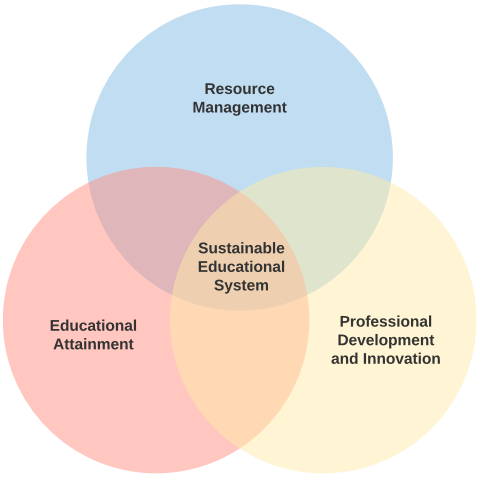

Figure 3.1: Domains of a sustainable educational system, based on the model of Stepanyan et al. (2010)

2010). Furthermore, various determinants of quality in education are mentioned: learning resources, learning design, level of learning flexibility, improvement of learning outcomes and engagement (Stepanyan et al., 2010). Also, Stepanyan et al. (2010) mention that assessment, student/teacher feedback and quality assurance are other indicators which can be used to measure quality. The professional development and innovation domain refers to the professional improvement teachers can make by using new technologies. Also the innovation of these teachers are taken into account (Stepanyan et al., 2010).

Culture

Online learning can also conflict with cultural differences. In most developing countries, there is high value placed on respect for authority (A. Kitchenham, 2011). In these cultures, it is often the case that discussion is considered to be disrespectful. Furthermore, in most cases teacher-centered education is preferred, which means that the teacher has the role of master, and students are just learning to pass tests (A. Kitchenham, 2011). E-learning has a more student-centered approach. Transforming educational systems from a teacher-centered approach to a student-centered approach can be challenging (A. Kitchenham, 2011). Another cultural issue that is mentioned by A. Kitchenham (2011) is motivation. It is described that other elements (e.g., socialisation or family) may receive a higher priority by students than education. Therefore, A. Kitchenham (2011) mentions that the courses that are offered need to be constructed in an engaging way, so that students are motivated to attend the course.

Technology Acceptance

It is not self-evident that a novel technology will always be accepted by students, teachers, or other stakeholders. Therefore, Koondhar et al. (2015) describe that it is important to conduct research on the reasons why technologies are accepted or rejected. The technology acceptance model (TAM) of Davis, Bagozzi, and Warshaw (1989) is widely adopted in order to conduct this type of research (Figure 3.2). This model is designed in order to model the user acceptance of information systems (Davis et al., 1989). Davis et al. (1989) proposed to use the concepts of *perceived usefulness* and *perceived ease of use* in the TAM, since these are of high relevance in the computer science acceptance behaviours. Next to that, the variables *attitude towards using*, *behavioural intention to use*, and *actual system*

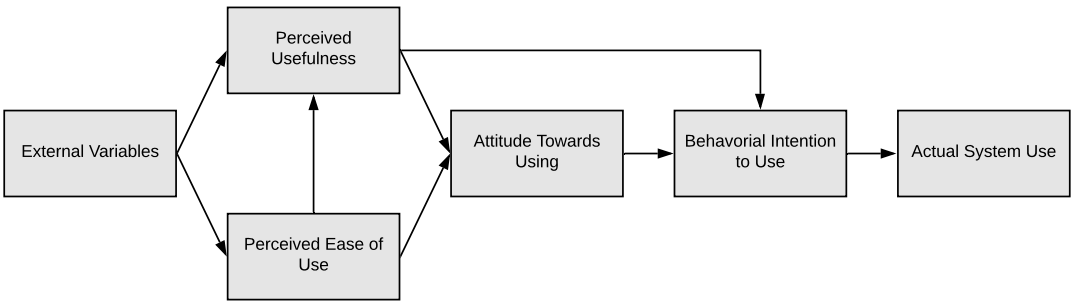

Figure 3.2: Technology Acceptance Model (TAM), based on the model of Davis et al. (1989)

Perceived usefulness is defined by Davis et al. (1989) as the subjective probability of a user that a specific system or platform will increase the performance of working. *Perceived ease of use* is defined as the extent to which a user experiences ease of use of the system, thus the level of effort that is needed in order to use the system (Davis et al., 1989). *Perceived ease of use* influences the behaviour of the user by the mechanisms of self-efficacy and instrumentality. It is stated that an individual is likely to have a greater sense of self-efficacy when there is a higher level of perceived ease of use. It is also mentioned that efficacy is one of the main elements that underlies intrinsic motivation (Davis et al., 1989). Both *perceived usefulness* and *perceived ease of use* can be affected by a number of external variables (Davis et al., 1989). Figure 3.2 visualises the relationships between the various factors that determine the acceptance of technology. External variables influence the perceived usefulness and perceived ease of use of a system. Next to that, perceived ease of use might also affect the perceived usefulness. If a system is perceived to be easy in use, an individual might think of the system that it is more useful than an equal system with a lower perceived ease of use (Davis et al., 1989).

Both the perceived usefulness and the perceived ease of use affect the attitude of a user towards using the system, referring to the feeling users have about using the system. This, in consequence, influences the intention to use the system. However, this is only achieved if a user also acknowledges the added value of the system through perceived usefulness. Lastly, the extent to which a user has intention to use the system is influencing the factor of actual system use (Davis et al., 1989). Koondhar et al. (2015) build on the TAM of Davis et al. (1989) by adding various other variables that are used to relate to the behavioural intention towards information technologies. The variables used by Koondhar et al. (2015) are displayed in Table 3.5.

Table 3.5: Technology Acceptance Variables from Koondhar et al. (2015)

Factor Category	**Variable**
Application	Compatibility
Individual	Self-efficacy
Social	Subjective Norms
Technological	Complexity
Pervasiveness	Context Awareness & Ubiquity

3.2.3 Method Engineering

The term *method engineering* originates from the field of mechanical engineering. However, after that it is adopted in the domain of information systems development (Harmsen et al., 1994). Situational Method Engineering can be described as "*the discipline to build project-specific methods, called situational methods, from parts of existing methods, called method fragments*"(Brinkkemper et al., 1998, p.1). Harmsen et al. (1994) modelled the process of the configuration of a situational method in a number of steps, displayed in Figure 3.3. The process starts with a given project environment and includes the informa-

tion infrastructure, users, and organisational culture of the project (Harmsen et al., 1994). The project factors determine the characterisation of a project. Project factors include application characteristics, external factors, technical factors, and development expertise (Harmsen et al., 1994). With the input of the characterisation of a project, a selection of method fragments can be made. These method fragments are extracted from a method base. Subsequently, the method fragments are to be assembled into a method (Harmsen et al., 1994).

Furthermore, the method needs to be validated, which is done by assessing the method against the characterisation of the project defined earlier. In that way, it can be validated if the method fits within the project environment, or if some alterations to the method should be made. Lastly, the method can be implemented, which influences the project performance (Harmsen et al., 1994). In other words, a novel method can be constructed by selecting the method fragments or method chunks that are the most appropriate for a given project situation (Ralyté, 2002).

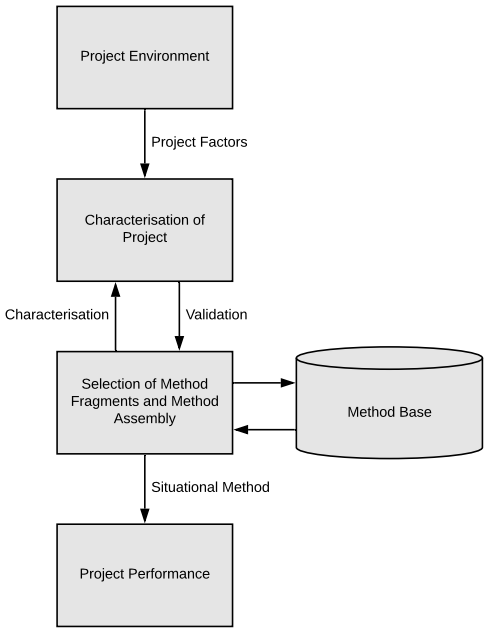

Figure 3.3: The configuration process of a situational method, based on the model of Harmsen et al. (1994)

Moreover, Harmsen et al. (1994) describe the life cycle of a situational method. Initially, a project is conducted with a specific *approach*. Some approaches may be coupled. After that, these approaches can be further defined and structured, and therefore involve in a *method*. If such a general method is to be applied in a specific project environment, the method might be altered according to the characteristics of that project environment. In this case, a *situational method* is defined. In some cases, a situational method is identified for a project, but has the need to be generalised. If this occurs, a method is generalised, and altered into a general method again (Harmsen et al., 1994).

A method consists of *method fragments*. Method fragments occur in two forms: process fragments and product fragments. Process fragments contain the processes, activities, or tasks that are carried out in the method. The product fragments include the deliverables of the processes in the method, such as products or documents (Harmsen et al., 1994). Another term that is used in the domain of method engineering is a *method chunk*. A method chunk is different from a method fragment, since a method chunk includes both a process fragment and a product fragment (Henderson-Sellers & Ralyté, 2010). Method fragments and method chunks are typically extracted from best practices, theory, or ealier defined methods (Henderson-Sellers, Gonzalez-Perez, & Ralyté, 2008).

The method fragments and method chunk are stored in a method base (Harmsen et al., 1994; Rolland & Prakash, 1996; Henderson-Sellers et al., 2008), as described earlier. According to Rolland and Prakash (1996), describes that it is of great importance to include information about the context of use if a method fragment or method chunk is stored in a method base. Context of use is defined as a situation in combination with a decision, thus the information in which type of situation the fragment or chunk is relevant, together with the decision that can be made in that situation (Henderson-Sellers & Ralyté, 2010; Rolland & Prakash, 1996). A situation is defined by Henderson-Sellers and Ralyté (2010) as a combination of a context and a project type.

Assembly-based method engineering is an example of a process that can be used in order to develop a situational method. Assembly-based method engineering entails three steps (Ralyté, 2013):

1. Specify method requirements
2. Select method chunks
3. Assemble method chunks

In order to determine which method fragments are the most appropriate for the given project characterisation, the method requirements need to be defined. Ralyté (2002) describes that two scenarios exist when constructing a novel method. The first scenario entails that the persons conducting a process already follow a given method. Secondly, it might also be possible that currently no regular method is used. Depending on which situation is taking place, a specific method for requirements elicitation is needed (Ralyté, 2002). If a method is already being used, it is of great importance that the current method is being analysed. All current activities should be identified and a decision has to be made if these activities must be included into the novel method, eliminated, or adapted (Ralyté, 2002, 2013). Ralyté (2002) defines this as the *Intention driven strategy*. Another strategy is named the *Process driven strategy*, which is based on the identification of the activities that need to be included in the novel method. These activities are structured to form a specific process, being the process model of the required method. Therefore, the process driven strategy is most suitable when a completely novel method is constructed (Ralyté, 2002).

Since the goal of this research is to design a novel method, the focus is on the process driven strategy. This strategy consists of three steps (Ralyté, 2013):

1. Assessing the project situation
2. Identifying a set of engineering intentions
3. Identifying potential strategies to achieve the intentions

After the process of identifying the method requirements, the method chunks need to be selected. Ralyté (2013) proposes to create an overview of the selected method chunks in a table. In such a table, the method requirements can be coupled to the method chunks. Lastly, the method chunks need to be assembled. Ralyté (2013) describes two methods that can be used in order to assemble the chunks into a method: association and integration. It is mentioned that integration should be used if the goals of the various relevant method chunks are similar. If method chunks have similar goals, their process and/or product models are most probably overlapping (Ralyté, 2013). If this is not the case, the association strategy should be applied.

In order to model a situational method, the process-deliverable diagram (PDD) can be used. As explained earlier, PDD is a meta-modeling technique based on UML activity diagrams and UML class diagrams (van de Weerd, Brinkkemper, & Versendaal, 2010). An example of a PDD is given in Figure 3.4.

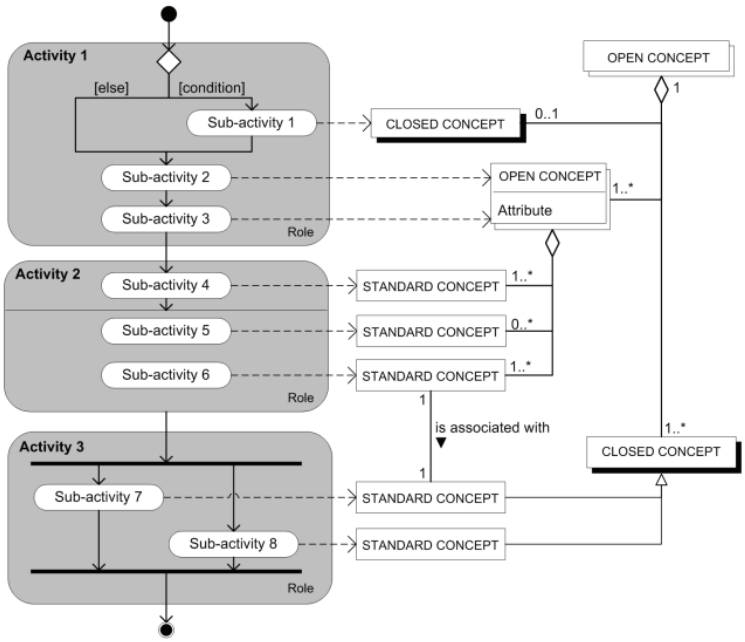

Figure 3.4: Example of a PDD, source: van de Weerd and Brinkkemper (2009)

The process side is shown on the left side of the model, the product side is displayed on the right side of the model. Within the process side, activities are displayed and within the product part of the model, concepts are shown. An activity and a concept can be (van de Weerd & Brinkkemper, 2009):

- **Standard.** A standard activity or concept does not contain further activities or concepts.
- **Complex.** A complex activity or concept does consist sub activities. Complex activities and concepts are divided over two types:
  - **Open.** An open activity or concept is a complex element where the sub-activities or concepts are also shown in the diagram.
  - **Closed.** A closed activity or concept is a complex element whose sub-activities or concepts are not elabourated on in the current diagram. This is done when the sub-elements are not relevant in the context.

Furthermore, most activities take place consecutively. However, it is also possible to model activities that are performed simultaneously. This is visualised with a large black bar, as can be seen in Activity 3 in Figure 3.4. Also, activities can be ordered, and unordered. If activities are ordered, their sequence is defined with arrows. Un ordered activities are visualised without the use of arrows. Figure 3.4 visualises two activities that are unordered: Sub-activity 5 and sub-activity 6. As can be seen at sub-activity 1, an activity can also be modelled as optional. The conditions for such optional activities should be written in square brackets. Aggregation and generalisation can be applied in order to develop different type of associations for the concepts (van de Weerd & Brinkkemper, 2009).

3.3 Expert Interviews

In addition to the literature review, various expert interviews are performed. The reason for performing expert interviews as a supplement to the literature review is to gain supplemental knowledge on the subjects that are relevant for this study. Experts have actual experience with the subjects that are studied during the literature review. Moreover, they might have insights that are not described in scientific literature and could potentially be of importance to know about before the design of a novel solution is drafted. These expert interviews are carried out in a semi-structured manner.

3.3.1 Interview 1

An interview is conducted with an expert in impact assessments and evaluations in the field of education and agriculture, more specifically in the domain of ICT4D. The interviewee was involved as program manager of impact assessments in education, and performed various evaluations of ICT in agriculture. Furthermore, the interviewee was part of various ICT related projects in Ghana. A development project that was aimed at education was described, where equipment was received from the Ghanaian government, as well as the organisation the interviewee worked for. The Ghanaian teachers that were involved in this project only received training about the new technologies, without information on how to apply these new technologies in the educational context. The organisation of the interviewee gave training on ICT-based pedagogy for these teachers. The interviewee mentioned that most governments in West-Africa do train people in IT, but not in education. However, it was mentioned that also training in how to involve ICT in education is of great importance. Next to that, she mentioned that ICT and digital learning can be used to improve the education quality of all courses, not only for ICT related courses. Therefore, it is necessary to support more advanced trainings than basic skills of, for example, how to turn on a computer and how to use Microsoft Word. She mentioned that ICT skills and programming skills are important. Besides that, a teacher program is important to use the knowledge in other elements of education. The ICT skills could for example also be used for administration purposes.

Next to educational development, the interviewee was also active in the domain of agriculture in multiple countries in West-Africa. Since these programs were related to agriculture, the programs mostly took place in rural areas. However, she also worked in the capital, since that is where all the policymakers are located. She conducted various monitoring programs and evaluations for agricultural projects. The interviewee denotes that there is a difference in evaluating on impact level and outcome level. Conducting an evaluation or assessment at impact level is more complicated than on outcome level, since outcomes are based on direct performance, and impact has a wider scope. If there is a focus on a wider impact, it also has to be taken into consideration that other (development) projects or factors can have an influence on the impact. It does not happen often that only one program reaches an impact. In most cases, multiple programs have contributed to the same impact. This is in contrast with an evaluation at outcome level, where performances can considered to be the result of one program. The interviewee describes also other experiences with impact assessment projects. It sometimes happens that an impact assessment project cannot be conducted, because she was involved too late. This led to the fact that

there was no proper baseline for the study to base the actual impact on. The interviewee mentioned that if you want to do an impact assessment, it is most beneficial to start assessing the impact at the same time the project that is to be measured starts. In that way, the improvement over time can be measured correctly. She denotes that there are four moments in time that need to be measured for an exhaustive impact assessment. First, a proper baseline is needed. Then, a midterm assessment needs to take place, whereafter a measurement should take place at the end of the project. Lastly, a year after the end of the project a final measurement should be conducted. Furthermore, the interviewee describes that it is not advised to use a randomised control trial for impact assessments in developing countries. If a randomised control trial is applied, a specific group of people are denied of development, because a stable factor is needed in order to compare with other groups that are developing.

Moreover, the interviewee used various methods for the execution of the evaluations. She mentions that it entirely depends on the kind of assessment you do which method should be used. For example, an evaluation that is done on an educational program needs to be different than an evaluation on an agricultural program. Next to that, it also depends on what the client wants to have measured. In most cases, the *theory of change* of a program is used. Also, a contribution analysis could be performed. The interviewee describes that for every program a situational proposal is written for the evaluation, which means that for every evaluation an adapted method is used. In the experience of the interviewee, the method is based on evaluation questions that are drafted by the client.

Furthermore, in the opinion of the interviewee a combination of quantitative and qualitative data is necessary when conducting an impact assessment. With quantitative data it is possible to measure progress for example, but the qualitative data is necessary for the 'why' questions. She explains that these type of questions are needed to learn from the evaluations for the purpose of development.

During the interview it is also asked which metrics were used in her experience with impact assessments. The interviewee responded that this depended on the type of impact assessment needs to be performed. An example for metrics that were used in education are exam results. However, the risk with this metric is that other factors could influence these exam results too.

Lastly, the cultural factors of conducting an impact assessment in West-Africa are discussed. The interviewee mentioned that there is a gender issue in West-Africa. One of the things she came across is that the ministry wants gender balance in projects. However, she gave an example: "If only ten percent of the teacher is female, always all the women have to attend, and only a small portion of the male teachers have to be present." This can lead to difficulties with finding balanced sample groups. Furthermore, she mentioned that, especially in the rural areas, women tend not to speak up if they are in a group with men.

3.3.2 Interview 2

Another interview is conducted with an expert on digital transformation in education. The interviewee works for the board of a school community of eighty schools in primary education in the Netherlands. Also, the interviewee is a teacher at a Vocational University. He has experience with the digital transformation in education in primary, secondary and higher education.

The interviewee first explained about the current situation of the ICT landscape within the educational domain. In his experience, the use of ICT facilities is used more in higher education than in primary and secondary education. The interviewee mentioned however, that ICT use is increased over the years. Especially when these new technologies became available for use in the educational context, most teachers did not really know how to use it, and sometimes the technologies were even experienced as scary tools. Therefore, most teachers stayed close to their own and familiar educational methods. Currently there is more data available about applying technologies in education. Therefore, these technologies can be applied in an effective manner, and personalised lessons can be given on the level that is needed. The interviewee described that he is not necessarily an advocate of the use of ICT in education. He stated that it is of great importance that the technologies are all applied in an effective and correct manner. If this is not the case, a digital transformation may be less valuable, or not valuable at all.

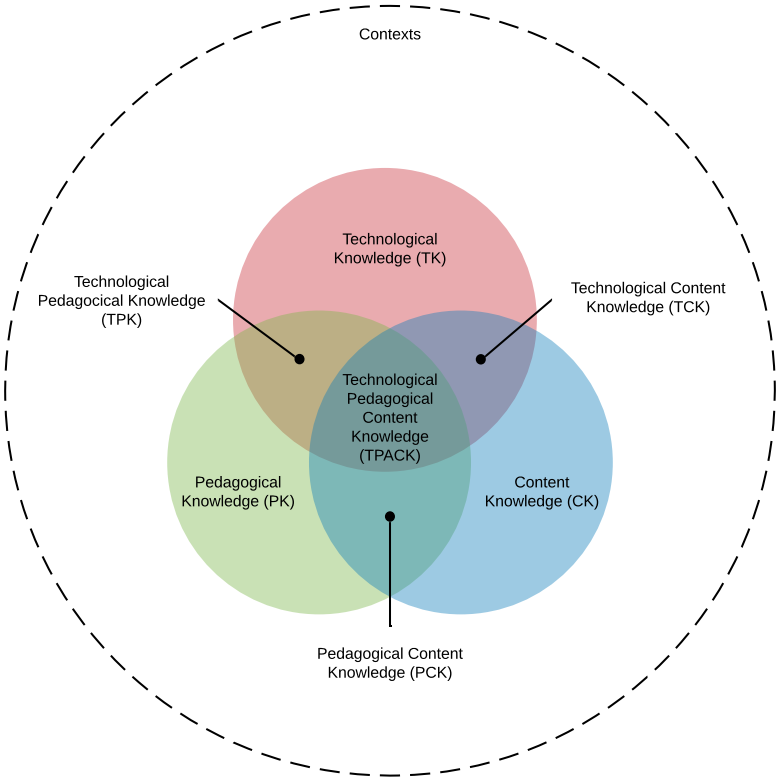

Figure 3.5: TPACK model adapted from Koehler and Mishra (2009)

The interviewee referred to the TPACK model, proposed by Koehler and Mishra (2009). The TPACK model describes the understanding of teachers about the educational technologies. Furthermore, the it describes the importance of the interaction between different domains in order to apply technologies in education in an effective manner (Koehler & Mishra, 2009). The model, as displayed in Figure 3.5, contains three main components. These three components all represent knowledge of teachers, being content, pedagogy, and technology. Next to that, the interactions between these bodies of knowledge are visualised. These interactions are displayed as the technological pedagogical knowledge (TPK), the technological content knowledge (TCK), and the technological pedagogical content knowledge (TPACK) (Koehler & Mishra, 2009).

The content knowledge (CK) refers to the knowledge of the teacher about the subject and material of the subject that is to be taught. The pedagogical knowledge (PK) refers to the knowledge of the teacher about the methods of teaching and learning. PK is about the knowledge of how students learn, classroom management skills, lesson planning and student assessment (Koehler & Mishra, 2009). The pedagogical content knowledge refers to the transformation of the subject matter to the process of delivering it to the students. The technology knowledge (TK) refers to the knowledge the teacher holds about the ICTs that are relevant in the educational domain. If all knowledge is applied together, TPACK is achieved (Koehler & Mishra, 2009). The interviewee described that the education can be less successful if TPACK is achieved. Education might be of greater value if TPACK is achieved, provided that it is applied in the correct manner. If this is not te case, it can even be possible to lower the quality of the education. The interviewee described this in order to explain the importance of the quality of applying the technologies in education. For example, if a teacher does not have the knowledge on how to effectively apply ICTs in his teaching practices, the way subject matter is delivered to the students might be less effective, thus lowering the quality of the education. Furthermore, there is a great circle around the three main knowledge bodies, which represents the context. The interviewee mentioned that the context is especially important for Ghana, and developing countries in general. He gave the example of rain in these countries in rural areas. For some reason, heavy rain can disturb the internet connection in these areas. Even if the TPACK model is applied in a correct manner but the context of the educational system, which is heavy rain in this example, does not allow for the education to be carried out, the model is also worthless.

After that, the interviewee described the SAMR model, introduced by (Puentedura, 2010). The model consists of four layers:

Enhancement:
- Substitution
- Augmentation

Transformation:
- Modification
- Redefinition

The first two layers are part of the transformation phase, and the second two layers are part of the enhancement phase. The interviewee mentioned that when technology

is applied initially, it will first used as a substitute. He gave an example of the digital blackboard. Initially, the digital blackboard would be used instead of an old chalkboard. In most cases however, a whiteboard or chalkboard would still be used next to the digital blackboard, so no functional change is carried out. Then, the augmentation phase would take place. In this phase, an addition is made to the new technology. For example, the digital blackboard would be used to watch educational videos in a plenary form, creating a functional improvement to the way of teaching. However, still all students are taught in the same manner and pace. The interviewee mentioned that it is getting interesting when modification and redefinition can be applied. In that way, a teacher is able to give lessons in another form, supported by the novel technologies. The interviewee explained that only when redefinition takes place, technologies are implemented in a way that it is most effective. Therefore, the full potential of ICTs can only be achieved if all these steps are ran through.

After that, the interviewee is asked about the potential risks that are included with the integration of ICTs in education. The interviewee mentioned that the expectations of novel technologies can be enormous. He described that it takes time for a new technology to find its place in a context environment, being an education environment in the scope of this research. Therefore it is important to think about the right moment to start adopting a novel technology. The interviewee referred to the hype cycle of Gartner[1], which is introduced in 1995 (Linden & Fenn, 2003). Linden and Fenn (2003) describes that the typical progression of an emerging technology is characterised. The hype cycle explains that when a technology is introduced, one takes a higher risk if it is adopted right away. However, if a technology is on the market for a longer time, the risks of adoption are lowered, since individuals in the domain are more used to the novel technology. The interviewee however also mentioned that if a technology gets "old", the should be replaced by a new one. If a technology reaches this stage, the risks will increase again.

The interviewee described that an introduction of a new platform or application is doomed to fail if only monetary support is given. It is also of great importance to invest in expertise, so that individuals know how to handle the new product. Therefore, training for teaching is an important investment according to the interviewee. However, not every teacher learns as quickly as the other. Therefore he mentioned that such training should be offered in a differentiated manner. Such a training should also be about taking away the fear of the technology, and the growth of confidence with the technology. Next to that, the interviewee described that it is important to have a clear picture of your vision of why the technology should be implemented.

In conclusion, the interviewee stated that quantitative terms are not that important in the digital transformation in education. The way novel technologies are applied is the essential element.

[1] https://www.gartner.com/en/research/methodologies/gartner-hype-cycle

3.4 Conceptual Overview Research Domain

In Figure 3.6 a semantic net is shown, containing the key concepts that are identified in the problem investigation phase. Both the exploratory and systematic literature review are taken into account, as well as the expert interviews. The decision is made to only include the most important concepts in the semantic net. If all identified concepts are displayed in the figure, the clarity of the figure would be lost. The semantic net aims to visualise the relationships between the key concepts. In this manner, also the relations between the three research domains are visualised.

Furthermore, the way in which method engineering is applied in this research is discussed. In general, method engineering is an approach that is applied in the domain of software engineering (Brinkkemper, 1996). However, the approach also lends itself greatly for the design of methods outside the scope of software engineering. Therefore, method engineering is applied in this research in order to develop a solution in the form of an impact assessment in the domain of ICT4D and education. For example, for the solution that is proposed by this research, the concepts *method fragments*, *method base*, and *incremental method evolution* are used. Furthermore, the PDD notation is used as a means to visualise the evolution of the method. Moreover, the subjects *impact assessments* and *digital learning transformation* are applied in the research as content knowledge for the impact assessment method, whereas the subject *method engineering* is applied as an approach to develop a novel situational method.

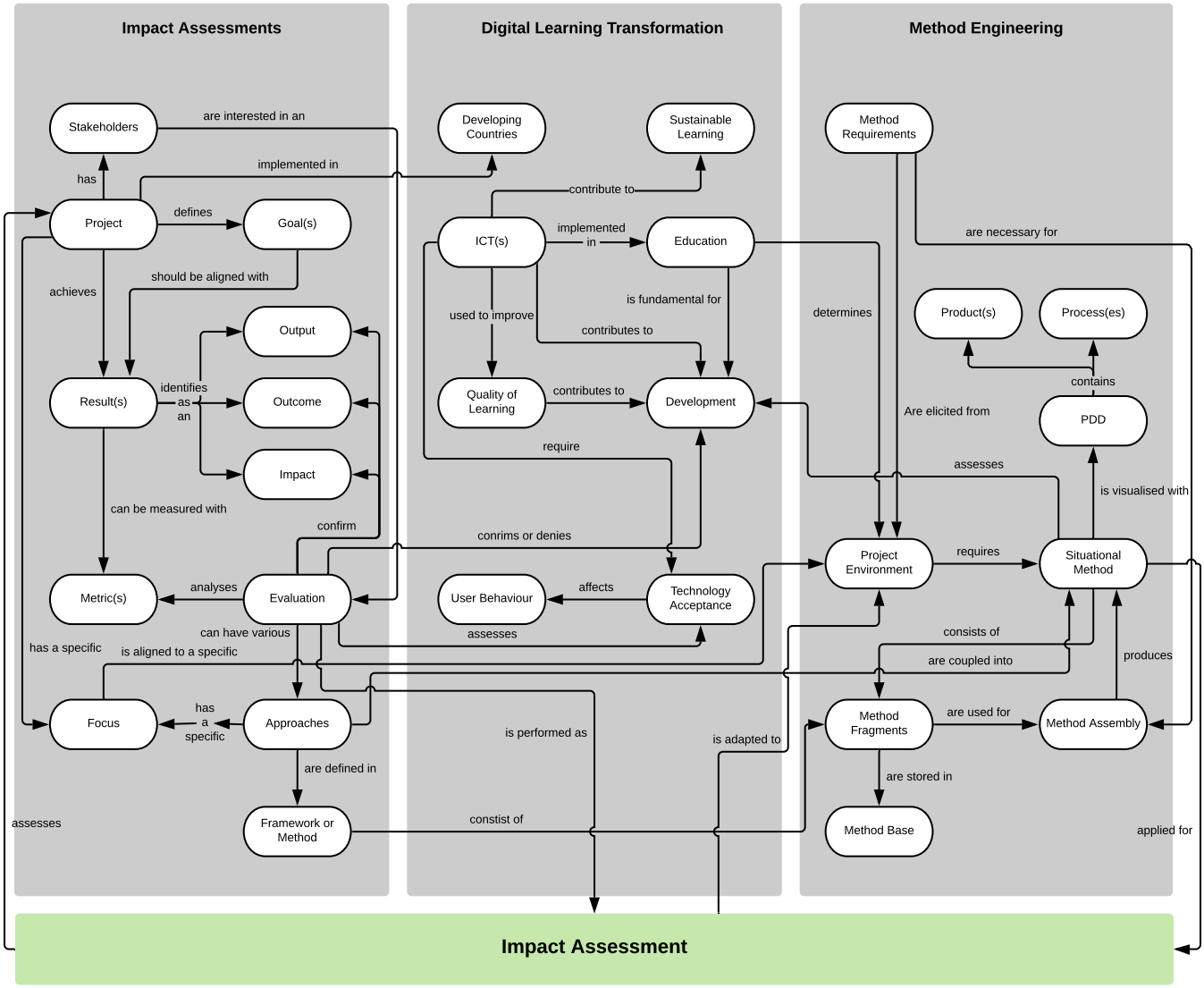

Figure 3.6: Semantic net of key concepts, derived from problem investigation phase

Chapter 4

Design of the Situational Impact Assessment Method

This chapter describes the treatment design of the situational impact assessment method. The process of designing the method consists of various steps. First, the requirements for the method are elicited. These requirements are collected by identifying stakeholder goals through stakeholder interviews. After that, the design of the method is described. All design decisions are explained in this chapter, and the first iteration of the method is discussed.

4.1 Requirements Elicitation

In order to identify the requirements for the impact assessment method, seven stakeholder interviews are performed. These stakeholders contributed insights from various backgrounds of expertise and experience. Stakeholder goals are elicited from these interviews, which are all united in a goal model. After that, these goals are translated in to method requirements which are applied in the design process of the impact assessment method.

4.1.1 Stakeholder Identification

In order to identify the stakeholder goals, first a set of stakeholders needs to be selected. This set of stakeholders should represent the entire population of relevant stakeholders, and need to be selected with care. This process is called Stakeholder Identification (SI) (Sadiq & Jain, 2014). First, a definition of a stakeholder needs to be defined. Freeman and McVea (2001) define a stakeholder as any group or individual which is affected by, or either can affect the achievement of the objectives of an organisation. Wieringa (2014) describes that stakeholders are the source of goals and constraints of a project, and thus the source for requirements in the treatment. Therefore, in the context of this research, individuals are sought that could support in the creation, or be affected by the achievement of a successful impact assessment method for development projects in the domain of education. In that way, useful requirements can be collected for the novel method.

Various types of individuals are identified to be of importance and a valuable addition to the set of stakeholders for this research. These types are selected during a brainstorm session together with two individuals that are active within Maxim Nyansa (D. van der Stelt S. K. Dankyira, personal communication, May 4, 2020). It was assumed that an exhaustive set of relevant stakeholder types could be drafted in this way. The list of relevant types of stakeholders is as follows:

1. Individuals with experience in development projects (if possible in West-Africa and/or in the domain of education.
2. Individuals with experience in performing impact assessments or evaluations (if possible on development projects).
3. Individuals with pedagogical knowledge and experience in education.
4. Individuals with knowledge about the educational environment and school system in West-Africa.

It is assumed that it is of importance to reach stakeholders with experience in development projects (preferably in West-Africa), since the goal is to design a method which evaluates on these type of projects. It is assumed that such individuals can contribute to the requirements elicitation process by sharing their experiences with development projects. Furthermore, experience in performing impact assessments is also assumed to be a valuable asset in the requirements elicitation process. Individuals that have experience with impact assessments could be able to provide information and experiences which are not captured in literature. Next to that, individuals with pedagogical knowledge and experience in education are identified as a relevant type of stakeholder, because this research is focused on development projects in the educational domain. Therefore, it is concluded that knowledge and experience in a pedagogical context could contribute to the method design process. Such individuals might be able to point out important aspects that should be taken into account when evaluation in the educational domain, and might not be relevant in other domains. Lastly, individuals with knowledge about the education environment and school system in West-Africa specifically are identified to be relevant stakeholders. The educational environment is not the same everywhere in the world. Therefore, some local experts in the field of education are assumed to be a valuable contribution to the list of relevant stakeholders.

4.1.2 Stakeholder Interviews

Based on the identification of possible relevant stakeholders, seven individuals are contacted. Therefore, seven semi-structured stakeholder interviews are carried out. An interview protocol is developed for these interviews, which can be found in Appendix C. The goal of these interviews is to elicit specific stakeholder goals of an impact assessment, and the argumentation on why those goals are important for such a project. Furthermore, the interviews are asked about which factors of measurement would be interesting to the stakeholders.

The individuals that are interviewed have a wide range of experience and backgrounds in various subjects. One of the interviews is conducted with two interviewees at once. The other six interviews are performed with only a single interviewee. So in total eight different stakeholders are consulted during this phase of the research, of which four have the Dutch nationality and four have the Ghanaian nationality. The eight interviewees are indicated with a letter (A-H). An overview of the interviewees is displayed in Table 4.1. The numbers in the table refer to the enumeration given in Section 4.1.1. If a cell is marked grey, the specific interviewee has experiences mentioned in Section 4.1.1. As can be seen in Table 4.1 is that only one interviewee has experience in performing impact assessments or evaluations. This is not identified to be an issue for the research. The

interviews are performed to identify goals from the different stakeholders in order to make informed decisions for the design of the novel impact assessment method. If the stakeholders actually have experience with the performance of such evaluations, it is viewed as a plus. Interviewee A has experience with development projects in East- and West-Africa. He works for an organisation in East-Africa, Kenia, and Tanzania, which is mainly focused on education and digital literacy. Also, this interviewee is part of the board of a computer school in Ghana. Interviewee B is one of the board members of Climbing the Right Tree (see Section 2.2). She is also experienced with development projects within Europe and in Africa. Then, interviewee C and D are part of an organisation that built computer labs in Ghana. Also, computer education is provided by this organisation for people in the surrounding areas. So, these two interviewees are also experienced with development projects in the domain of education and ICT implementations.

Furthermore, interviewee E is a founding director of a technology company in Ghana, which has the role of developing websites and software. Next to that, he has a job as a lecturer at a university in Ghana and he takes part in development work with various NGOs. Therefore, this interviewee has a combination of knowledge in different fields, being technological development projects, and education. During the stakeholder identification it also came forward that knowledge about the educational environment and school system in Ghana is relevant. Therefore, a public relations officer of the Ghana Education Service is interviewed (Interviewee F). The role of this interviewee is to communicate and get the various stakeholders that are involved in education delivery to understand the policies of the government and the Ghana Education Service. Next to that, the interviewee is involved in various running development projects with the role of project manager or consultant. Interviewee G is the director of Maxim Nyansa and appears as a product owner of learning transformation projects in Ghana. He also as a background as a teacher in Ghana. Lastly, interviewee H is active as a teacher at a senior high school in Ghana and is actively involved in development projects.

Table 4.1: Overview interviewees stakeholder interviews

ID	Nationality	Type of Organisation	Role	1	2	3	4
A	Dutch	Development organisation	Freelance / supporting staff				
B	Dutch	Development organisation	Co-founder and Managing board				
C	Dutch	Development organisation	Managing board				
D	Dutch	Development organisation	Managing board				
E	Ghanaian	ICT Company and Technical University	Founding director and Lecturer				
F	Ghanaian	Ghana Education Service	Public relations officer				
G	Ghanaian	Development organisation	Co-founder, Director, Product owner				
H	Ghanaian	Senior High School	Teacher				

4.1.3 Stakeholder Goals

Two types of goals are identified during the interviews: development project goals, and impact assessment goals. During the interviews the interviewees were asked to discuss their perspective on goals for an impact assessment method. Next to that, goals they could come up with for development projects were also asked about, so that these goals could be aligned with each other. Since this research has the aim to develop an impact assessment method, the impact assessment goals are of greater importance. However, both type of goals are discussed, since the development project goals also brought some relevant insights for the research, which are described in the next section. Including the development project goals was assumed to be of importance because these goals also need to be taken into account while designing the impact assessment method. No direct requirements are elicited from these project goals, but the novel impact assessment should not neglect or counteract the goals of development projects.

Development Project Goals

The development project goals that are discussed here do not represent an exhaustive set of goals. The stakeholder interviews did not have the direct aim to collect development project goals. However, some of the goals described below were mentioned during the interviews and provided some interesting insights which could be used during the design

process of the impact assessment method. As mentioned before, an impact assessment method should not work against the goals of a development project. Next to that, some development project goals described in this section can be

Improve human capital One development project goal is to improve the human capital. During the interviews it was mentioned by interviewee A that some cities in Africa are quite large. In these cities, normal jobs can be found as we know them in Europe. Interviewee A mentioned that it would positive for the local economy and population if these jobs could be performed by local individuals from Africa. A job at a large technology firm does have brighter career perspectives than selling bottles of water on the streets. Large organisations in Africa are growing, and interviewee A mentioned that is of great importance to fill those vacancies with local employees, instead of importing employees from higher developed countries, since the development of local individuals will stay behind in that way. Interviewee E also highlighted the importance of improving human capital. In addition, a subgoal of improving human capital is to improve the life or lifestyle of local individuals. Interviewee G described that most development projects have the goal to improve the human capital of local beneficiaries. This could be done by improving their skills or their livelihoods, depending on what the exact goals of the project are. Interviewee G also mentioned that some projects directly incline towards the lives or lifestyle of people in Ghana. When he described some development projects he was involved in, he mentioned that each stage of each project is designed with a people centred point of view in mind.

Let as many children as possible follow lessons with computers Interviewee D described that one of the general goals of their specific development project is to let as many children as possible follow lessons with computers. In many schools in Africa it is still the case that students receive ICT lessons from a book or a poster. In that way, the theory of ICT is learned. However, in that way it is not possible to teach about ICT in practice. In many cases, students pass their ICT exam without having ever touched a computer. That is mostly the case in the primary schools. Another important nuance in this project goal is that as many children as possible should follow lessons with a computer, not necessarily computer lessons. Almost every course can be supported with computers in order to add to the interactivity of the education.

Let children discover the possibilities of ICT Another goal of ICT related development projects that is mentioned by interviewee C is to let children discover the possibilities of ICT themselves. Some of the children will pursue a career where no ICT knowledge is needed. However, some children are very clever and might want to start a business in ICT. Interviewee C mentioned that it is creating conditions to let children decide themselves if they want to pursue something with ICT in their future. She stated that is is of great importance to let the children discover themselves what the possibilities of ICT are, and let them make the decisions themselves to use it.

Let locals impact their own environment This goal has some overlap in being a project development goal and an impact assessment goal. Interviewee A mentioned that is essential that young people actually grow in their personal development. In that way

they can make sure that they will obtain good jobs. Consecutively they can be of impact on their own environment.

Make impact on the ground Interviewee G is actively involved in development projects in Ghana and he mentioned that they do not want to develop anything that they feel is the right thing to do. It is not about feeling, but it is about the actual impact on the ground. He mentioned that every single project that comes up must be able to impact the people directly, not just the top. He mentioned that having ideas is one thing, but actually performing the action and directly impacting the individuals on the ground is the most important aspect.

Mastering 21st century skills This is a goal that came up during multiple interviews. What you see in various West-African countries is that the education is very directive, meaning that the teacher is in front of the classroom and is explaining everything. Interviewee A, B, and G mentioned that one of the goals is to develop 21st century skills. Interviewee A explained these skills as the ability to be a critical thinker, working together in groups, and asking questions. This interviewee therefore referred to changing the directive education to a more interactive form. It was also mentioned by him that young people can actually develop their personal skills in that manner, so that they can obtain well-paying jobs later in their career. Interviewee B described that one of the main goals of their development projects is to improve digital skills and 21st century skills. She described these skills as creativity, working together in groups, working cross-cultural, problem solving, and digital literacy.

Sustainable Development Goals The sustainable development goals were also mentioned by interviewee B as driving forces for development projects. The sustainable goals are no direct goals, but every sub-goal that contributes to one or multiple sustainable development goals have the aim to improve the personal situations of local individuals.

Stimulate careers of locals Lastly, stimulating careers of locals was described by interviewee A as an important development project goal. This goal is already slightly touched upon in goals that are described earlier. This is an important goal, because it is essential that locals can find jobs in their own community. There is a large demand on well educated persons, also in Africa. It is described that one of the goals of development projects aimed at education is to stimulate the careers of locals so that the vacancies at organisations can be filled with locals.

Impact Assessment Goals

As mentioned before, the aim of the stakeholder interviews was to identify the stakeholder goals of an impact assessment method on development projects in the educational domain. In this section, all the impact assessment goals that are mentioned during the stakeholder interviews are defined. For each impact assessment goal the argumentation as described by the interviewees is specified.

Confirm if project goals are met Interviewee E mentioned that one of the main important goals is to find out if the development project actually yields results. He mentioned that he has worked with a number of development projects for some years. He sometimes looks back at the end of a project and feels like no proper results are achieved. In most cases, there is a good result for documentation and consultation, but there is no real impact. So he mentioned that he really wants to be sure that what is stated in the initial goals is actually achieved at the end of the project: achieving what is intended to achieve. Interviewee F described a successful impact assessment as an evaluation that explains what the project is intended to achieve, if these goals are achieved, when the goals are achieved, and how it influences the behaviour of the people. He stated that it is important to not only see if the project is adopted in the context of the project itself, but also if it is adopted in their actual lives.

A sub-goal of confirming the achievement of project goals is to confirm if actual improvement took place. It is mentioned by several interviewees that for them an impact assessment is successful if you can prove that the interventions that are carried out actually have an effect. This effect could be expressed in various forms, also depending on the type of development project that is assessed. Interviewee B mentioned that it is desirable to prove that the lives of the children that went to school in a place that received a development intervention actually are improved. This could be expressed in having a more positive mindset, having more confidence, and independent from others in their thinking and daily practice. Interviewee E explained that he wanted to be sure that there is an improvement in the human capital, in the sense that people got an improvement in either their skills or their livelihoods, depending on whatever the project was. He also explained that, especially for the African context, the weight of the community is quite high. Therefore it is of great importance that is confirmed with a community leader that there was an actual substantial benefit from the implementation of a project and if the project made an impact on the lives of the individuals within the community. Furthermore, behavioural change was identified to be of great importance in improvement within a community. Therefore it was mentioned by interviewee F and H that it would be very interesting to measure behavioural change. It was discussed that if the behaviour of individuals is changing, then definitely learning will start taking place.

A second sub-goal of the confirmation of the achievement of project goals, mentioned by interviewee E, is to confirm that no negative consequences are left behind. Interviewee E gave the following example: If you have given a school some technological solution, did you unintentionally introduce some e-waste? Or, do you unintentionally influence some change in behaviour that is undesired? He described that a development project might have some negative consequences in a community or environment. Often, these negative consequences are overlooked, because there is a direct focus on all the positive changes of the project.

Confirm impact towards funders The goal to confirm the impact of the development projects towards funders is also mentioned by interviewee A and B. Fundraising is not the main aim of the impact assessment, but in order to qualify for big funds, the impact and results of a project must be proven. Interviewee B mentioned that at their development organisation, many potential beneficiaries are on the waiting list. However, there is a need

for large capital in order to let the organisation grow and expand to other areas. This could be fulfilled if the organisation is supported by large funders. However, before these funders will open up their monetary support, first the impact of the development projects need to be confirmed. That is where a validated impact assessment method could be very helpful. Such a method could verify if the development project actually has a desirable effect.

Create advice for managers Another sub-goal of the impact assessment that is identified during the interviews is to be able to give advice to the project managers of the development project. It was assumed by interviewee E that the results of an impact assessment are very specific, in a sense that less assumptions need to be made in future decisions about the project, or even future projects. In other words, the results of the impact assessment could contribute to advising project managers about current or future development projects.

Improve the project Creating advice for managers directly contributes to the goal of improving the project, and the same argumentation as described for the goal of creating advice for managers could be given for this goal. The results of the impact assessment could be used to improve the project. An impact assessment could provide insights in ways the community or environment is affected by a specific development project. If some undesirable effects are being measured, or some effects could be even improved upon, the project managers can use these data to guide the development project in a specific direction. Furthermore, three of the interviewees (A, B, and F) directly pointed out that project improvement is a very important goal of an impact evaluation.

Realise an overview of the current situation It was also mentioned by interviewee F that the data that is collected during an impact assessment could be used to create an overview of the current situation within the educational domain. The output of the assessment (i.e., the data) could be used as a means to monitor the current situation. Furthermore, if the current situation in the educational domain of a country or community is mapped and various development projects are performed, the data could later on even be used for prediction purposes. In order to make a better estimation of the effect of a specific development project, some prediction analysis could be carried out based on the results of earlier development projects with the same characteristics.

Develop the organisation Next to the improvement of the project, also the goal of developing the development organisation itself is mentioned. Interviewee G described that the performance of an impact assessment provides the opportunity to plan. In that way you know where you are going wrong, where you are going right, and what is needed for you to move forward. He believes that having an impact assessment is key for the development of every single aspect of an organisation.

Establish awareness at ministry of education One of the goals that is identified during the interviews is to create awareness at the ministry of education. In most West-African countries, it is not top priority at the ministry of education to actually improve

or change the education system. Interviewee G described that it is their dream that the ministry of education will be able to see how positive particular impacts of their projects are on the ground, and that they will be able to fuse part of it, or maybe even all of it, in the general educational system. By performing impact assessments on the development projects, he described to be a step closer to this dream. Interviewee D also mentioned that the ministry of education should be included. It is the job of the government to improve the education. Furthermore, interviewee H mentioned that it is of great importance to show educational stakeholders the need to provide all Ghanaian senior high schools with effective computer labs.

Next to that, another goal that is rather equal to this one is to show educational stakeholders the need of computer labs. At the moment, most stakeholders in the education sector do not see the need to provide all Ghanaian schools with computer labs, and that is problematic.

Achieve transparency for sponsors and donors The goal of creating transparency for sponsors and donors seems to be similar to the goal of confirming impact towards funders. This is not entirely true. Non-governmental organisations like Maxim Nyansa need to rely on sponsors and donors to be able to keep the organisation running. Sponsors are organisations or individuals that support the organisation by voluntarily donating money to the organisation. Donors, in the case of Maxim Nyansa, are the organisations or individuals that donate their hardware (e.g., personal computers, laptops, and smartboards). Creating transparency about the development processes is very important, as mentioned by interviewee B and G. From the perspective of a sponsor or a donor it is pleasant to being able to see what is being done in practice with the support they gave. In that sense, an organisation might also increase the incentive of potential sponsors or donors to support the organisation. Moreover, interviewee B described that being able to show a donor what is being done with the computers he donated, and what the effects of his donation are should be a no-brainer.

Realise the independence of data availability It is also mentioned that the method should work even when there is little data available. Interviewee B denoted that it can be the case that for some elements no conclusion could be drawn if no data is available. Interviewee G described that it should be easy to work on something without all the data. With only little data, it should still be achievable to define the impact of a project. It might be the case that the conclusion is less robust. However, the accessibility of data could be problematic in developing countries, so that should definitely be taken into account.

In addition, it was discussed during the interviews with interviewee B and interviewee G to divide the method into various sub-parts. It was mentioned by the interviewees that this would be a good solution for various reasons. First, one of the interviewees that it would be easier to reach a broader population in the data collection process. Second, if less data is available for a part of the method, some assumptions might need to be made based on equal schools. However, having the method divided over sub-parts creates the opportunity to scale down the results and give insights into which part of the development project has which specific impact.

Prove long term outcome Another goal that is mentioned by interviewee C that is in line with the goal of this research, is to prove the long term outcome of the development project. She described that the long term effects are definitely more interesting than the short-term effects.

Executable by locals It is also mentioned that the task of performing the assessment should be executable by locals. It is not going to be only one person that is performing the assessment within an organisation, but interviewee B explained that it should be easy enough to be carried out by every person within the development organisation. However, interviewee A mentioned that if this is the case, very elaborate and clear instruction is necessary.

Prevent the use of technical terms The use of technical terms should be prevented in the impact assessment method. That is another goal that is identified. This goal aligns with the previous goal. If the method should be executable by locals, interviewees A, B, E, and G mentioned that also the use of technical terms should be limited. In this way, the barrier of starting an impact evaluation is lowered. Interviewees A, B, and E described that the use of jargon should be limited.

Achieve the measurement on how people are affected Another main goal that is identified is to find out how people are affected. The emphasis should really be put on the "how", not only the "if". Interviewees E, G, and H mentioned that an impact assessment should not only assess whether beneficiaries are effected or not, but also in what sense they are affected. In order to do so, the measurement of behavioural change is mentioned during multiple interviews.

Realise the inclusion of external factors If impact is proven, interviewee B described that in many cases there are also external factors that could have been of influence on these results. Interviewee A gave an example in education. For example, he has experience with the grades of students being used as measurements. Often, the grades of the students will rise after the implementation of a development intervention. However, external influences could have also had an effect on these grades. There are always situations where there is a more stable situation in a specific school because a teacher is retained, instead of a teacher leaving for example. But it is always difficult to prove an event like that to be of influence.

Realise a check to confirm approach adoption Another goal that is mentioned is rather straightforward: checking if the approach is adapted. In most development projects a specific approach is used or implemented. Interviewee F and G mentioned that the main goal of an impact assessment is to see if the approach that is implemented is actually adopted by the educational institutions. If an approach is adopted, the ways of working are intertwined in the normal practices, and that the novel approach becomes a new default.

Realise the independence of technology The last goal that is elicited from the interviews is that the method should be independent of technology. In some areas in West-Africa there is no availability of electricity. Such a situation can make it difficult to collect data with technological support. In that sense, the method should be able to adapt to the situation and use pen and paper to collect data locally for example. Furthermore, interviewee E described that if you want to use technology to collect data, or you want to use technology to communicate with the key stakeholders, or even if you want the data to be collected by some internet based system, then technology could really become a barrier. It is also mentioned by interviewee F that around seventy percent of the entire population in Ghana is covered with electricity. So it is around thirty percent that does not have access to electricity. There is a large number of schools in the communities without electricity. Therefore, record keeping is very poor. Even if the record keeping is being performed manually, many challenges exist. Also, these individuals are not technology inclined. So using technology to collect data can become a problem in that sense. And even if technology is available, not all individuals in these areas have the skill to make meaningful information out of these data. Various interviewees (A, B, E, F, and G) described that the default option should be to use a technological solution for the data collection, but also a back-up plan should be in place which could be used if the use of technology is not a feasible option. Furthermore, it is also discussed by interviewee B that the method should work without the availability of a working internet connection. Not everywhere in West-Africa, especially in rural areas, internet is available.

Goal Model

In order to create an overview of all the goals that are identified, a goal model is created. The multi-perspective Goal Modelling Language (GoalML) is used for the design of the goal models (Overbeek, Frank, & Köhling, 2015). GoalML can be used to determine the hierarchy in goals, and more importantly, which goals are similar (Overbeek & Janssen, 2015). GoalML includes a large set of visual symbols which can be used to add extra information to the goal models. However, not all the symbols are necessary to be used in the context of this research. Therefore, only a small set of extra symbols is added to the model. The clarification of Köhling (2013) about all the different symbols is used in order to design the model.

All the impact assessment goals that are identified during the stakeholder interviews are visualised in the goal model (Figure 4.1). The overarching goal of performing an impact assessment is to increase the impact of a development project. All the other identified goals contribute to the achievement of this goal. Therefore, “increase impact” is the goal with the highest priority. During the interviews, interviewees were asked about the level of importance of the goals they described. However, it was not possible to prioritize one goal over the other. It became clear that most interviewees strived for the achievement of every single goal in order to let this impact assessment be successful.

The goal model contains two types of goals: engagement goals and symbolic goals. An engagement goal is a specific goal which could be indicated with time and responsibility mappings. It is used for the visualisation of specific goals, which can directly be measured using specific metrics. In other words, an engagement goal is a goal of which the desired

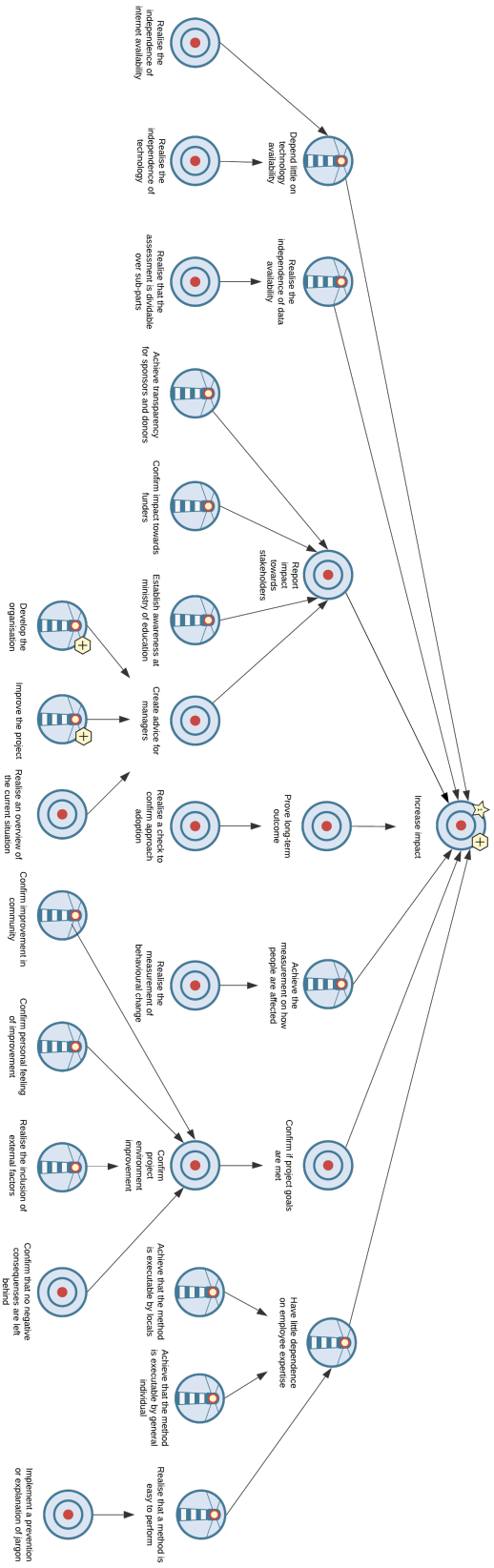

Figure 4.1: Goal model of stakeholder goals

result is quantifiable (Köhling, 2013). A symbolic goal is a goal with a more abstract form, where no time specifications or responsibilities can be ascribed. Thus, symbolic goals are goals where no specific metrics can be defined to measure that specific goal. In other words, a symbolic goal is a goal of which the desired result is not directly quantifiable, and includes a qualitative aspect (Köhling, 2013). The two types of goals are shown in Figure 4.2.

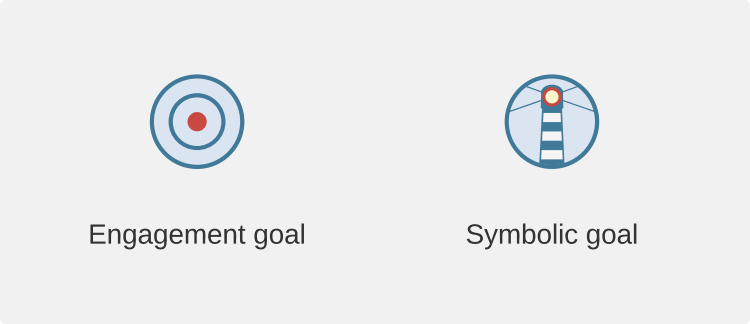

Figure 4.2: Types of goals in the GoalML modelling language

The goal model visualises which goals are similar. For example, the goals "develop the organisation" and "improve the project" are both goals that contribute to the goal of creating advice for project managers. Also, confirming an improvement in a community, realising the inclusion of external factors, and confirming that no negative consequences are left behind, all contribute to the goal of confirming that the project environment is improving.

4.1.4 Method Requirements

The goals that are visualised in the goal model (Figure 4.1) are translated into requirements. Wieringa (2014, p.51) defines a requirement as "*a property of the treatment desired by some stakeholder, who has committed resources (time and/or money) to realize the property*". The aim is to keep the requirements for the method as close to the goals as possible, so that the input of the stakeholders is followed closely. In that manner, the theory of Wieringa (2014) is followed, which describes that the requirements should contribute to the goals. In order to do so, the stakeholders are translated into the requirements for the impact assessment method. The translation is shown in Table 4.2. Every goal and requirement are being denoted with a code identification for reference purposes.

Table 4.2: Translation of stakeholder goals to requirements

#	**Goal**	#	**Requirement**
G1	Depend little on technology availability		
G2	Realise the independency of technology	R1	The method must also be executable without the use of technology
G3	Realise the independency of internet availability	R2	The method must be executable without a working internet connection
G4	Realise the independency of data availability	R3	The method must be executable with different levels of data availability
G5	Realise that the assessment is dividable over sub-parts	R4	The method must be dividable over different sub-parts without interdependency
G6	Report impact towards stakeholders		
G7	Achieve transparency for sponsors and donors	R5	The method must be transparent towards stakeholders, sponsors, and donors
G8	Confirm impact towards funders	R6	The method must report on impact measures which are relevant for funders
G9	Establish awareness at ministry of education		
G10	Create advice for managers		
G11	Develop the organisation	R7	The method must report on factors which can be implemented by project managers to improve the project to be assessed
G12	Improve the project	R8	The method must report on factors which can be implemented by project managers to improve the organisation
G13	Realise an overview of the current situation	R9	The method must report on the current status of the project to be assessed (AS/IS)
G14	Prove long-term outcome	R10	The method must report on the long-term outcomes of the development project to be assessed
G15	Realise a check to confirm approach adoption	R11	The method must confirm or disprove that the project to be assessed is fully adopted or not

Continued on next page

Table 4.2 – *Continued from previous page*

#	**Goal**	#	**Requirement**
G16	Achieve the measurement on how people are affected	R12	The method must measure the means in how people are affected by the project to be assessed
G17	Realise the measurement of behavioural change	R13	The method must measure the behavioural change of the people that are affected by the project to be assessed
G18	Confirm if project goals are met	R14	The method must confirm or disprove that the project goals are met
G19	Confirm project environment improvement	R15	The method must confirm or disprove the improvement of the project environment over time
G20	Confirm improvement in community	R16	The method must confirm or disprove the improvement of the community within the project environment over time
G21	Confirm personal feeling of improvement	R17	The method must confirm or disprove that stakeholders and beneficiaries personally experience improvement
G22	Realise the inclusion of external factors	R18	The method must confirm or disprove that impact is achieved without the influence of external factors
G23	Confirm that no negative consequences are left behind	R19	The method must prove or disprove the absence of negative consequences of the project to be assessed
G24	Have little dependency on employee expertise	R20	The method must be independent of the expertise of employees
G25	Achieve that the method is executable by locals		
G26	Achieve that the method is executable by general individual		
G27	Realise that a method is easy to perform		
G28	Implement a prevention or explanation of jargon	R21	The method must prevent the use of jargon OR contain an explanation of jargon

Not every goal can directly be translated into a method requirement. G1 is very similar to G2 and G3. However, G2 and G3 are more specific, and defining a requirement for G1 would result in redundancy in the final set of requirements. Therefore, G1 is not directly translated in a requirement. This goal is captured in the requirements R1 and R2, which are translated from G2 and G3. A similar situation occurs for G6. The goal of reporting impact towards stakeholders is a very high-level goal, and is already captured in the requirements defined for various other goals. For example, R5 states that the method must be transparent towards stakeholders, sponsors, and donors. This requirement contributes directly to G7, but also contributes to G6. Furthermore, the goal of establishing awareness at the ministry of education (G9) is argued to be out of the scope of the impact assessment method. The results of an impact assessment could be described in a document which could create awareness at a ministry of education. However, a development organisation must discuss internally how the results of the impact assessment are applied. Using the results to approach a ministry of education is a step in the process after the impact assessment has been carried out. Therefore, this goal could not be translated into a requirement for the impact assessment method. Then, G10 is also a high-level goal which is divided over various other goals. Therefore, all the requirements that are defined for the sub-goals of G10 already contribute to the goal of creating advice for managers. Therefore, no requirement is defined for this goal. Lastly, G25, G26, and G27 do not result in a requirement for the impact assessment method, since all these goals refer to employee expertise, which is captured in R20.

Additional Requirement

Next to the requirements that are derived from the stakeholder goals, one additional requirement is defined for the novel impact assessment method. The goal of this research is to design a situational method for the performance of an impact assessment method on development projects in the educational domain. The aim is to design a method that is not focused on a specific project context, but a method that can be applied to as much development projects in the educational domain as possible. Therefore, the method should be generalised, and should not contain elements that are linked to a specific project context. Hence, the following requirement is defined:

R22

The method must be able to adapt to the majority of projects that belong to the domain of ICT4D in the field of education

4.2 Method Design

In this section, the design of the impact assessment method is discussed. First, the PDD of the method is shown and the method is explained. The method is divided over four phases, each containing various steps. For every phase and step of the method, an explanation is given and the design decisions are discussed.

4.2.1 The Impact Assessment Method

A PDD of the impact assessment method is shown in Figure 4.3. The figure includes an adaption to the original PDD notation in order to depict for which steps an additional document or tool is supplied or needed. In Section 4.2.2 a more extensive explanation is given on the extension for the PDD notation. A more in-depth explanation of the steps of the method and an elaborate description of the deliverables of the method can be found in Appendix I. The method is designed in a way so that it consists of four phases:

1. Project purpose definition
2. Data collection
3. Data analysis
4. Impact evaluation

The phases described here are defined based on multiple existing impact assessment methods. The project goals framework as described in Section 3.2.1 prescribes that four steps should be performed. It is discussed that first the specific project goals should be identified (Heeks & Alemayehu, 2009). The project goals framework also states the importance of the identification of indicators to measure goal achievement, and the identification of appropriate methods to measure these indicators. However, the last step of the project goals framework is to measure the indicators and the evaluation of goal achievements. The project goals framework is assessed to bring a solid foundation for an exhaustive impact assessment method. The steps that are defined for the method are assessed to be too shallow. However, the project goals framework defined by Heeks and Alemayehu (2009) does underline the importance of a clear definition of the purpose of a development project. The information mappings framework, which is also described in Section 3.2.1, also explains the importance of the identification of information needs or requirements of a project. The method, proposed by Heeks and Alemayehu (2009), prescribes that it is of importance to define the information needs of a project goals before the impact assessment is performed, so that these can be evaluated on later. Furthermore, the outcome mapping approach (Section 3.2.1) is divided over three main stages. First, the intentional design stage is mainly focused on defining the correct scope for the impact assessment. Here, project goals are defined and the targets for these goals are noted. The second stage focuses on the monitoring of the project, and gathering outcomes of the project. Lastly, the third stage consists of performing an evaluation plan (Earl et al., 2001). The theory of change, mentioned in Section 3.2.1, is also used as inspiration for the design of the four phased impact assessment method. The theory of change as described by Li and Thomas (2019), also denotes the importance of the definition of project goals. What is also mentioned by Li and Thomas (2019) is that the context of the project environment should also be taken into account. The conclusion can be drawn that many impact assessment

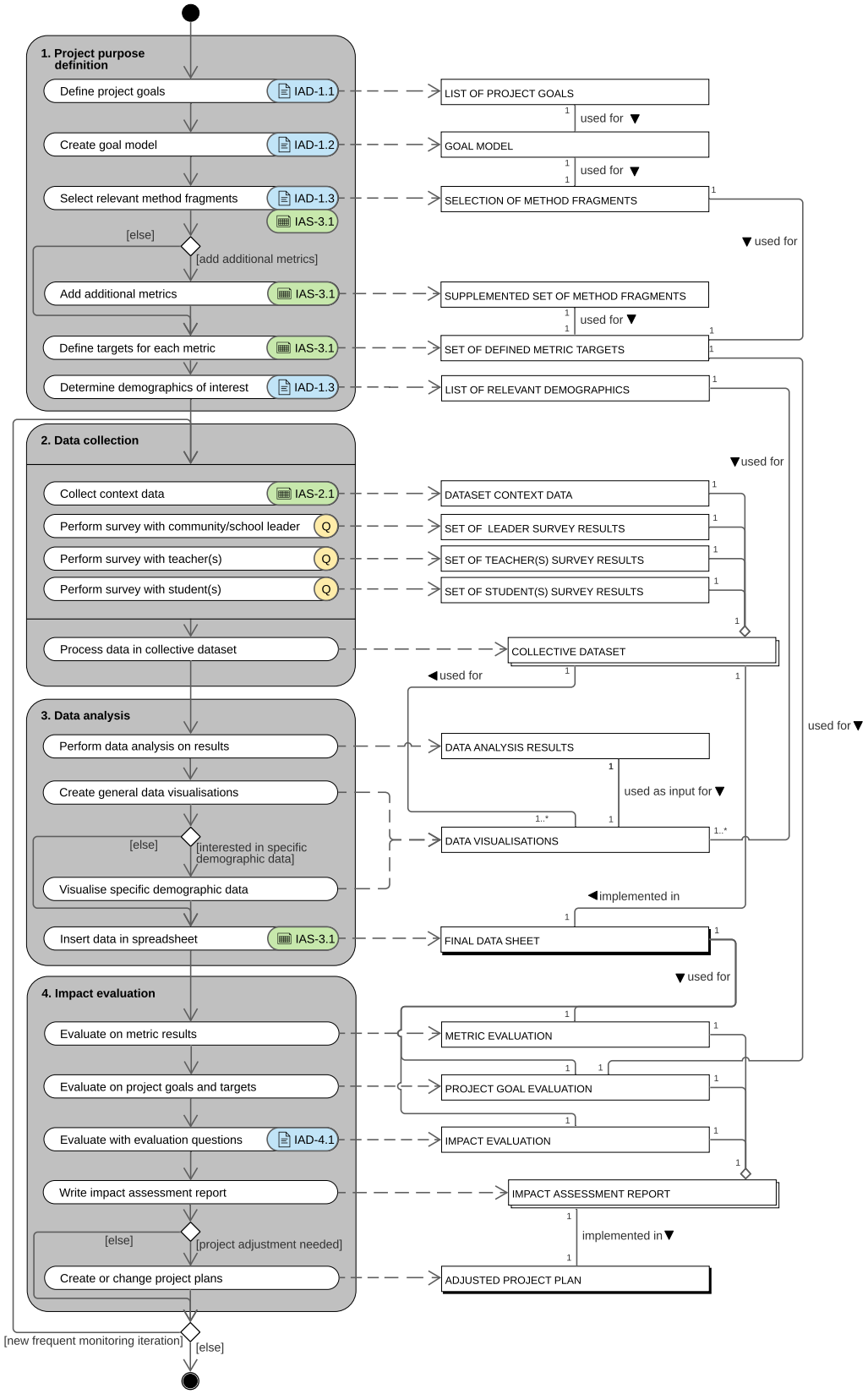

Figure 4.3: PDD of the situational impact assessment method

methods have an initial phase which focuses on defining project goals and actually sketching the context of the development project. Based on the exact purpose of a development project, decision can be made on how to perform the evaluation. Also, in that way a decision can be made on the importance of specific individual parts of an evaluation. Durden et al. (2018) support this by describing that the ideal impact assessment starts with a screening and scoping phase. In this phase, it is decided whether an impact assessment should be performed, and at what level the assessment should be carried out. Since multiple already existing impact assessments use the starting phase of an impact assessment method to define the purpose of a development project, this idea is adopted and used in the novel impact assessment method.

The second "data collection" phase, seems an evident design decision. An impact assessment cannot be performed without the collection of data. All the methods that are discussed in Section 3.2.1 do rely on data. There are different types of data that are used in the existing methods. Fore example, the information mappings framework (Heeks & Alemayehu, 2009) (Section 3.2.1) explains that interviews can be used in order to collect retrospective data. This can be useful if a development project is already started, without having performed a baseline study. Such a baseline study is mentioned by Heeks and Alemayehu (2009) to be of great importance. A baseline study should be performed prior to the development intervention. In that way, the results of the survey can be mapped against the actual results of the ICT4D project. During one of the exploratory interviews in the problem investigation phase Section 3.3.1, it was also mentioned that a proper baseline for a study is of importance. These data can be used to base the impact of the development project on as a starting point. Furthermore, the change of the impact of a project over a period of time should be taken into account. This is already touched upon in Section 3.1.1. Cmte. on Guidelines & Principles for SIA (1995) describes that the input and impact of a context environment can change over time. So, after having performed a baseline study, Cmte. on Guidelines & Principles for SIA (1995) also suggests to collect data in other moments in time. This is defined as the concept of frequent monitoring. Frequent monitoring provides the opportunity to evaluate on the results over a large period of time. But since there are multiple intermediate measurement moments, also the impact in between those moments can be evaluated. In that way, it is easier to get a clear overview of the entire process of the development project, and its impact upon the target environment. Therefore, it is decided that the novel impact assessment method adopts frequent monitoring. The details on how this is applied in the method will be discussed later. What data needs to be performed for the novel impact assessment method is discussed later in Section 4.2.1 under *Data collection*.

The third phase in the novel method consists of the "data analysis" part. The data that is collected during the previous phase needs to be collected before conclusions can be drawn. This phase consists of various steps which guide the user in performing the data analysis for the impact assessment. Further steps are explained later in this chapter. After the data analysis is performed, the fourth and final phase of the method can be initiated. The fourth phase focuses on the evaluation of the impact, which is based on the data analysis conducted in the previous phase. An evaluation step or phase is common practice existing impact assessment methods. Naturally, the method has the requirement to evaluate a development project on the impact it has. Therefore, a phase

which supports such steps needs to be included in the method. Also, the project goals framework (Section 3.2.1)(Heeks & Alemayehu, 2009) also includes a step which is committed to an evaluation task. Other evaluation frameworks or impact assessment methods also revolve around the evaluation of certain predefined indicators. Examples of these are the communication-for-development framework (Chesterton, 2004; Heeks & Alemayehu, 2009), the capabilities framework (Alampay, 2006; Heeks & Alemayehu, 2009), the livelihoods framework (Adato & Meinzen-Dick, 2002; Heeks & Alemayehu, 2009), the information economics framework (Heeks & Alemayehu, 2009), and the information mappings framework (Heeks & Alemayehu, 2009)(Section 3.2.1).

In the following sub-sections, every phase is described in detail and all steps will be discussed elaborately. Decisions that are made in the design process for every step are supported with literature and the requirements which are drafted before. The IDs that are defined for each requirement (excluding R22) in Table 4.2 are used to refer to the requirements in the following sections. Furthermore, as can be seen in Figure 4.3, for various steps an additional notation is used. A more elaborate argumentation on extending the PDD notation is given in Section 4.2.2. For some steps, an external document is drafted to support the assessor in the performance of the impact assessment. These documents serve as a source of assistance, and as an extension to the explanation that is given in the PDD (Figure 4.3) and the activity- and concept-tables (Table I.1, Table I.2. Each of these documents contains a short description of the purpose of the document, and a reference to the corresponding step in the method. These additional documents will be further explained in the following sections. Furthermore, it is important to mention that the impact assessment method should be performed by an assessor, which should be assisted by an employee of the development organisation (i.e., project provider) for which the evaluation is carried out. The employee of the development organisation should have the rights and possibilities to provide the assessor with current and relevant information about the concerned project.

Phase 1: Project purpose definition

As mentioned before, the first phase of the impact assessment is named *project purpose definition*. This first phase consists of six steps. The first step is called *Define project goals*. As the name already suggests, the project goals of the development project should be defined here. The decision has been made to include project goal definition in the method for several reasons. First, it is argued that defining project goals helps in creating an overview of the development project. This process requires the assessor to think about the most important factors of the development project. Furthermore, the assessor might be able to define a selection and/or prioritisation of the goals that need to be assessed. In that way, the evaluation process can be planned accordingly. The second argumentation for including project goal definition in the impact assessment method is derived from the project goals framework (Heeks & Alemayehu, 2009). The project goals framework is based on the assessment of a project against the goals of the stakeholders. The framework proposes to identify project goals early in the project, so that data can be collected, targeting specific indicators and metrics which are aligned to these goals. Since R14 prescribes that the method must confirm or disprove that the project goals are met, the project goals framework is followed in this part of the evaluation process. In the

most optimal situation, project goals are already defined, and can be copied directly. For example, a development organisation might already have a defined theory of change (Section 3.2.1) from which these goals can be adopted. However, it can also occur that project goals of a development project are not clearly defined yet. Identifying the goals of the project can be perceived as a difficult task, especially when the tasks are ill-defined (Turner & Cochrane, 1993). Therefore, an additional document (IAD-1.1) is created which can aid the assessor with the identification of the project goals. The document can be found in Appendix D. The document contains four open-ended questions which can help with the identification of project goals. Open-ended questions can promote creative thinking (Kampylis, Berki, et al., 2014), and therefore help with the identification of concrete goals. Next to the four open-ended questions, also a list of twenty-one keywords is included in the document. This list of keywords is defined based on categories of metrics which are described in Section 4.2.1. It is assumed that these keywords can aid the thought process of the assessor and the project provider. The result of this first step is a list of project goals of the concerned development project.

The list of project goals is used for the performance of the next step, which is named *Create goal model*. In order to make the assessor and project provider aware of the different goals and priorities for the evaluation, a goal model should be created in the second step of the method. Furthermore, R14 requires the method to confirm or disprove that the project goals are met. Visualising them in a coherent model makes it easier to perform an evaluation later on in the method. It is suggested to create this goal model using GoalML. GoalML is a modelling language which provides the opportunity to determine how goals are ordered in a goal hierarchy, and determine which goals are similar or whether they interfere with each other (Overbeek & Janssen, 2015). GoalML is a user-friendly modelling language which does not require much knowledge about modelling techniques. The GoalML notation features a large set of symbols. However, only a specific set of symbols is assumed to be relevant for the creation of the goal models during this impact assessment. An additional document (IAD-1.2) has been developed which serves as a manual on how to create a goal model using GoalML. In this document the relevant symbols are explained. This document can be found in Appendix E.

Based on the identified project goals and the goal model, relevant method fragment should be selected in the third step: *Select relevant method fragments*. This step is of great importance in the process of the impact assessment, and should be performed with great care. First, some requirements that are relevant in the design process of this step are discussed. R3 prescribes that the method must be executable with different levels of data availability. When an impact assessment is performed, data should be collected to base the evaluation on. However, data might not be always available for every indicator or metric. For example, some bureaucratic constraints may arise during the data collection process, which might obstruct the assessor in performing the impact assessment. In order to prevent such situations, the method must also be executable if some parts of data are missing. Therefore, the decision has been made to adopt situational method engineering in the design process. As mentioned before, situational method engineering is the process of creating a method which can adapt to a specific situation (Henderson-Sellers & Ralyté, 2010). In order to do this, a method base is created containing 29 method fragments. These method fragments are all created in the form of categories of metrics. Other words

for these method fragments can therefore be categories of metrics, or indicators. From here on, the term method fragment is used. Each method fragment consists of a set of metrics. In this step of the impact assessment, the assessor and project provider are required to make a decision on which method fragments are relevant for the development project that is to be assessed. In order to make this decision, two additional documents are created (IAD-1.3 and IAS-3.1). IAD-1.3 can be found in Appendix F, and provides an overview of all the different method fragments and their corresponding metrics. In other words, IAD-1.3 serves as an overview of the method base. The collection of the method fragments with their corresponding metrics is based on literature, currently existing impact assessment methods and frameworks, and discussions with the director of Maxim Nyansa. The development of the method base and the contents is discussed later in this section. IAS-3.1 is a spreadsheet document containing five sheets, which aids the assessor in selecting the relevant method fragments. The first sheet in the document is shown in Figure 4.4.

Method Fragments								
General project		TRUE	Hardware infrastructure	☐	FALSE	Self-efficacy	☐	FALSE
General national		TRUE	ICT employment	☐	FALSE	Service and support	☐	FALSE
General regional		TRUE	Information needs	☐	FALSE	Smartphone usage	☐	FALSE
Demographic		TRUE	Internet availability	☐	FALSE	Student performance	☐	FALSE
Accessibility	☐	FALSE	Internet usage	☐	FALSE	Tablet usage	☐	FALSE
Additional effects	☐	FALSE	Livelihood	☐	FALSE	Teacher efficacy	☐	FALSE
Affordability	☐	FALSE	Local economy support	☐	FALSE	Technology acceptance PC	☐	FALSE
Career	☐	FALSE	Network speed and quality	☐	FALSE	Technology acceptance smartphone	☐	FALSE
Cost-Benefit	☐	FALSE	PC usage	☐	FALSE	Technology acceptance tablet	☐	FALSE
Education level	☐	FALSE	Security	☐	FALSE	TPACK	☐	FALSE

Figure 4.4: First sheet of IAS-3.1

Method Fragment	Metric	Type	Target
General project	Number of schools reached (number of projects)	Num	
General project	Number of students reached	Num	
General project	Deployment rate (per month)	Num	
General national	Unemployment rate national	Num	
General national	Unemployment rate youth (ages 15-24) national	Num	
General national	Gross domestic product (GDP) per capita	Num	
General national	Most recent poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	Num	
General national	Average grade for target students (national)	Num	
General national	Child enrolment (percentage of children not in school ages 5-14) national	Num	
General regional	Unemployment rate target region	Num	
General regional	Unemployment rate youth (ages 15-24) target region	Num	
General regional	Average grade for target students (regional)	Num	
General regional	Child enrolment (number of children not in school ages 5-14) regional	Num	
General national	Average student grade ICT class	Num	
General national	Repeater ratio	Num	
General regional	Average student grade ICT class	Num	
General regional	Repeater ratio	Num	

Figure 4.5: Second sheet of IAS-3.1

This sheet provides the opportunity to select the relevant method fragments. Selecting or deselecting method fragments will activate or deactivate the corresponding metrics in the other four sheets of the spreadsheet document. Method fragments and metrics that are not relevant for the project are thus not shown. An example of this is shown in Figure 4.5, where the method fragment *Cost-Benefit* is deactivated. Therefore, a grey box appears in the place where otherwise the metrics for *Cost-Benefit* are displayed. In that way, the spreadsheet document is adapted to the development project at hand, and the document remains clear. As can be seen, the first four method fragments (i.e., *general project, general national, general regional*, and *demographics*) are coloured green and no checkbox can be ticked for those indicators. These method fragments are set as default, and are included for each development project that is evaluated with this impact assessment method. Making these four method fragments default has several reasons. First, a set of default method fragments provides a solid base for the impact assessment. All the methods that are discussed in the literature review (Section 3.2.1) are static, meaning that the method does not change based on specific properties of the development project that is to be assessed. Since the novel impact assessment which is proposed by this research adapts to the project at hand, it can be the case that no resemblance exists between the results of evaluations of different projects. In that way, no comparison can be done. R8 requires the method to report on factors which can be implemented by project managers to improve the organisation. One development organisation may perform multiple development projects. With making these four method fragments a default value provides the opportunity to compare the different projects, and use them as a foundation for bench-marking purposes. In that way, the data can be used to improve the organisation. Second, the metrics that are part of the default method fragments are assumed to be relevant for each development project within the domain of ICT4D. The data consists of of national, regional, and local data about the education environment of the project. The other four sheets that are mentioned here are based on four types of data that collecting data:

- Context data
- Survey data: community/school leader(s)
- Survey data: teacher(s)
- Survey data: student(s)

On the other four sheets that are mentioned, the method fragments and their corresponding metrics are displayed. Context data refers to data that can be extracted from existing project documentation. The project provider should be able to provide these data, and thus this is done during discussions between the assessor and the project provider. Next to that, three types of surveys are developed: (1) one survey aimed at community or school leaders, (2) one for teachers, and (3) one for students. These three stakeholders are identified as the main beneficiaries of educational development projects. Kashorda and Waema (2014) performed an e-readiness research at universities in Kenya. The sample that was used here consisted of teaching staff, non-teaching staff, and students. Also, during the exploratory interviews with experts Section 3.3 it came forward that the aim of most development projects within the educational domain is to improve the educational environment of students and teaching staff. Therefore, it is decided to design surveys for both teachers and students. Furthermore, a community or school leader is also designated as an important source for information. A community or school leader can provide data

that might not always be available for teachers. Also, a community or school leader is assumed to have a clear overview of the entire project environment. Next to that, in the case of Maxim Nyansa, a school leader is always contacted before a development project is initiated. This person also remains the main point of contact between the project environment and the development organisation. Therefore, another survey is developed, aimed at community/school leaders. Non-teaching staff is also targeted as a source of information by Kashorda and Waema (2014). However, non-teaching staff were not identified as a direct beneficiary of the development project for education. Also, the characteristics of non-teaching staff are also included in the surveys aimed at students. In Table 4.3 an overview is given of the method fragments and how data for them is collected.

As mentioned before, the other four sheets, of which an example is shown in Figure 4.5, display the indicators (i.e., method fragments) and their corresponding metrics. The fourth step in the impact assessment method is named *Add additional metrics*. This step is optional. This step is added in order to cope with the situation that not all metrics that could be relevant for the development project to be assessed are included in the method base. In this way, the assessor is not bound to the method fragments that are included in the method base. The assessor is able to extend the method base with extra method fragments if there is a need for this.

As can be seen in Figure 4.5, the spreadsheet document also provides the opportunity to assign a target value for each metric. This aligns to the fifth step of the first phase, which is named: *Define targets for each metric*. This is an addition to the process of the project goals framework. Defining targets includes the advantage of having a goal for the project, and a solid base for the evaluation of the project. Reaching certain targets, or not reaching these targets, can have a wide range of reasons, which are be discussed during the fourth phase of the impact assessment method. Some targets might be able to be copied from the targets which are defined earlier in the GoalML model. Others need to be discussed within the development organisation. Furthermore, R15 requires the method to confirm or disprove the improvement of the project environment over time. R16 requires the method to confirm or disprove the improvement of the community within the project environment over time, and R17 prescribes that the method must confirm or disprove that stakeholders and beneficiaries personally experience improvement. Stepanyan et al. (2010) describes that, among other things, improvement is a determinant of quality in education. In order to determine improvement, various measurements over time should be made, which is discussed later in Section 4.2.1. However, defining targets for each metric can aid in this process, by making the improvement and the project goals insightful. It should be mentioned that the definition of targets should be done carefully. The targets that are defined should be realistic for the time span of the project.

The fifth and final step of the first phase of the method is named: *Determine demographics of interest*. It is discussed internally with employees of Maxim Nyansa that for some development projects only a specific target population is relevant to be assessed. Therefore, it is decided to add an extra step in the first phase where a set of demographics of interests can be defined. In this way, a more specific target population can be reached during the data collection phase, and some boundaries for the data analysis phase are set.

Table 4.3: Method Fragments per Data Collection Type

Context Data	**Community / School Leader(s) (Survey)**	**Teacher(s) (Survey)**	**Student(s) (Survey)**
Cost-Benefit	Accessibility	Additional effects	Additional effects
General national	Additional effects	Demographic	Career
General project	Affordability	Education level	Demographic
General regional	General project	ICT employment	Education level
	Hardware infrastructure	Information needs	ICT employment
	Internet availability	Internet usage	Information needs
	Local economy support	Network speed and quality	Internet usage
	Network speed and quality	PC usage	Livelihood
	PC usage	Service and support	Network speed and quality
	Security	Smartphone usage	PC usage
		Tablet usage	Self-efficacy
		Teacher efficacy	Service and support
		Technology acceptance PC	Smartphone usage
		Technology acceptance smartphone	Tablet usage
		Technology acceptance Tablet	Technology acceptance PC
		TPACK	Technology acceptance smartphone
			Technology acceptance Tablet

Frequent monitoring It is mentioned in previous sections that frequent monitoring is included in the novel impact assessment method. Frequent monitoring is a term that is used to describe that there are measurements being done in multiple moments in time (Cmte. on Guidelines & Principles for SIA, 1995). It provides the measuring of short term impacts (Cmte. on Guidelines & Principles for SIA, 1995). Also, Pade-Khene and Sewry (2012) describe that various assessments should be performed throughout the life of a project in order to thoroughly analyse the impact a project has on its environment. An example of an impact assessment in which frequent monitoring is applied, there is referred to Canter and Wood (1996). Canter and Wood (1996) performed an environmental impact assessment, in which metrics are measured more than once. Some metrics are measured quarterly, monthly, weekly, or even continuously. Continuous monitoring is

very expensive, especially in an educational environment. This would mean in practice that for each project and data point (i.e., metric) an enumerator needs to be available, and needs to actively collect data for multiple students and teachers at a time. Furthermore, collecting data weekly or monthly is assumed not to be necessary in educational development projects. For example, exams are only performed during a limited number of specific moments in time over a year. Also, overall students are going to the same school for a longer period in time. However, in order to make sure that improvement can be identified, measurements need to be performed over different moments in time. Another benefit of frequent monitoring is that the project or the way of working can be changed during the process if the data and evaluation of the project shows that changes need to be made (Cmte. on Guidelines & Principles for SIA, 1995). This provides the development organisation with a tool to keep improving their development projects and the organisation itself, supporting R7 and R8. Frequent monitoring is added to the novel impact assessment method in the following manner. Measurement should take place at four moments in time (at least):

1. At the beginning of the project
2. Halfway through the project
3. At the end of the project
4. A year after the end of the project

The timestamps that are used are based on the experience of an expert, which is interviewed during the problem investigation stage of the research (Section 3.3.1). During this interview it was suggested to perform a first measurement before the beginning of the project, in order to define a proper baseline. It is discussed that it is most beneficial to start assessing the impact at the same time the project that is to be measured starts. Using a baseline study prior to an intervention is also suggested by the Information Mappings Framework Section 3.2.1. In that way, the results of the project can be mapped against the actual results of the project after the project is carried out. Also, a solid foundation is built to base the rest of the impact assessment on. During the expert interviews it is mentioned that the second moment of measurement should be halfway through the project, as a midterm measurement. After that, another measurement should take place at the end of the project. Then, lastly, it was suggested that a year after the end of the project a final measurement should take place. This is done, because it is important to check whether the project remains having impact in the project environment after the development organisation has left. It might also be the case that the project environment might return to old practices. This is something that needs to be prevented. It should be mentioned that these four moments in time are a suggestion. If it is deemed necessary, extra measurements can be added after the fourth one.

Assembly Method Base As mentioned before, the method base consists of 29 method fragments which can be selected in IAS-3.1 (Figure 4.4). These method fragments represent indicators which contain a total of 281 metrics. An overview of these method fragments and indicators is shown in Appendix F. These metrics are based on several sources, which will be discussed in this section. These sources are found in literature and some are based on the interviews. Some method fragments are entirely adopted from its source. Other method fragments are adapted or partly used based on relevancy for the

scope of this research. An overview of the sources used for each method fragment is shown in Appendix J.

The method fragments that are part of the context data are *general project*, *general national*, *general regional*, and *cost-benefit*. As mentioned earlier, the context data is data that should be collected in discussion with the assessor and the project provider. These data should be retrievable from project documentation and other open sources on the internet. *General project* data is based on an internal document from Maxim Nyansa (Stephens et al., 2020), which describes the importance of project data like the numbers of schools that are reached by the project, the deployment rate (of PCs), and the numbers of students reached by the project. Furthermore, Kashorda and Waema (2014) performed an e-readiness research in Kenyan higher educational institutions. This research uses an elaborate survey with indicators that can also be used for the cause of an impact assessment. This research suggests to use metrics which provide basic information about a development project, in order to sketch the current situation in the educational environment to be assessed. This is also consistent with R9. Examples of such metrics are the number of teachers with a teaching certification and the average student grades. These metrics are adopted, with an extension to ICT related metrics. Since this research is focused on the domain of ICT4D, also the following metrics are used: number of teachers with ICT literacy skills, and the average student grades in ICT class.

Furthermore, the total number of courses that are offered by the school is mapped. Two other method fragments that are part of the *context data* are *general national* and *general regional* data. The metrics that are part of these two method fragments are equal. However, the scope for these two are different. *General national* is based around data that is applicable to the entire country in which the development project is carried out. *General regional* is focuses on regional specific data. It is suggested to define a region as a province. The reason for including different scopes for these data is that such data can be used for bench-marking purposes. If the impact assessment method is used for the evaluation of multiple development projects, the data can be used to compare the different projects. An example of this data is the repeater ratio of students, the gross domestic product per capita, and the unemployment rate of the youth. This data is suggested by Heffernan, Lin, and Thomson (2016), Stephens et al. (2020) and The World Bank (2016).

Lastly, a method fragment called *cost-benefit* is placed in the context data. This method fragments is based on the cost-benefit analysis framework (Heeks & Alemayehu, 2009). Heeks and Alemayehu (2009) describe that a financial analysis can be used to measure the financial sustainability and cost-effectiveness of a project. Performing an exhaustive financial analysis on a project is very elaborate. Also, this is not the main goal of an impact assessment of development project, since the goal should be on the impact on the ground, as mentioned in during the stakeholder interviews (Section 4.1.2). However, it is assumed that a basic financial evaluation should be part of the impact assessment method, since most development organisations are NGOs, meaning they do not have the goal to create a profit. However, even though most development organisations are NGOs that do not have the goal to create a profit, it may still be important to include a basic financial evaluation to prevent losses. Four metrics are included in the impact assessment, which measure the expenses and savings of a development project. These metrics are

based on the Cost-Benefit Analysis (Heeks & Alemayehu, 2009), from which a selection is made.

Furthermore, the method fragments that are part of the community/school leader(s), teacher(s), and student(s) surveys are discussed. These are discussed collectively, since an overlap in method fragments exists between them. First, the method fragment *demographic* is discussed. In order to analyse the results of the impact assessment in a structural manner, demographic data is needed. In that way, differences in various demographic groups can be identified. This can be very interesting for a development project, since each demographic group can be influenced differently by a specific project. The importance of demographic data is denoted by Das, Barik, and Biswas (2007) and Kashorda and Waema (2014).

Then, the method fragment *Accessibility* is added to the method base. This method fragment is also based on the research of Kashorda and Waema (2014), where accessibility metrics are used in the measurement of e-readiness. Accessibility refers to the convenience of using hardware and software in the educational environment. The study of Kashorda and Waema (2014) researches ICT usage and access to computers. Also, the purpose of using computers is taken into account. These metrics are adopted in the novel impact assessment method. Example of metrics used in the novel impact assessment are the number of hours that computers are used for scheduled lessons, and the number of hours that computers are accessible for outsiders. It is also measured whether students and employees have access to personal accounts. Another method fragment in the community/school leader(s) category is *additional effects*. In the livelihoods framework (Section 3.2.1) it is described that some additional effects might be perceived during or after the implementation of a development project. In order to check whether this is the case, survey questions are drafted in order to ask about wider effects in the community or personal lives of the beneficiaries of a development project.

Also placed in the method base is the *affordability* method fragment. This method fragment refers to financial elements of the development project. The research of Kashorda and Waema (2014) makes use of the "Readiness for the Networked World - A Guide for Developing Countries" (CID) tool proposed by Sachs (2000). This CID tool makes use of four network access categories. One of these indicators is affordability. The affordability indicator attempts to determine whether institutions find internet access expensive. This is translated into survey questions in the three different surveys. These questions are discussed in the data collection section (Section 4.2.1). The internet affordability is extended with maintenance costs and budgeting metrics of the school. Another indicator that is used by the CID tool is information infrastructure. However, the CID tool only focused on the availability of telephone lines. From personal communication with experts in education in West-Africa it turned out that fixed landlines are barely used in practice. In general, most individuals have a smartphone at hand. Therefore, it is decided not to include the availability of telephone lines in the impact assessment method. However, another infrastructure method fragments has been added, named *hardware infrastructure*. The metrics for this method fragment are based on survey questions proposed by Kashorda and Waema (2014). The metrics include the availability of hardware at the project environment, and the connectivity to a local network. Furthermore, the CID tool suggests

to include *internet availability* and *network speed and quality*. Both are used in the novel method as method fragments. *Internet availability* refers to, as the name already suggests, the availability of an internet connection at the project environment. Also metrics about the speed of the internet are included in this method fragment. *Network speed and quality* refers to the quality of the internet and local network (i.e., intranet), and the restore time of network failures. Furthermore, adopted from the research of Kashorda and Waema (2014) are metrics for the measurement of satisfaction on internet speed and the perception of the restore time of a network failure.

Another method fragment that is added is named *local economy support*. During the stakeholder interviews (Section 4.1.2) it is mentioned that the local economy should be supported as good as possible. If there is a possibility to support local businesses instead of importing goods from developed countries, this should be realised at all costs. Therefore, a method fragment is included to test this. This method fragment consists of the measurement of hardware or supplemental accessories that is provided by local parties. Additionally, a method fragment named *PC usage* is included in the impact assessment method. Like other method fragments, *PC usage* is adopted from the research of Kashorda and Waema (2014). Kashorda and Waema (2014) do not directly use an indicator which measures the usage of PCs. In their study the usage term is combined with ICT. However, including a method fragment named ICT usage involves some disadvantages for an impact assessment which has the goal to be generalisable for other development projects in the domain of education. A development project might be working with a very specific type of ICT hardware. For example, the school project of Maxim Nyansa only includes PCs. However, other ICT hardware like tablets or smartphones can also be widely used within development projects. For this reason it is decided not to use a method fragment named ICT usage, but instead*PC usage*. In addition to that, two similar method fragments are included named *tablet usage* and *smartphone usage*. The contents are practically the same, but with another scope of hardware being measured.

Another method fragment that is used is named *security*. Kashorda and Waema (2014) describes that security is a big challenge for most educational institutions. Security can have two forms: digital security and physical security. Digital security needs to be well organised. Therefore a metric is added to check whether anti-virus is installed on the hardware of the educational institution. Next to that, it is checked how many times a year a system back up is made. The physical aspect of security is also of great importance. Personal communication with employees of Maxim Nyansa yielded the insight that a quick scan is used before a Maxim Nyansa implementation is performed. This quick scan entails that various subjects need to be in order before the implementation is initiated. One of these elements in physical security. For example, metal bars need to be installed in front of the windows to prevent burglars to take the donated PCs. For this reason, a metric has been included within the *security* method fragment to check for a solid physical security.

Then, *service and support* is added as a method fragment. Kashorda and Waema (2014) suggests to include (the perceptions of) service and support as an indicator to measure how many employees are available to perform maintenance tasks. The service and support method fragment also allows to measure the frequency of computer and power failures,

and the perceptions of students and employees about these factors. Furthermore, the method fragment *information needs* is included. Kashorda and Waema (2014) described the importance of knowing what type of information is needed, and what source is used to gather this information. Therefore, for the *information needs* method fragment, two metrics are introduced to measure this. Also two metrics have been added for the method fragment named *internet usage*. Since internet can be a great benefit within an educational setting (Singhal, 2004), it is important if an influx of internet availability actually improves the educational environment.

One metric that is added for this method fragment measures the extent to which a beneficiary has used internet services before the implementation of the development project. Next to that, the perceived importance of internet services for education is measured (Kashorda & Waema, 2014). *Education level* is another method fragment in the novel impact assessment method. This method fragment takes the perception of the student and teacher on the level of education into account. There is asked about the satisfaction on the level of education through five metrics in total, based on Kashorda and Waema (2014) and Stephens et al. (2020).

Also included as a method fragment in the novel method is *ICT employment*. Kashorda and Waema (2014) defines five metrics (i.e., motivation, qualification, retainment, and saturation of ICT professionals, and the importance of ICT literacy for career progression), which denote the employment opportunities within an educational institution. These five metrics are adopted for the novel impact assessment method. Then, the term *teacher efficacy* is adopted as one of the method fragments to be imported in the method base. Teacher efficacy is defined by Tschannen-Moran, Hoy, and Hoy (1998, p. 203) as a type of self-efficacy: "a cognitive process in which people construct beliefs about their capacity to perform at a given level of attainment"(Tschannen-Moran et al., 1998). Ashton (1984) defines teacher efficacy as the extent to which teachers believe themselves for having the capacity to have an effect on student performance. It is explained that if teachers have a low self- or teacher-efficacy, the level of education is lower. A development project might have an influence on teacher-efficacy. Therefore, the teacher-efficacy part of the survey of Tschannen-Moran and Hoy (2007) has been adopted for the novel impact assessment method, so that the level of teacher-efficacy can be measured. The survey includes three types of questions. These questions are testing instructional strategies, classroom management, and student engagement.

Another method fragment focused on teachers is *TPACK*, which refers to the TPACK model as described in Section 3.3.2. The TPACK model describes the understanding of teachers about the educational technologies. It also describes the importance of the interaction between different domains in order to apply technologies in education in an effective manner (Koehler & Mishra, 2009). As described before, the model contains three main components: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). These three components and their interaction is of great importance for a succesful implementation of technology in education. Therefore, it is decided to include the assessment of these three components in the impact assessment model.

Based on the technology acceptance model (discussed in Section 3.2.2), three method fragments about technology acceptance are added: *technology acceptance PC*, *technology*

acceptance tablet, and *technology acceptance smartphone*. It is not self evident that technology always will be accepted (Koondhar et al., 2015). Also, when a technology based development project is implemented, it cannot be assumed that the technology is accepted instantly and without problems. If such a development project is carried out, it should be measured whether the technology that is implemented has actually been accepted. If this is not the case, the impact of the project may be lowered. For this reason, three method fragments based on technology acceptance have been added to the impact assessment method: *technology acceptance PC*, *technology acceptance tablet*, and *technology acceptance smartphone*. The division over three types of hardware has been discussed earlier in this section. The same reasoning for this division applies here. Abu-Dalbouh (2013) proposes a questionnaire in order to measure technology acceptance. Metrics based on these questionnaire items are adopted. Two metrics for each method fragment are added for the measurement of the perceived ease of use, and four metrics for each method fragment are included to measure the user satisfaction of the concerned technology. Usability is not used in the novel impact assessment method, since such metrics needed to be specified very context-specific.

Teacher-efficacy is already mentioned earlier in this section. Next to teacher-efficacy, also *self-efficacy* is taken into account as a method fragment. Self-efficacy is about the cognitive perceived capability of the self (Bong & Clark, 1999). In other words, self-efficacy is the feeling of to which an individual feels that it is capable of something. Self-efficacy can have a great influence on the performance of students (van Dinther, Dochy, & Segers, 2011). Therefore, the decision is made to include a method fragment based on self-efficacy in the impact assessment method. The research of Tsai and Tsai (2003) guided as inspiration for the development of six metrics for the self-efficacy method fragment. The metrics from this research are adopted so that they fit in the novel impact assessment. Another method fragment that is added to the method base is named *career*, based on the results from the stakeholder interviews (Section 4.1.2). The method fragment contains five metrics which are designed around the career perspectives of beneficiaries (i.e., students). Lastly, a method fragment named *livelihood* is included, based on the livelihoods framework (Heeks & Alemayehu, 2009; Adato & Meinzen-Dick, 2002; Parkinson & Ramirez, 2007), and the research of Mwenda and Turpin (2016). The livelihoods framework is used to get an overview of the entire perspective of a development project (Heeks & Alemayehu, 2009). Based on the indicators defined by Livelihoods Centre (n.d.) and Mwenda and Turpin (2016) eight metrics are defined for the method fragment. Examples of these metrics are the availbility of support services in the area of the beneficiary, the perceived sense of community participation for the development project, and the feeling of personal empowerment.

Phase 2: Data collection

The second phase of the impact assessment method revolves around data collection. Data is collected in four ways. First, as mentioned earlier, context data is gathered by the assessor and the project provider. Next to that, three surveys are performed. A survey is performed with students, one with teachers, and one with the school or community leader. For each metric in the method base, a question is defined. Based on the selection of method fragments that is made for the development project to be assessed, a complete

survey is formed. Each metric of the selected method fragments is translated into a survey question. The translation of metrics to survey questions is shown in Appendix K. Some survey questions are in the form of open-ended questions, where in most cases a numeral or string type answer is required. Also closed-questions are included, in the form of boolean type answers (e.g., Yes/No), and multiple choice answers. Next to questions, also statements are given, in which the participant is asked in what sense they agree with various statements. Answering to what extent the participant agrees with these statements is done with a seven point Likert scale. Matell and Jacoby (1971) describes that using a seven-point likert scale is the optimal number of items in a likert question. Vagias (2006) is followed in order to design the different likert-type scale response anchors for the questions in the survey. The response items of the likert scale that are used are as follows:

Level of Agreement

1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Neither agree or disagree
5. Somewhat agree
6. Agree
7. Strongly agree

It should also be mentioned that some terms in the survey statements are in bold. This is done to denote variables. In other words, these terms can be changed if this is deemed necessary to adapt the survey to the scope of the development project that is concerned. It is suggested to perform the surveys using the mWater platform (*mWater Portal: Technology for Water and Health*, n.d.). mWater follows an open access business model. This means that anyone can use the platform without any costs. The mWater platform provides a survey tool which can be installed as a mobile application on an IOS or Android device. Once a survey is created, it can be downloaded on the mobile device. The mobile application can be used without an active internet connection, so no internet connection is needed to fill in the surveys. The survey data can be stored locally on the mobile device. Once an internet connection is available again, the survey data can be synchronised to the internet and the results can be accessed through a web browser. Since R2 prescribes that the impact assessment method must be executable without a working internet connection, and not in all rural areas in West-Africa a working internet connection is available, mWater provides a perfect solution with its platform. Another advantage of the mWater platform is the option to assign multiple enumerators and manage the responses all together. Therefore, many surveys can be performed simultaneously. It should be mentioned that the data collection steps can be performed simultaneously. After the data is collected, the final step of the second phase is performed: *Process data in collective dataset*. By processing all the data in a collective dataset, it can be accessed easier for analysis purposes in the next phase of the method.

Phase 3: Data analysis

The *data analysis* phase is the third phase of the impact assessment method. The method contains three mandatory steps, and one optional step. The first step is named *perform data analysis on results*. For this step, as the name already suggests, data analysis should be performed on all the data that is collected. Data analysis can be performed in many ways. This can be done with the programming language or software tool of choice. It is suggested to use the programming language R (R Core Team, 2020). R is free software for statistical computing and graphics. It provides a wide variety of statistical and graphical techniques, and extra packages can be used in order to extend the standard functionalities (R Core Team, 2020). It is not anchored in the impact assessment method what type of data analysis should be performed. The reason for this is that every development project has its own specific goal. A data analysis that is relevant for one development project, might be irrelevant for the other development project. Therefore, the first step of this phase should be done with care. Based on the demographics of interests and the chosen method fragments defined in the first phase of the method, a decision must be made on what type of data analyses are relevant and of added value for the impact assessment. This should be done in discussion with the assessor and the project provider. For example, some statistical tests can be performed, correlations between different metrics can be carried out, and filters on specific demographics can be placed.

After the first step, the step *create general data visualisations* should be carried out. This step consists of the process of creating general data visualisations based on the data analyses that have been carried out. Since the data collection is based on method fragments consisting of multiple metrics, it is suggested to visualise the results of each method fragment with a spider chart (i.e., Radar chart), like is done in the research of Kashorda and Waema (2014). This can be done with numeral data, but also for likert-scale data. Each item anchor point from 1 to 7 can be used as a value on the Y-axis of the spider chart. However, Robbins, Heiberger, et al. (2011) describe that a spider chart can be difficult to interpret. One might quickly interpret that a linear relationship is present, since lines between static points are visualised. Therefore, they should only be used to give a quick overview of the results of the surveys per method fragment. Robbins et al. (2011) also give other options for data visualisations of rating scale data. Examples of these are divided bar charts and grouped bar charts. If there is an interest to also visualise specific demographic data, an additional step can be performed by creating visualisations based on different demographic samples.

After these steps are all carried out. The data analysis results are to be inserted in the spreadsheet IAS-3.1. This is the same spreadsheet in which the method fragments are selected during the first phase of the method. The target for each metric are also defined for each metric. The spreadsheet has a default setting for four measurement moments (M1 - M4), based on the frequent monitoring stages. This can be extended if desirable or deemed necessary. The advantage of processing all the data in one final spreadsheet, is that the data can be overlooked at once.

Phase 4: Impact evaluation

The fourth and final stage of the impact assessment method is the *impact evaluation* phase. This phase consists of four mandatory steps and one optional step. The first step is named *evaluate on metric results*. Based on the data analysis that has been carried out during the third phase, and the visualisations that have been made, an evaluation can be performed. This evaluation is fairly superficial. The assessor and the project provider can look at the results of the statistical tests and conclude if the development project is following the right path.

After that, a more in-depth evaluation should be performed. Based on the project goals framework (Heeks & Alemayehu, 2009), the data analysis should be mirrored with the project goals that are defined during the first phase of the impact assessment. Also, the targets that are defined in IAS-3.1 earlier can be used to evaluate on the progress of the project. In this way it can be identified if the project is in the right direction to reach the targets that are intended. If this is not the case, it can be attempted to identify the potential problems that cause the delay of the target and goal achievement. The spreadsheet (IAS-3.1) also has a built in function to calculate what the percentage is towards achieving the target.

The next step in the impact evaluation phase is named *evaluate with evaluation questions*. Impact that is achieved can have various pitfalls. In order to make the assessor and the project provider aware of these pitfalls, an additional document is drafted (IAD-4.1). This additional document is shown in Appendix G. The document contains seven evaluations questions to guide the assessor and project provider in the evaluation process. It is not necessary to define an answer for each question, but for every impact result these questions can be walked through in order to perform a more in-depth evaluation.

The first question asks whether the impact is desirable. Cmte. on Guidelines & Principles for SIA (1995) describes that a difference should be made between an impact being desirable and not desirable at all. A project might have a negative impact on a specific environment, but a project might also bring opportunities (Franks, 2012). This question provides the opportunity to evaluate if the local beneficiaries actually perceive the impacts of the project as desirable. Furthermore, a question is drafted which lets the assessor and project provider think about the time of the impact. Some impacts might be of a short duration, whereas some impacts might have a long-term effect. Some communities might recover their old habits rather quickly after the source of change is removed (Cmte. on Guidelines & Principles for SIA, 1995). With this source of change, the development project is meant here. Therefore, it is important to assess whether the impact is of short duration or is sustainable for the long term. The third question aligns with the second one. The third question asks whether the impact is sustainable over time. If the results of a project are not showing at the fourth measurement (a year after the end of the project), the impact of the method is not sustainable for example.

Furthermore, Cmte. on Guidelines & Principles for SIA (1995) also suggests to focus on the severity of the impact. It is mentioned that the severity of the impact is relative to the project environment. Therefore, it is important to check whether the impact of the development project that is to be assessed is as severe as expected. A possible influence on

the severity of the impact of a development project is the presence of other development projects. The effects could be cumulative or complementing. However, the effects could also be mutual counter-balancing (Cmte. on Guidelines & Principles for SIA, 1995). The sixth question focuses on the level of impact for different individuals in the community. The impact of a development project can be different for people who fulfill different roles in a community or society. This refers to the pursuit to social equity. In other words, all the beneficiaries of the project should perceive a fair, just, and equitable level of impact from the development project (Svara & Brunet, 2005). The last question refers to the project goals framework (Heeks & Alemayehu, 2009). This question makes the assessor and project provider aware to check if the results of the impact assessment actually are in line with the goals of the development project.

The fourth step of the impact evaluation phase is to *write an impact assessment report*. All the conclusions and impact results need to be assembled and described in an impact assessment report. This makes sure that the results of the impact assessment are reported on and well documented. The final step of the impact assessment method is optional, and is named *create or change project plans*. If it is desirable, the decision can be made to change the project plans, based on the impact assessment report that is written in the previous step. If the conclusion can be made that the project is going in the right direction, plans do not have to be changed.

4.2.2 Extending the PDD notation

As can be seen in Figure 4.3 and Figure 4.6, the PDD model that is created for the impact assessment method differs from the way that is intended by the original creators of the notation. Originally, the PDD notation does not include a way to model input for an activity. For various steps in the novel method, additional supportive documents are designed. However, the original PDD notation does not include a way to hint a user to the use of these additional documents when performing a certain activity. One way to handle this is to add the usage of such an additional document as an extra activity. However, this would result in an unnecessary crowded PDD model, including activities that are redundant. Therefore, it is decided to add a small field on the right side of an activity if an extra document or tool is available that can be used to aid the user in performing that specific activity. Three types of extra fields are defined:

- Text documents
- Spreadsheets
- Software tools

Text documents are denoted with a blue oval. An icon that represents a text document is shown on the left side of the oval. On the right side of this icon the name of the additional document is shown. Spreadsheets are denoted with a green oval. Also, an icon that represents a spreadsheet document is shown on the left side of the shape. Right next to the icon the name of the additional spreadsheet document is shown. Lastly, software tools are denoted with a yellow circle. The letter Q is displayed within the circle. This letter is an abbreviation for questionnaire.

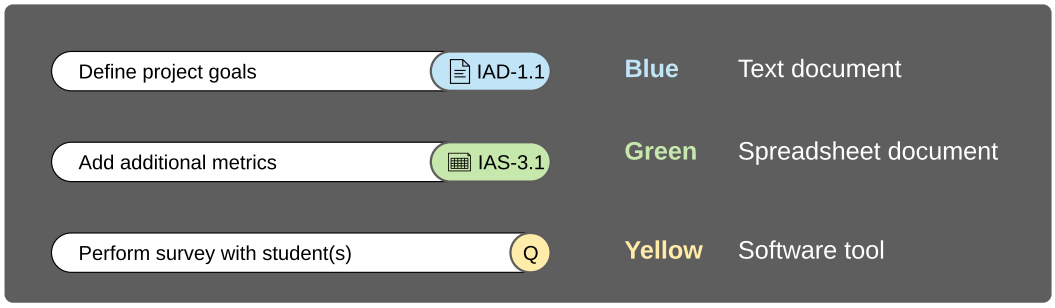

Figure 4.6: Extension of the PDD notation

Chapter 5

Validation of the Impact Assessment Method

In this chapter, the validation of the novel impact assessment is discussed. Before the method can be implemented, validation needs to take place (Wieringa, 2014). Wieringa (2014) describes that a validation entails the investigation of the effects of the interaction between a prototype of an artifact and a model of the problem context. Next to that, Wieringa (2014) describes that the requirements of the treatment should be compared with the actual method. Based on this, a design theory is developed. With the help of such a design theory, it can be predicted what would happen if the novel method is implemented. First, an explanation of the design theory is given. Then, two focus groups are performed in order to ask experts in different domains ask for their judgement on the proposed solution. Lastly, the satisfaction of the method requirements is discussed.

5.1 Design Theory

During the validation process, no real world implementation is available. Therefore, it cannot be directly investigated whether the treatment contributes to the stakeholder goals. In order to solve this problem, a validation model of the artifact is drafted. This validation model is also called a design theory. A design theory consists of a description of the properties of the artifact and the interaction with the problem context (Wieringa, 2014). Such a theory provides the opportunity to predict what would happen if the artifact were transferred to its intended problem context (Wieringa, 2014). The goal of developing a design theory is to let experts form their opinion on the applicability and usefulness of the novel method. A design theory is not drafted before the start of the focus groups. Actually, the design theory is formed during the focus group discussions. During the focus group discussions, the development projects of Maxim Nyansa are explained as the problem context. Then, an elaborate explanation of the novel impact assessment method is given. The participants in the focus groups are asked to think about the interaction between the impact assessment method and the problem context. The implementation of the novel method into the projects of Maxim Nyansa is elaborately discussed and thus a design theory is created during the focus groups. The argumentation for performing the focus group in this manner is as follows. If a design theory is drafted beforehand, the thought processes of the participants, and thus the discussion, might be limited. By letting participants think about the implementation themselves, new insights might come up and can be discussed. In this way, a researcher bias is prevented.

5.2 Focus Groups

It is decided to perform focus groups for the validation of the novel method for multiple reasons. First, focus groups can provide information about a range of ideas and feelings that individuals have about a certain topic (Rabiee, 2004). Next to that, Rabiee (2004) explains that focus groups can provide a large amount of data in a relatively short time span. Onwuegbuzie, Dickinson, Leech, and Zoran (2009) describe that focus groups are a fast and efficient method for obtaining data from multiple participants. Compared to one-to-one interviews, focus groups are less time consuming. Next to that, focus groups allow discussion between the participants. The advantage of this is that the participants can generate ideas based on the input of others. Therefore group interaction is a great advantage (Rabiee, 2004).

Many sources in literature write about the optimal number of participants for a focus group. Rabiee (2004) discusses that a focus group should be organised with six and up to ten participants. This makes sure that the group is large enough to gain a variety of perspectives, and small enough to make sure the discussion will not be disordered (Rabiee, 2004). Silverman (2016) describes that the norm for the number of participants in a focus group is between four and eight. Onwuegbuzie et al. (2009) mention that a well-designed focus group usually lasts between one and two hours, and consists of between six and twelve participants. The rationale they provide for the number of participants is in line with the rationale of Rabiee (2004). Onwuegbuzie et al. (2009) state that focus groups should include enough participants to yield diversity of information. However, not too many participants should be included. Large groups can create an environment where participants do not feel comfortable sharing their thoughts, opinions, beliefs and experiences (Onwuegbuzie et al., 2009).

In order to validate the novel method, two focus groups are carried out. One focus group is performed with mostly Dutch experts in different domains. The other focus group is performed with Africans, with knowledge on the ground. An overview of the individuals that participated in the focus groups is displayed in Table 5.1 and Table 5.2. The participants in the focus group partly overlap the participants in the interviews. P3 and P7 are also interviewed earlier in the research during the stakeholder interviews.

During the focus groups, first the project context of Maxim Nyansa is explained to the participants. In short, it is described that Maxim Nyansa performs ICT related development projects which have the goal to equip West-African schools with computers and other hardware facilities. Also, trainings are supplied in order to train teacher in improving the education with the help of computers. After that, the impact assessment method that is proposed by this research is discussed, and the participants are asked about their thoughts, opinions, and beliefs about the novel method. Lastly, the evaluation model of (Moody, 2003) is used to validate the method based on the following constructs:

- **Actual efficiency:** the effort that is required to apply a method.
- **Actual effectiveness:** the extent to which a method achieves its objectives.
- **Perceived ease of use:** the degree to which the participants believe that the use of the method is free of effort.

- **Perceived usefulness:** the extent to which the participants believe that the method is effective in achieving the intended objectives of the method.
- **Intention to use:** the degree to which the participants have an intention to use the method.
- **Actual usage:** the extend to which a method is actually used in practice.

Actual usage is left out during the validation, since the method is not used in practice yet. Only a proposal for the method is given in this research.

5.2.1 Focus Group 1

The first focus group is performed with six participants (excluding the organiser/researcher). All participants are experts in a specific field. All participants are denoted with an ID, which can be found in Table 5.1. As can be seen in this table, most participants are Dutch. In order to also make use of the expertise of local African experts, a second focus group is carried out (Section 5.2.2). The first participant (P1) is an independent consultant. He works on international cooperation projects focused on Africa. Furthermore, he has experience with evaluation projects and impact monitoring. The second participant (P2) is a member of the PR and communication team of Maxim Nyansa, and has experience working with development projects. Furthermore, the third participant (P3) is a board member and co-founder of Maxim Nyansa and Climbing the Right Tree. The fourth participant (P4), is active as a university teacher. She is involved with the internationalisation of the PABO, which is the pedagogical academy of primary education. The focus area for this internationalisation is Southern-Africa. Next to that, she is the founder of a foundation that aims to improve the education and culture in Southern-Africa. The fifth participant (P5) is also an independent consultant with experience in development projects focused on ICT in education and ICT in agriculture. Currently she is active with the digitisation of the agricultural sector by performing evaluations and working on program design. Lastly, the sixth participant (P6) is also a member of the board of Climbing the Right Tree, and has experience with the implementations of digital strategies.

Table 5.1: Participants Focus Group 1

ID	Nationality	Description
P1	Dutch	Independent consultant, working on international cooperation projects focused on Africa.
P2	Ghanaian	Member of the PR and communication team of Maxim Nyansa. Has experience working with development projects, particularly in the field of monitoring and evaluation.
P3	Dutch	Board member and co-founder of Maxim Nyansa and Climbing the Right Tree.
P4	Dutch	University teacher, involved with the internationalisation of the PABO. Founder of a foundation for education and culture in Southern-Africa.
P5	Dutch	Independent consultant with experience in development projects focused on ICT in education and ICT in agriculture.
P6	Dutch	Board member of Climbing the Right Tree. Has experience with the implementation of digital strategies.

After an introduction, the project context and the proposed impact assessment method is explained. The participants are asked to provide feedback on the impact assessment method at any time. The opinions, perspectives and beliefs of the participants are described in this section. Also the discussion between the participants is described. Not every aspect of the impact assessment method is described in this section. Only the elements on which feedback is given are discussed here.

Using the Term *Impact*

The first thing that P1 notices about the novel method is that the term *impact* is being used. A large difference exists between a *impacts*, *outcomes* and *outputs*. P1 asked if the method performs an actual impact evaluation, an outcome evaluation, or an output evaluation. It was discussed that a large distinction is being made between these three terms. It is discussed that the impact of a project can be denoted by comparing all the different outcomes of the project, and measuring if they are still active and sustainable over time. P5 did not agree with this. P5 stated that it really depends with the concept that is desired to be achieved. She mentioned that output is something a development organisation or project can achieve itself. Outcomes can be described by the behaviour that is provoked at the schools in which the projects are performed. Lastly, she mentioned that the impact of these projects is the fact if the children that benefit from these projects actually have a better life in the future. P5 states that is very difficult to actually prove something like the impact of a project. Therefore, she suggests to always speak of an outcome assessment when evaluating a specific development project, instead of an impact assessment. P1 agrees with this suggestion. He adds to this that, when talking about impact, the anticipated consequences, but also the unforeseen consequences on the long

term are important. Especially when talking about the consequences of a project on the long term make such an evaluation very complicated and expensive. Therefore, P1 describes that in order to deal with this, long lasting studies need to be performed in order to define the impact of a project. He described that in his experience, such a long lasting impact study is rarely carried out.

P1 described that an impact evaluation study should have a duration of multiple years, and even approximately five years after the implementation the measurements should still be performed. These measurements should be performed based on a predefined set of parameters. He discusses that a baseline study (before the start of the project) is of importance, but also the measurements during the performance of the project are of great value. P1 adds to this that for this reason, it is widely accepted that for most projects it is almost not possible to actually determine the actual impact. Outcome is possible on the other hand, because in that way you stay closer to the project and what the project causes. P5 describes that for evaluations within the agricultural sectors, it is more common to use the term impact. Within this sector, you can work with randomised control trials. However, it is not ethical to use randomised control trials within the educational domain. In that way, you would have to shield a specific school from the development project, and even other development activities. In that way you can measure the differences between a school that has received development help, and a school that did not develop at all.

P4 mentioned that the term outcome would also be better since it is related to education. P2 mentioned that she also agrees with the statements being made by the other participants. P1 wanted to add to this discussion, that potential funders for a development organisation like Maxim Nyansa would have no problem with using the term impact. P3 described that it is very important to check the direct outputs of a project. She wants to prove that the development projects that are carried out are meaningful. Next to that, she wants to prove that the school results of the children are improving. P5 denoted that school results are on the outcome level. Furthermore, P3 explained that also the unintended outcomes (or impacts) are of great importance. P6 described that it is also important that a development organisation is working on evaluation and monitoring tasks. He mentioned that it is important Maxim Nyansa that it is made clear towards outsiders, especially for funders, sponsors and donors, that the organisation is critically looking at the effects of a development project. Defining the impact, but also the outputs and outcomes are valuable.

Development Goals and Project Goals

After explaining the use of GoalML during the performance of an impact assessment with the novel method, P1 asked about the engagement goals and the symbolic goals. P1 explains that often a distinction is made between development goals and project goals. Project goals are mostly focused on output level. Development goals are on a higher level, focusing on the outcome and impact level. P1 asked if these terms can be compared: engagement and symbolic goals versus project goals and development goals. Then it was explained that not a direct comparison can be made. Within a GoalML model, a hierarchy of goals is displayed. At the top of the model, probably the more abstract goals are displayed, representing the development goals. These goals are supported by project

goals. In most cases, development goals are also modelled as a symbolic goal, since such goals are not quantifiable. However, project goals will not necessarily be in the form of an engagement goal. A project goal can be in the form of a quantifiable goal, or in the form of a more abstract, non quantifiable goal. P1 mentioned that the use of a hierarchy in the goal model is very useful. In that way the different levels of results can be nicely visualised. Also the GoalML model is included within the impact assessment method in order to visualise the project goals. One might decide to also include the development goals of a project in this model. However, it is not deemed necessary to create a distinction between the two types of goals. P1 agreed with this.

Method Fragments and Indicators

P1 denoted that the use of a predefined list of method fragments in the form of indicators is very interesting. He mentioned that what you see in practice, is that in most cases a specific set of indicators is defined. This set of indicators is then bound to the development project that is to be evaluated. And for each development project, this process of searching and defining indicators is done all over again. P1 mentioned that using a predefined list of indicators, like is done in the impact assessment that is proposed in this research, is really standardizing that process. P5 explained that using a standardised set of indicators is very interesting to use, especially when measurements over a long period of time are performed. However, P3 did describe that the enormous list of indicators and metrics can be overwhelming. P5 also mentioned that she would advise not to use too many indicators and metrics for a single evaluation. Since measurements need to take place multiple times during a the evaluation process, it can be difficult to measure the same metrics every single moment in time. So P1 stated that this should be "fool proof" and that the data should be fairly easy to collect. Furthermore P1 and P5 discussed that the step in the first phase of the method named *Add additional metrics* is of great importance. They discussed that project management might have an interest in some project specific metrics that are not predefined in the existing method base. Furthermore, a large funder might have some specific metrics which they would like to see being measured in an evaluation. Therefore, they point out that this step is essential.

Self-Assessment

The surveys that are performed also contain some questions that require the participant to do self-assessment. P5 described that most Ghanaian(s) (teachers) are not familiar with performing self-assessments. P4 described that there is a risk of receiving answers that are socially desirable. P5 added to this that in order to deal with this problem, enumerators are needed that are capable of formulating questions in a way so that honest answers are given by the participants. P2 explained that she also had some experience with such situations. She mentioned that it is important to really probe further with the questions in order to find out about the real truth. This cannot be done with the use of a survey, so that is something that should be taken into account.

Data Collection

P5 suggested to use a tablet as the hardware of choice for the data collection process. She confirmed that a survey tool should be used which provides the opportunity to collect and store data locally. In that way, no internet connection is necessary to collect data. Once the internet connection is available again (back in the office for example), the data can be shared. P5 added to this that if it is not feasible to send an enumerator armed with a tablet to a specific location for data collection purposes, that the survey should also be working on an Android device. The reason for this is that most Africans obtain an Android smartphone. In that way, she mentioned that participants can still be reached. However, letting individuals fill in a survey without the support of an enumerator should not be the first choice, since this can be very prone to errors. P4 agreed with P5 that is is necessary to use a survey tool which provides the option to collect data with an internet connection, since in most rural areas no internet connection is available. Therefore, P4 has experience with collecting data with pen and paper. P5 stated however that the usage of pen and paper is very prone to errors and should be prevented if it is feasible.

Furthermore, P5 mentioned that the data that is collected has a mainly quantitative nature. She confirmed that for the purpose of comparing various schools and evaluating project over a period of time, quantitative data is most optimal. However, qualitative data can also be very interesting to collect in order to find out about the "story behind the data". P1 explained that stories cannot be replaced by statistics. P4 mentioned that semi-structured interviews or open-ended questions could be very insightful. Having such information could also help in improving the project and the organisation, said P5. She mentioned that such information can be very valuable. P2 and P3 agreed with these statements. P2 mentioned that this is a very good manner to collect rich information.

P5 also described that she misses a step to guide the assessor and the project provider with sample selection. P3 explained that it was her goal for Maxim Nyansa to perform evaluations for as many schools as possible. However, P5 explained that if the method has the goal to be generalised to other development projects, it is not always possible to evaluate every implementation environment. Therefore, P5 argued that a sample selection step should be included in the method, to support the assessor in choosing a relevant sample. P3 agreed with this statement.

P5 mentioned that the method that is proposed is very well suited to perform measurements in a repetitive manner. Therefore, the actual impact can definitely be determined, since the same measurements can be performed over a longer period in time.

Actual Efficiency

The participants all agreed with the fact that performing the method requires some effort. A lot of preparation and work needs to be put in, in order to fully perform the method. P1 explained that this counts for all impact evaluations. However, the participants did agree that the method is perceived to be efficient in use.

Actual Effectiveness

P1 explains that if the method would be effective in use if a leader/assessor is assigned who fully understands the method. If this is not the case, data can be collected and evaluations may be performed, but the method would not be utilized to its full extent. P5 agrees with this statement.

Perceived Ease of Use

P2 mentioned that the method might not be entirely free of effort. Enumerators need to be trained so that the data is collected in a structured and consequent manner, which requires some effort. P5 mentioned however that the enumerators will remain free of effort, since the only thing that needs to be explained to the enumerators is the survey. However, the method should be understood by the assessor and the project provider. She mentioned that it could take some time to familiarise with the method, but after that it can be quite easily implemented.

Perceived Usefulness

P2 described that she perceives the usefulness is high. She thinks that the method is practical and that it will work. P6 mentioned that the proposed method inspires confident and very useful in practice. He mentioned that it should be very valuable for a development organisation like Maxim Nyansa. P1 also mentioned that he is confident that the method will work in practice.

Intention to Use

P3 and P6 described that there is an actual intention to use the method in practice. They described that it is very important for a development organisation to collect data about the influence their projects have on the project environments. Also, they are planning to use the method to attract sponsors, donors and funders to support Maxim Nyansa, and they feel that such a method can really help with this.

5.2.2 Focus Group 2

The second focus group is performed with three African participants (excluding the organiser/researcher). Again, the participants are denoted with an ID, which can be found in Table 5.2. Initially, it was planned to perform the focus group with more participants. However, unfortunately some last-minute cancellations were made due to connection problems and personal circumstances. The first participant in this focus group (P7) is the founder and director of Maxim Nyansa in Ghana. The second participant (P8) is a charity partner of Maxim Nyansa in Burkina Faso, and has a background as a social and digital entrepreneur. The third participant (P9) is a Ghanaian teacher and a volunteer for Maxim Nyansa.

Table 5.2: Participants Focus Group 2

ID	Nationality	Description
P7	Ghanaian	Founder and director of Maxim Nyansa.
P8	Burkinabe	Charity partner of Maxim Nyansa in Burkina Faso, and a social digital entrepreneur.
P9	Ghanaian	Teacher and volunteer for Maxim Nyansa.

Unfortunately, the second focus group was less effective than the first focus group. As the first focus group is performed in person, the second focus group is carried out through a video conference call. Because of this, less discussion between the participants was triggered, and the discussions remained relatively short.

After an introduction, the project context and the proposed impact assessment method is explained. The participants are asked to provide feedback on the impact assessment method at any time during the focus group. The opinions, perspectives and beliefs of the participants are described in this section. Unlike the first focus group, this focus group mainly focused on the data collection phase of the impact assessment. This is done, since less time was available for the focus group. Therefore, a more in-depth discussion on the data collection was preferred over a shallow discussion about the entire method.

Data Collection

P7 mentioned that in many cases Africans will not speak their minds when asked about a project. P7 described that the quality of the education is of great importance for the people in Ghana. So it really depends who you are speaking with. For example, if you speak with the educational director of the Greater Accra region, you will get totally other answers than when you speak to persons that are actually doing the work on the ground. He mentioned that the government paints a beautiful picture about the educational environment. In practice, this beautiful picture is not always reality. P8 described that the situation is the same in Burkina Faso. In many West-African countries, the government describes the educational environment more positive than it actually is. So, P7 mentioned that it is not only about socially desirable answers, but also about providing information from a varied sample. In that way, many different perspectives can be taken into account. Therefore, P7 described that the differentiation between school leaders, teachers, and students is a good way to cope with this. P9 agreed with this. He explained that he as a teacher has an entirely different perspective on the way education needs to be improved, than the individuals that are making decisions higher up. Furthermore, it was discussed by P7 that there is also a difference between performing surveys with individuals from a public school and individuals from a private school. It does not matter if the student is from a public school or from a private school. According to P7, all students will provide you with facts about the situation on the ground. Teachers from a private school however, will give you some different views about infrastructure, than teachers from public schools would. Also teachers from private and public school will give other answers about motivation for example. P7 described that the way the data is collected for the proposed impact

assessment method is good, since many perspectives are taken into account. P7 stated that in the method, all relevant stakeholders involved are tackled. However, drawing conclusions about the differences between public and private schools for example need to be done with care.

Actual Efficiency

P8 mentioned that it would be easier to use the method if the method is translated, or at least the surveys, in French. French is the native language of Burkina Faso. Since the goal is to start school projects in Burkina Faso soon, the method can be directly applied. If a generalisation of the impact assessment method over all the countries in West-Africa is desirable, such translation is deemed necessary. If participants in the survey can use their native language, it is much easier to provide information about their perspectives and opinions on the development projects.

Actual Effectiveness

P7 and P8 both agreed that the proposed impact assessment method is effective in reaching the objectives. Especially the data collection part is determined to be effective in practice.

Perceived Ease of Use

P7 discussed that the method will not be difficult to use in practice. He mentioned that it is just a matter of dedicating a period of time from their work to do it. It will take some time and manpower to perform the evaluations, but he described that he does not perceive the method as too difficult in practice.

Perceived Usefulness

P7 mentioned that he thinks the usefulness of the method is high, and that it will work in practice. He explained that an impact assessment as proposed could really help improve the development projects, and create awareness about the influence of development projects on the educational system in West-African countries, and Ghana in particular.

Intention to Use

It was mentioned by P7 that it is the intention to apply the method in practice. P8 described that the novel school projects in Burkina Faso are a great opportunity to start performing the method at the start of a development project. In that way, a solid baseline can be set.

5.3 Requirement Satisfaction

In order to justify that the solution contributes to the stakeholder goals and method requirements, the method requirements that are drafted in Section 4.1.4 are discussed in this section. Each requirement is discussed and it is explained in what sense the requirement is satisfied. This section describes a self-evaluation that is performed as a supplement to the validation. For each requirement that is drafted in Section 4.1.4, the novel method is assessed whether it meets the specific requirement and it is described how the method actually meets this requirement. **??** provides an overview of the satisfaction for each requirement. The table displays with a grey marking if the requirement is fully satisfied, partially satisfied, or not satisfied.

R1 The first requirement describes that the method must also be executable without the use of technology. This requirement is fulfilled by the proposed method. The most optimal and efficient way to perform the impact assessment is with the use of technology. However, it can also be done without the use technology. If all the manuals and additional documents are printed on paper, the first phase of the project can be carried out without using technology. The second phase consists of collecting the data. Optimally, data collection is performed with an (online) survey tool. However, if this is not possible it can also be carried out with pen and paper. Data analysis in the third phase is highly inefficient to be done without using technology. But it is assumed that this requirement focuses mostly on the data collection phase, since making the use of technology mandatory might cause issues.

R2 This requirement describes that the method must be executable without a working internet connection. It is also assumed that this requirement focuses on the data collection phase. Not in all places where an implementation of educational development projects is performed, internet connection is available. Therefore, it is required that data collection can be performed without using internet services. It is advised to use an online survey tool which can be installed and used on a portable Android device (e.g., tablet). The mWater survey tool that is used has the option to locally download surveys. The results of these surveys can be synced to the online system when an internet connection is available again. In this way, an enumerator can go to a project environment and perform the survey without any problems.

R3 The third requirement describes that the method must be executable with different levels of data availability. This requirement is fulfilled by developing the method based on situational method engineering theory. The method, and especially the data collection, is divided over multiple sub-parts. Four main sources of information are used for the data: the project provider, school/community leaders, teachers, and students. Moreover, the surveys are designed in a situational manner, during the performance of the evaluation. Method fragments are selected based on the characteristics of the development project that is concerned. If data is not available for one method fragment or source of information, this does not directly influence the results of the evaluation. No calculations are made for which the results of each method fragment need to be aggregated, but for each method

fragment a separate conclusions can be drawn. The method remains executable in this way.

R4 The method must also be dividable over different sub-parts, without inter-dependency. This requirement aligns with R3. Using situational method engineering concepts, the method is divided over four phases. Furthermore, relevant method fragments can be selected for the project at hand. Each method fragment is independent of other method fragments.

R5 The fifth requirement describes that the method must be transparent towards stakeholders, sponsors, and donors. Since the method is developed through scientific research, the method is available for all stakeholders. Furthermore, Maxim Nyansa is an NGO, and thus is required to be transparent in their processes. Since the method is developed commissioned by Maxim Nyansa, the method will be transparent for the stakeholders, sponsors, and donors. Furthermore, this requirement focuses mostly on making the results and impact of a development project transparent for stakeholders. This is done, since the results of the evaluation are openly shared.

R6 R6 describes that the method must report on impact measures which are relevant for funders. The method fulfills this requirement to the extend that research has been done in order to provide metrics that are relevant to funders. These metrics are placed in categories which are called method fragments, and are placed in the method base. If the current method base is not adequate for funders, additional metrics can be added in a specific step in the first phase of the method. In that way, the assessor can confirm that the impact measures that are relevant for funders are included in the project evaluation.

R7 This requirement describes that the method must report on factors which can be implemented by project managers to improve the project to be assessed. All the data that is collected and the conclusions that are drawn by the impact assessment can be used by project managers to improve the project at hand. Also, the method includes a step that prescribes that an evaluation report should be written based on the evaluation. This can be handed to the project managers of the concerned development project.

R8 The eighth requirement depicts that the method must report on factors which can be implemented by project managers to improve the organisation. The same argumentation can be given here, as is given for R7.

R9 The method must report on the current status of the project to be assessed (AS/IS). This requirement is realised by including a baseline study as the first measurement. A baseline study reports about the current situation that the project environment is in.

R10 The tenth requirement specifies that the method must report on the long-term outcomes of the development project to be assessed. Since frequent monitoring is applied, the project at hand is being assessed for a long duration in time. The first measurement takes place before the start of the project, and the latest measurement takes place a year

after the project has ended. If it is desirable, additional measurements can be performed after the latest. In this way, the long-term outcomes of the project are measured.

R11 The method must confirm or disprove that the project to be assessed is fully adopted or not. It is difficult to confirm if a method is fully adopted. In order to do this, first it should be defined what a full adoption should look like. In order to satisfy this requirement, the method includes steps which require the definition of project goals and targets. One could argue that the method is fully adopted if all the targets are reached. However, it should be taken into account that project goals and targets will not always be realistic.

R12 This requirement describes that the method must measure the way in which people are affected by the project to be assessed. The surveys include an elaborate set of method fragments (indicators) which have the goal to measure how people are affected by the project. Some specific questions are aimed to collect data about how the project is actually perceived by the beneficiaries.

R13 The method must measure the behavioural change of people that are affected by the project to be assessed. The survey that is used to collect data includes metrics that are measuring behaviour. Since multiple measurements are being performed over a period of time, it can be seen if this behaviour changes or not.

R14 This requirement describes that the method must confirm or disprove that the project goals are met. In the first phase of the method a goal model should be made, and targets should be specified. In the final phase of the method an evaluation is performed on the project goals that are defined. Also, an evaluation is carried out in order to check whether the project targets are achieved.

R15 The fifteenth requirement depicts that the method must confirm or disprove the improvement of the project environment over time. The same argumentation can be used as is given for R12. The surveys include an elaborate set of method fragments which have the goal to measure how the project environment is affected by the project. In this way, it can be concluded if the project environment is improving or not.

R16 The method must confirm or disprove the improvement of the community within the project environment over time. The same argumentation can be used as is given for R15.

R17 The method is also required to confirm or disprove that stakeholders and beneficiaries personally experience improvement. In order to satisfy this requirement, the surveys include specific questions that are included so that the personal feeling of improvement can be measured. In that way, the method is able to confirm or disprove the personal experience of improvement for stakeholders and beneficiaries.

R18 This requirement specifies that the method must confirm or disprove that impact is achieved without the influence of external factors. This requirement cannot be fully satisfied. As is discussed during focus group 1, the influence of external factors cannot be fully controlled, without using a randomised control trial. It is not possible to conclude from a this impact assessment that the development project at hand is the only factor that leads to change, be it improvement or deterioration. Since the use of a randomised control trial is not ethical in this field of study, this requirement cannot be fully satisfied.

R19 This requirement describes that the method must prove or disprove the absence of negative consequences of the project to be assessed. Since the method includes a large set of method fragments, data is collected for a very broad set of metrics. It is expected that the conclusion can be drawn that the development project has a positive influence on its environment. However, it can also be the case that data shows that deterioration takes place. In this way, it can be proved or disproved whether a development project leaves some negative consequences behind.

R20 The twentieth method requirement depicts that the method must be independent of the expertise of employees. An attempt was done to satisfy this requirement by drafting additional documents which can be used to guide employees when performing the impact assessment with this method. Also, everything that should be known in order to perform an impact assessment with the method that is proposed is written in this thesis.

R21 This requirement describes that the method must prevent the use of jargon OR contain an explanation of jargon. During the documentation process it is pursued to use as little jargon as possible. If this could not be prevented, jargon is explained as clearly as possible.

R22 The final requirement depicts that the method must be able to adapt to every project which belongs to the domain of ICT4D. This requirement is satisfied by using situational method engineering as base for the development of this novel method. As explained before, method fragments can be chosen so that the impact assessment method adapts to the development project at hand. Furthermore, the method fragments and metrics that are currently available in the method base all have in common that they could be relevant for a development project within the domain of ICT4D.

Table 5.3: Overview requirement satisfaction

#	Requirement	Full	Partial	No
R1	The method must also be executable without the use of technology			
R2	The method must be executable without a working internet connection			
R3	The method must be executable with different levels of data availability			
R4	The method must be dividable over different sub-parts without inter-dependency			
R5	The method must be transparent towards stakeholders, sponsors, and donors			
R6	The method must report on impact measures which are relevant for funders			
R7	The method must report on factors which can be implemented by project managers to improve the project to be assessed			
R8	The method must report on factors which can be implemented by project managers to improve the organisation			
R9	The method must report on the current status of the project to be assessed (AS/IS)			
R10	The method must report on the long-term outcomes of the development project to be assessed			
R11	The method must confirm or disprove that the project to be assessed is fully adopted or not			
R12	The method must measure the means in how people are affected by the project to be assessed			
R13	The method must measure the behavioural change of the people that are affected by the project to be assessed			
R14	The method must confirm or disprove that the project goals are met			
R15	The method must confirm or disprove the improvement of the project environment over time			

Continued on next page

Table 5.3 – *Continued from previous page*

#	**Requirement**	**Full**	**Partial**	**No**
R16	The method must confirm or disprove the improvement of the community within the project environment over time			
R17	The method must confirm or disprove that stakeholders and beneficiaries personally experience improvement			
R18	The method must confirm or disprove that impact is achieved without the influence of external factors			
R19	The method must prove or disprove the absence of negative consequences of the project to be assessed			
R20	The method must be independent of the expertise of employees			
R21	The method must prevent the use of jargon OR contain an explanation of jargon			
R22	The method must be able to adapt to the majority of projects that belong to the domain of ICT4D in the field of education			

5.4 Second Iteration of the Method

It can be concluded that some minor changes need to be made based on the validation. Changes are implemented based on the theory of incremental method evolution, as proposed by van de Weerd, Brinkkemper, and Versendaal (2007). First, the concept of incremental evolution is explained. After that, the changes that are made to the impact assessment method are discussed.

5.4.1 Incremental method evolution

Incremental method evolution is a evolutionary approach which can be used to increase the maturity of a method (van de Weerd et al., 2007). Furthermore, van de Weerd, Brinkkemper, and Versendaal (2010) propose a supplemental notation to the original PDD notation, in which the changes to the method can be visualised. For incremental method evolution, the term *snapshot* is used to define a model of the process as it was at a specific moment in time (van de Weerd et al., 2010). Therefore, the evolution of a method can be captured in multiple snapshots. The differences between two different snapshots (i.e., the method adaptation) are called *method increments* (van de Weerd et al., 2010). Method increments exist in three types (van de Weerd et al., 2007):

- **Insertion** of a concept
- **Modification** of a concept
- **Deletion** of a concept

The PDD notation that is used for incremental method evolution is displayed in Figure 5.1 (van de Weerd et al., 2007). As is shown in the figure, the activities and concepts that are added to the method are highlighted with a dark-grey color.

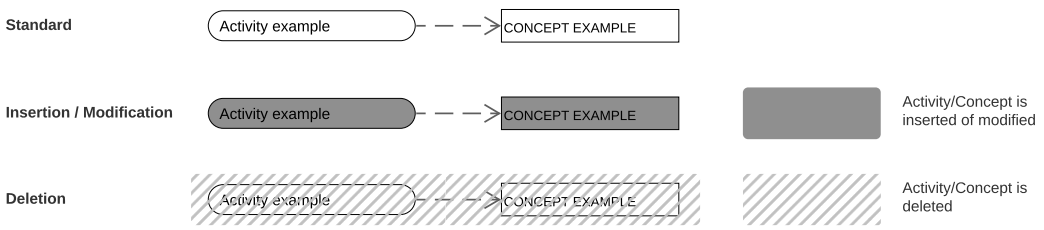

Figure 5.1: PDD notation for Incremental method evolution

5.4.2 Changes made to the method

The changes that are made to the method (i.e., method increments), based on the validation, are discussed in this section. First, the focus groups proved that it is desirable to add some open-ended questions to the surveys in order to collect some additional qualitative information. Therefore, each survey is supplemented with an open-ended question in which the participants can express their feelings about the project. Furthermore, during

the focus groups it is discussed that a step is missing which allows the assessor to choose a suited sampling strategy. In order to do so, an additional step is inserted in the novel impact assessment method which guides the assessor in choosing the most appropriate sampling strategy. This step additional step is shown in an updated version of the PDD of the situational impact assessment method Figure 5.2. A supportive document is added in order to guide the assessor in choosing a sampling strategy. This document is named IAD-2.1, and is shown in Appendix H. IAD-2.1 is based on the work of Gombitova et al. (2020). An overview of all the snapshots and their corresponding method increments are displayed in Appendix M.

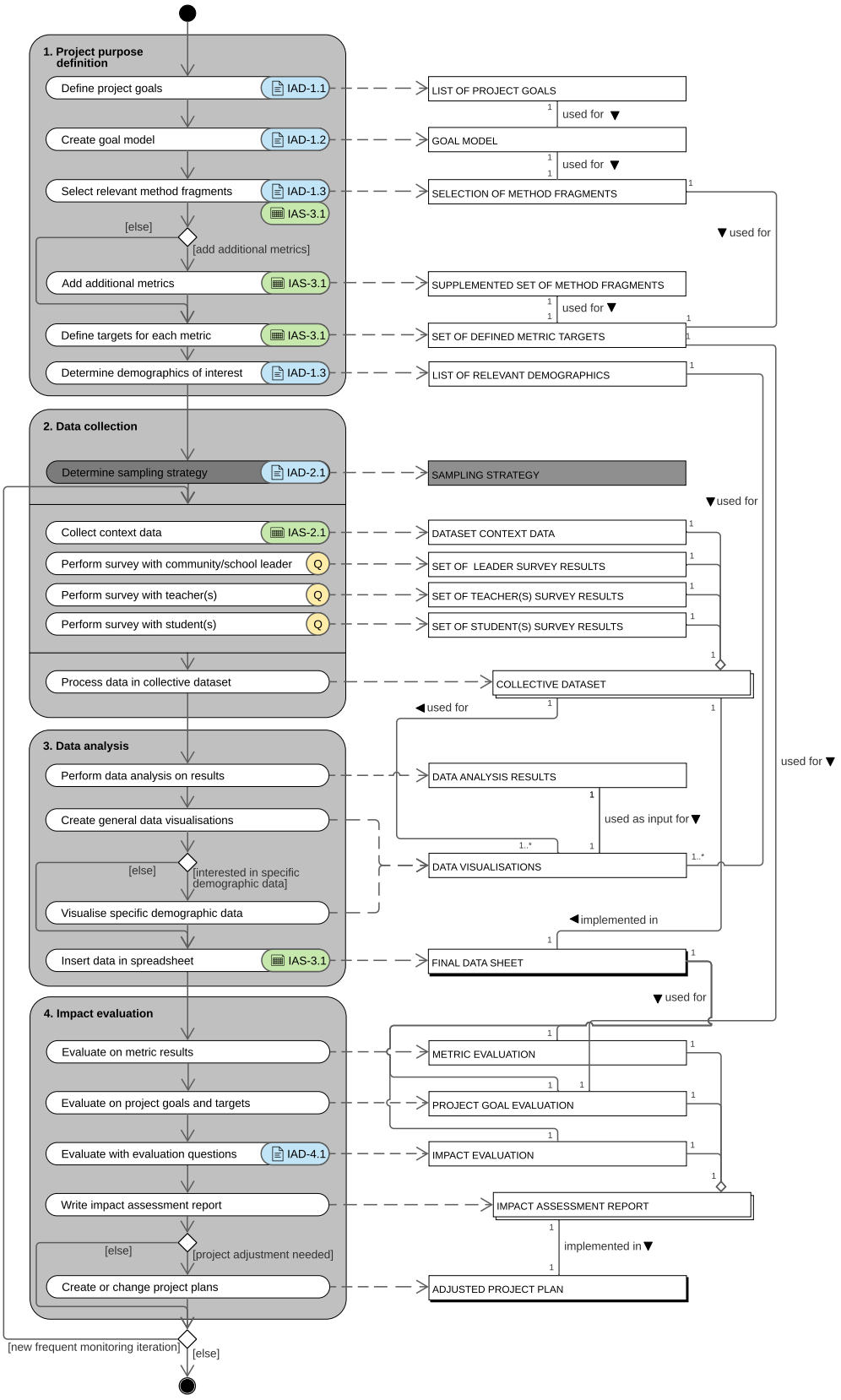

Figure 5.2: PDD of the second iteration of the situational impact assessment method

Chapter 6

Implementation of the Impact Assessment Method

In order to test whether the proposed solution works in practice, it is implemented in a real-world context. The implementation of a treatment is defined by Wieringa (2014) as "the application of the treatment to the original problem context". In other words, the impact assessment method that is developed for this research is tested in practice, being the school projects of Maxim Nyansa. In short, the school projects of Maxim Nyansa have the goal to improve the career perspective of young Africans. IT laboratory are set up in local schools in order to improve the education environment as part of an integrated approach (e.g., training teachers and students in 21st century skills).

The method is not implemented in its entirety. The first three stages (i.e., *Project purpose definition*, *data collection* & *data analysis*) are performed. However, due to the ongoing COVID-19 pandemic, very little data could be collected. Most schools in Ghana are closed and travelling is restricted. Since most individuals in the target population do not have (direct) internet access, it is necessary to travel to schools to reach these participants. Therefore, it is almost impossible to perform surveys with school leaders, teachers, and students. Fortunately, some participants could be reached in order to test the method in practice. However, the sample was too small for a full implementation. Therefore, it was decided that the fourth phase (i.e., *Impact evaluation*) of the method could not be performed. Not enough data could be collected in order to evaluate on the impact of the school projects of Maxim Nyansa. Therefore, a pilot study is run in order to test whether the method functions in practice, and to investigate if some alterations need to be made based on the results.

This chapter describes the implementation of the novel impact assessment method in the context of the school projects of Maxim Nyansa. The first three phases of the method are discussed.

6.1 Project Purpose Definition

The first step of the method is to define the project goals of the school projects of Maxim Nyansa. The steps are drafted in collaboration with the project provider (i.e., Co-founder of Maxim Nyansa).

6.1.1 Goal Model: Project Goals of Maxim Nyansa

As part of the second step of the method, a goal model is created, based on GoalML. This model is shown in Figure 6.1. The main goal of the projects is to improve the career perspectives of young Africans. This goal is supported with four sub-goals. One of these sub-goals is to improve the chances of students to reach tertiary education. In order to do this, it is attempted to improve the quality of education by improving the quality of teachers, increasing the access to ICT in schools, and increasing the quality of the educational content. This is sought to be realised by making education more interactive in comparison of the traditional teaching methods that are used now, and improving teaching with the inclusion of digital skills. The inclusion of digital skills within the African education is sought to be accomplished by setting up IT desktop laboratory. Another sub-goal of improving the career perspectives of young Africans is to make sure that more people know how to apply a certain profession. This is supported by increasing the number of quality internships, and the realisation of practical training programs. Furthermore, it is sought to create viable companies, in which young professionals can start their careers. Lastly, it is sought to realise that more people are trained in 21st century skills.

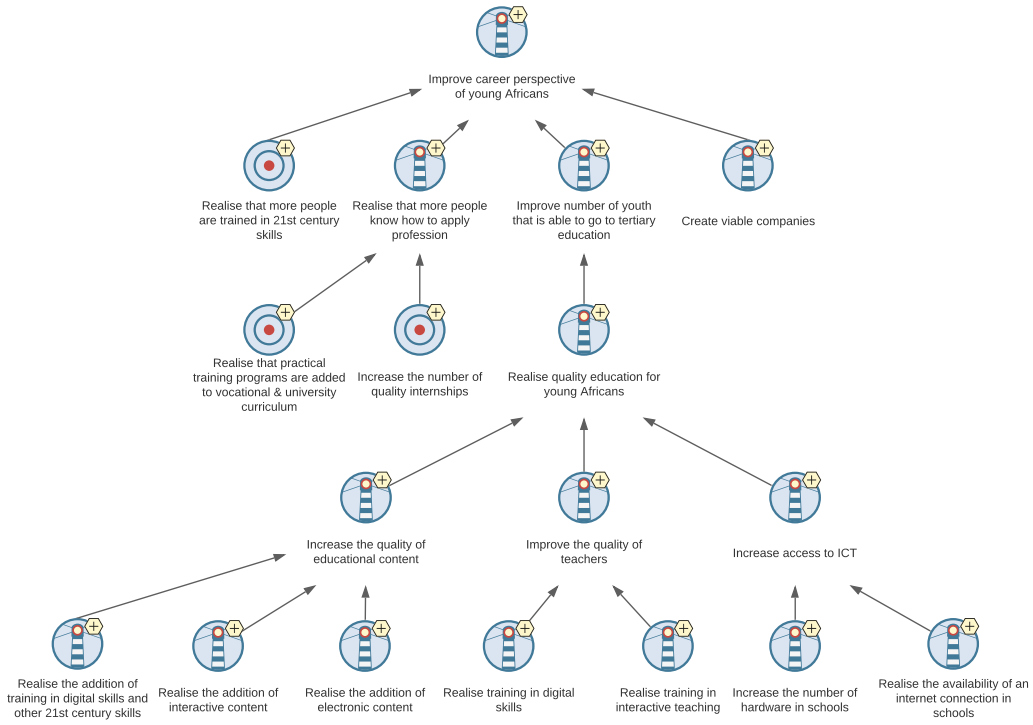

Figure 6.1: Goal model: Project goals of Maxim Nyansa school project

In the goal model, no prioritisation is given. It is discussed that no clear prioritisation could be given on all the different goals, since all are determined to be important. Next to that, one goal supports the other in reaching the ultimate main goal: improving the career perspective of young Africans. Furthermore, no numerical targets are defined, since these were not yet discussed within the team of Maxim Nyansa.

After the creation of the goal model, the third step is to select relevant method fragments. The selection of method fragments is also done in collaboration with the Co-founder of Maxim Nyansa. The method fragments that are selected are the following:

1. **General project**
2. **General national**
3. **General regional**
4. **Demographic**
5. Accessibility
6. Additional effects
7. Affordability
8. Cost-Benefit
9. Education level
10. Hardware infrastructure
11. ICT employment
12. Information needs
13. Internet availability
14. Internet usage
15. Livelihood
16. Local economy support
17. Network speed and quality
18. PC usage
19. Security
20. Self-efficacy
21. Service and support
22. Student performance
23. Technology acceptance PC

The selection of these method fragments is based on the goals that are identified during the previous step. Also, the method fragments that are selected are assumed to be relevant for the school project of Maxim Nyansa. However, during the discussion of the selection of the method fragments, it can forward that some metrics that are not yet part of the method base could also be an interesting contribution. Therefore multiple metrics are added, which will be discussed in the following sub-section.

6.1.2 Adding Additional Metrics

Additional metrics are added to four method fragments. First, for the *general project* method fragment, it was discussed that it would also be very useful to include the central exam results. Therefore, the average student grade for the Basic Education Certificate Examination (BECE) are added. BECE is the exam that is taken before students go to junior high school. Moreover, it is discussed that the type of school, being public or private, would also be an interesting addition as a metric to the *general project* method fragment. Then, for the method fragment *affordability* the student tuition for ICT metric is added. This metric has the goal to measure if a student must pay extra tuition for ICT facilities at the school. For the *hardware infrastructure* method fragment a metric is added which represents the number of smartboards and projectors that are available. Since Maxim Nyansa does not only supply desktop PCs in their laboratories, but also other hardware that can be of use in an educational environment (e.g., smartboards). Lastly, for the *service and support* method fragment, a metric is added which measures if their is made use of the online call center of Maxim Nyansa when a PC or laptop is broken.

6.1.3 Targets & Demographics

After the step for adding additional metrics, targets for each metric should be defined. During the pilot study, no targets are defined. The reason for this is that no evaluation (phase 4) can be performed during this implementation, and therefore the definition of metrics is not necessary. After that, demographics of interest should be performed. As mentioned earlier, this step is included in the method so that a narrower scope can be used in the data collection process. However, since it was already known that collecting

data for the pilot study would be challenging, no distinct demographic sample is defined. Furthermore, the pilot study has the goal to test whether the method works in practice. By performing the survey with a sample that has a wide variation in demographic characteristics, the method is tested on a diverse data sample.

6.2 Data Collection

Since the decision is made to reach as many participants as possible, no specific sample size is defined. Also, since the schools are closed due to COVID-19, and thus participants are hard to reach, it is chosen to use convenience sampling as a sampling strategy. The metrics which are part of the method fragments that are chosen during the *project purpose definition* phase are translated into survey questions. This is done based on the translation tables that are shown in Appendix K. After that, the custom surveys are implemented in the mWater survey tool, as proposed in Section 4.2.1. An employee of Maxim Nyansa is assigned as enumerator for the surveys. This enumerator made a multi-day field trip, in which six schools are visited. These schools are chosen to be visited, since an estimation is made that some beneficiaries of the school projects of Maxim Nyansa would be present. During the field trip, surveys are performed with seven teachers, five students, and four school leaders. The surveys are processed with the mWater survey tool on an Android tablet. After the finalisation of the data collection process, all the collected data is downloaded from the survey tool and processed into a collective dataset.

6.3 Data Analysis

The data that is collected during the data collection phase is analysed in the third phase, named *data analysis*. Based on the analyses, ten visualisations are created in order to demonstrate some examples for data visualisation. It should be taken into account that the data that is analysed as part of the pilot study does not have the goal to draw conclusions about the impact of the school projects of Maxim Nyansa. Too little data is collected to find significant results. Each survey resulted in multiple visualisations. It should also be taken into account that the method is not limited to the visualisations that are shown in this section. However, since the survey response was very low (n=16), not for all the data meaningful visualisations could be created. The bar charts and spider charts are created with the programming language R (R Core Team, 2020), whereas the divergent stacked bar charts for the Likert scales are created with Microsoft Excel (Microsoft Corporation, 2020). In Table 6.1 an overview is given of the number of survey responses and the number of schools over which the participants are divided. It has to be mentioned that the number of schools are overlapping values.

Table 6.1: Overview Survey Responses

Survey	Number of responses	Number of schools
School Leaders	4	4
Teachers	7	6
Students	5	3

6.3.1 School Leader Data

The first visualisation that is created is based on data that is collected with the school leader survey. School leaders are asked about the certification of their teachers. What is shown in Figure 6.2 is the total number of teachers per school, supplemented with the certifications the teachers have. It can be seen in the graph that in three of the four schools, most teachers have a teaching certification. However, almost none teachers have a teaching certification from Maxim Nyansa. These results can be explained, since the four schools that are visited have not yet received a teacher training program of Maxim Nyansa.

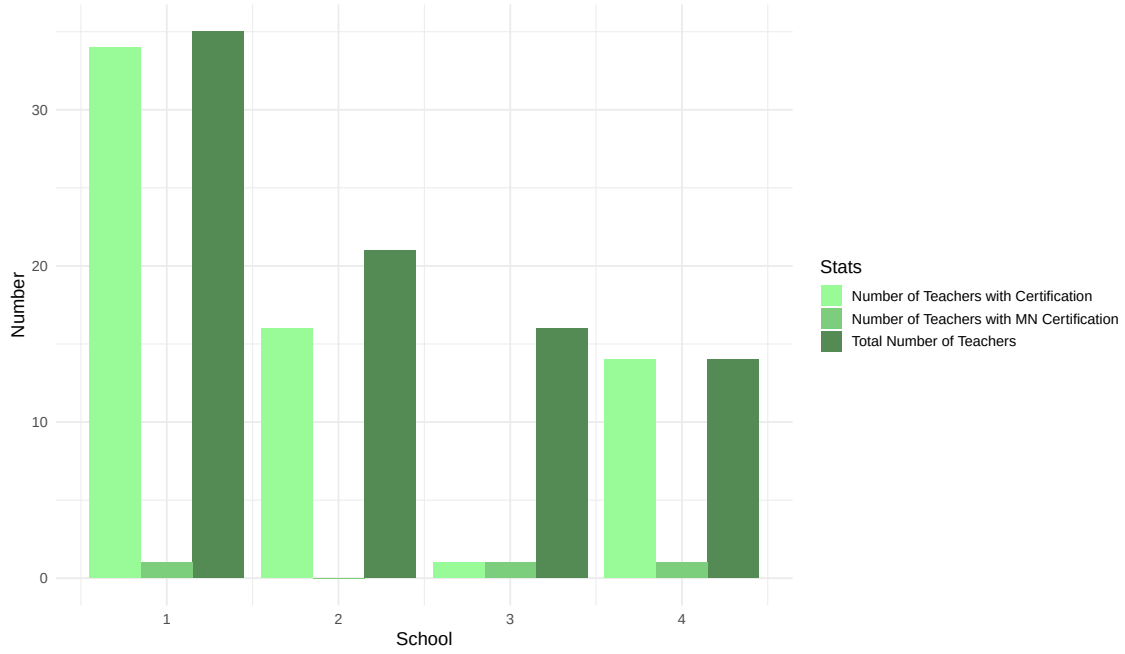

Figure 6.2: Number of teachers with teacher certification per school

The school leader survey also asked about the average exam grades of students. Too little data was supplied in order to create a meaningful visualisation about this. However, if such data is collected on a larger scale, an interesting option is to test the correlation between the number of teachers that have a teaching- or Maxim Nyansa certification, and

the average exam grades of the students. In order to visualise this, a correlation plot could be produced.

In Figure 6.3 the number of hardware that is present in each school is shown. A differentiation is made between PCs, printers, and tablets. What stands out is that school 4 is the only school that has a large collection of PCs. School 3 only has two PCs, and School 1 and 2 have no PCs at all. The reason for this is that in school 1, 2, and 3, no deployment of Maxim Nyansa PC's has taken place. For these schools, the pilot study serves as a baseline study, since the schools are selected for a Maxim Nyansa project deployment. Figure 6.4 displays the ICT literacy skills of each employee within the four schools. What stands out is that only in one of the four schools each employee possesses ICT literacy skills. For the other three schools, the ICT literacy skills ratio for school staff is relatively low.

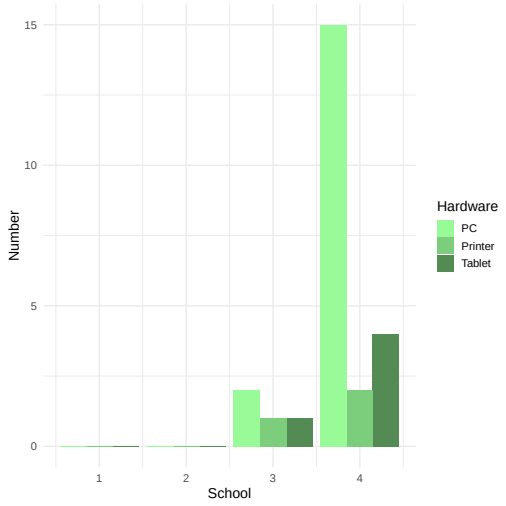

Figure 6.3: Number of hardware present in schools.

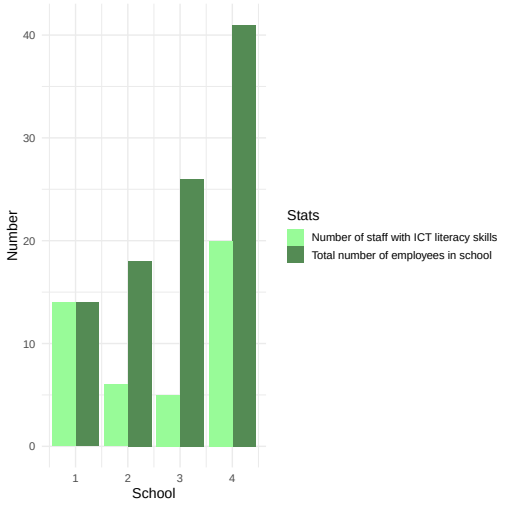

Figure 6.4: Number of employees with ICT literacy skills per school.

6.3.2 Teacher Data

The teacher survey contains a large number of statements which can be answered with a Likert scale. A way of visualising the Likert scale answers is by using a diverging stacked bar chart as can be seen in Figure 6.5. The bar chart displays the five different questions that are part of the ICT Employment method fragment for the teacher survey. The plot is now based on absolute data. Since the teacher survey only had seven responses, no percentages are used. Using percentages in this manner would result in a plot that can be misleading and misinterpreted. What can be seen in the figure is that the participants of the survey are mostly positive about the ICT employment in their schools.

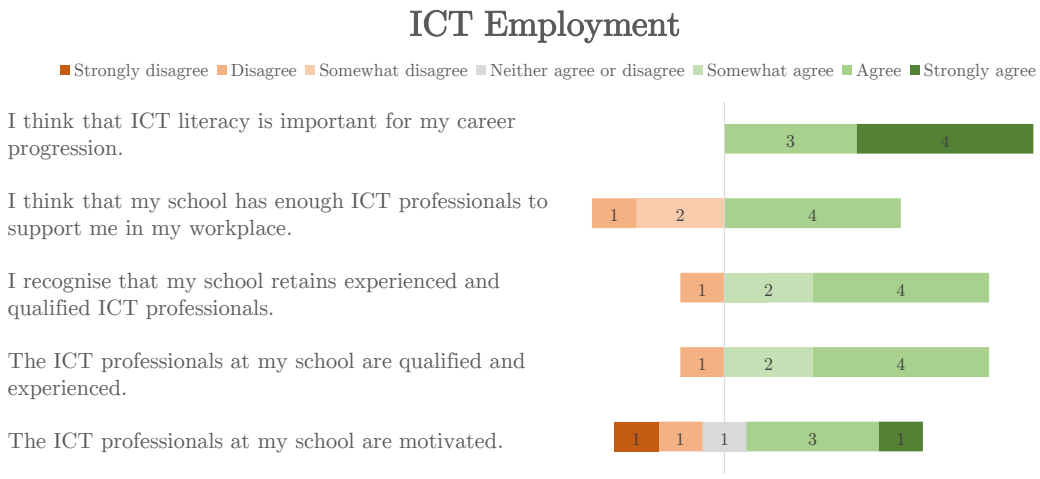

Figure 6.5: Results of ICT employment questions

Another divergent bar chart is created based on the perception of the network speed and quality of the teachers (Figure 6.6). As can be seen in the figure, the network speed and quality if not assessed to be high. Results in the figure are divided.

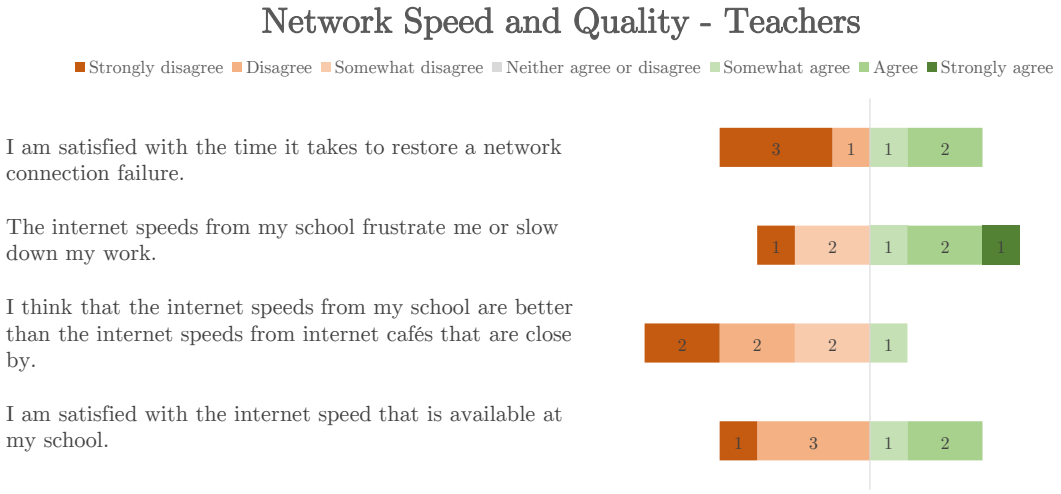

Figure 6.6: Results of network speed and quality questions in the teacher survey

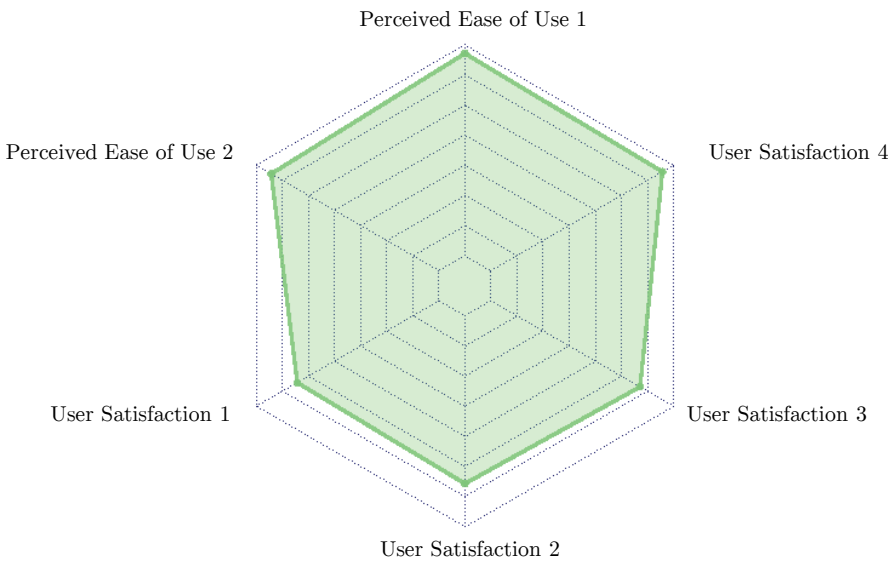

Figure 6.7: Results of technology acceptance PC questions

Another way to visualise Likert scale data is by using spider charts (i.e., radar charts). An example of a spider chart visualisation is shown in Figure 6.7, where the technology acceptance of teachers on using a PC is displayed. The spider chart uses seven segments, with *Strongly disagree* as the first segment, and *Strongly agree* as the seventh segment. Segment one is the center of the spider chart, and segment seven is the outer line of the chart. A disadvantage of using such a visualisation however, is that the average value is used. Therefore, outliers cannot be spotted, and no hard conclusions can be drafted based on the visualisation. On the other hand, the spider chart can give a quick overview. In order to visualise the Likert type data in more detail, diverging bar charts can be used.

6.3.3 Student Data

As with the teacher survey, also the student survey contained questions about the perception on network speed and quality. The results are displayed in Figure 6.8. What stands out is that the students are very negative about the internet speeds at the schools, even more so than the teachers are. It has to be taken into account however, that the plot only visualises five responses of the student survey.

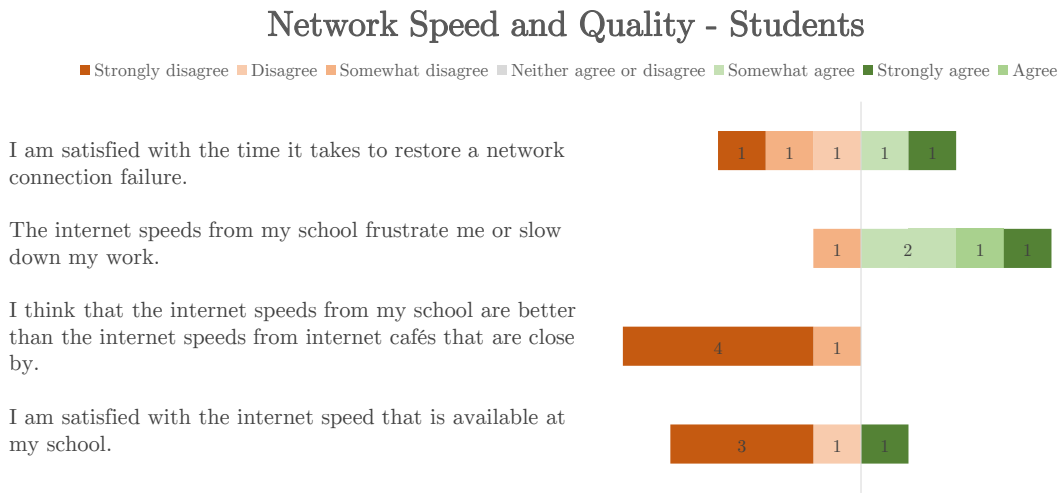

Figure 6.8: Results of the network speed and quality questions in the student survey

Also, the Likert scale data of the Livelihoods method fragment are visualised (Figure 6.9). However, instead of using the average for the spider chart, the values are given for each participant. Each color in the spider chart displays the answer values given by each participant. Since only five responses are recorded for the student survey, data can be visualised this way. However, if a larger data sample is used, a visualisation like Figure 6.9 would get too cluttered. It can be seen that large differences in answers are given. Then, also the diverging bar chart would be a better option. What stands out in Figure 6.9 is that most participants do not indicate that they have learned new skills in the past six months. A possible explanation for this could be that no Maxim Nyansa project has been active in these schools. Another explanation could be that schools were closed for a large portion of the past half year due to the global COVID-19 pandemic.

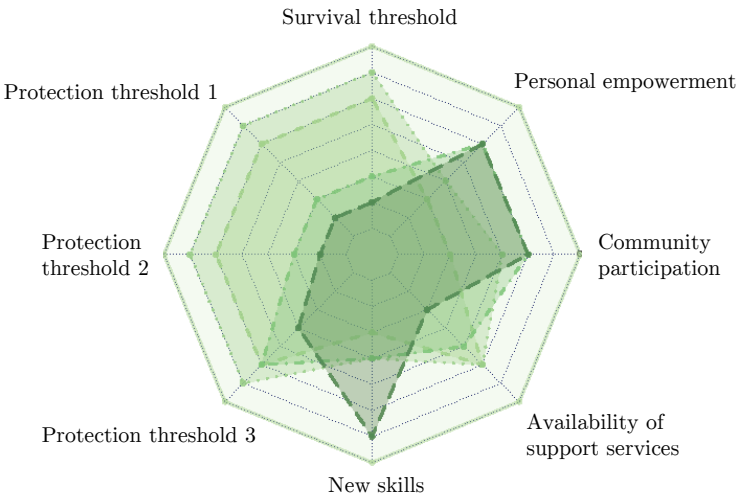

Figure 6.9: Results of the network speed and quality questions in the student survey

6.3.4 Aggregated Data

Furthermore, data from different surveys can be combined in order to analyse the data. Figure 6.10 displays the satisfaction of the level of education of teachers and students. Teachers are asked whether they are satisfied with their own level of ICT knowledge and expertise. Then, students are asked if they are satisfied with the level of ICT knowledge of their teacher(s). What stands out is that the students only gave positive answers to this question. Most teachers also were positive about their own level of expertise in ICT. However, some teachers indicated that they are not satisfied with their own expertise in ICT. This visualisation shows the difference in perception between teachers and students.

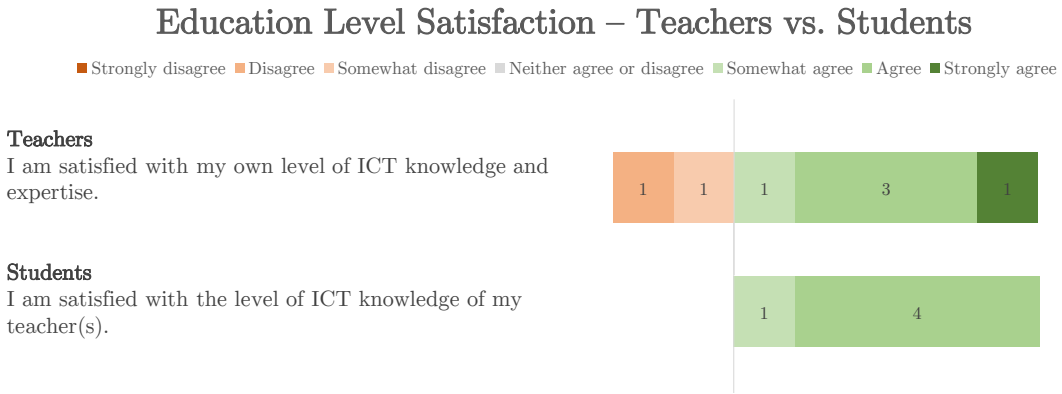

Figure 6.10: Satisfaction of education level: students vs. teachers.

6.3.5 Open-ended questions

Lastly, the surveys contained some open-ended questions. These results cannot directly be visualised with data visualisations. However, discussions during the focus groups did point out that the stories that are given by participants of the surveys are of great value. Therefore, the decision can be made to highlight some of the interesting stories that are written in the open questions. For example, one open-ended question that was asked to teachers was if they wanted to share something about the additional effects of the Maxim Nyansa school project. Some examples of the answers that are given are as follows:

> "Yes! Since the project started, especially here at (Attakwaa), it has really helped not only the children but also some teachers who had a little knowledge about ICT to familiarize themselves with it."

> "It has lessen the burden of teaching ICT as a subject."

> "Students interest as well as participation in computer lessons has improved tremendously."

Furthermore, teachers were asked if they had any other comments on the project. Some examples of the answers that are given are as follows:

> "This project has gone a long way to raise the school's standard in terms of education, and also raise some level of confidence in the teaching learning process."

> "The Maxim Nyansa school project has generated a lot excitement towards teaching and learning of ICT."

> "The Maxim Nyansa ICT facility has really made the teaching and learning very practical in the school."

Data visualisation is the final activity that is carried out as part of the implementation of the novel impact assessment method. Further activities would be to start the evaluation on the data. As mentioned before, too little data could be collected to perform a meaningful evaluation.

Chapter 7

Evaluating the Implementation of the Impact Assessment Method

An evaluation is performed based on the treatment implementation which is described in the previous chapter. Wieringa (2014) explains that in the implementation evaluation there is a benefit of hindsight. In other words, a direct evaluation can be performed based on the experiences that are gained during the implementation phase. For the evaluation of the implementation of the novel impact assessment method, two unstructured interviews with stakeholders are carried out. One interview is performed with the co-founder and member of the board of Maxim Nyansa. The other interview is performed with an assistant of the enumerator that was in charge of the data collection at the schools in Ghana. Initially, an interview with the enumerator himself would be performed. However, due to illness this was not possible.

7.1 Treatment Evaluation

Overall, the implementation was successful. No major problems occured during the performance of the pilot study. It was discussed that the process of deciding which method fragments are relevant is very practical with the use of the spreadsheet document. Furthermore, Wieringa (2014) proposed an evaluation on the effect of the implemented solution. During the interview it is discussed that the effect of the solution is a higher level of alertness with stakeholders within the Maxim Nyansa ecosystem. However, also within the schools, the alertness about the impacts of development projects is increased.

Furthermore, the critical evaluation points that are discussed during the interviews are described.

- The first metric that is part of the method fragment named *general project* is discussed. The concerned metric is named *numbers of schools reached*. It is mentioned that schools are in a pipeline in the Maxim Nyansa projects. First, schools are on the waiting list. After that, teachers receive training, after which the hardware (e.g., PCs and laptops) are delivered and installed. Therefore, it is discussed that a decision needs to be made on the definition of the metric: when are schools actually reached? Hence, an additional step in the novel impact assessment method is to go through each metric and provide a definition if deemed necessary.
- Like the previous point that is mentioned, also a clear definition should be given to the boundaries of the project. It is assumed that most development organisations perform multiple development projects. This is the case for Maxim Nyansa. The novel impact assessment method is designed to evaluate on one development project

at a time. Therefore, the boundaries of the project at hand should be defined properly. In the case of Maxim Nyansa, the school projects are identified to be the scope of the impact evaluation. The same is considered for the region. In different countries, regions can be denoted differently. In the case of the school project of Maxim Nyansa, regions are denoted as provinces.

- Furthermore, it is discussed that the duration of the surveys was too long. Many participants complained about the large number of questions in the surveys. The average time that is taken to perform the surveys is estimated to be between twenty and thirty minutes. The reason for the large number of questions is that many method fragments were selected to be relevant for the project. It also has to be mentioned that some questions could not be directly answered. For example, some participants had to ask for permission to provide financial data. Therefore, the duration of performing the surveys was delayed.
- In line with the previous point, it is discussed that the method is experienced as a bit too complete. It is mentioned that the decision of which method fragments to choose is difficult, since all relevant metrics are wanted to be included in the method. However, this can lead to large surveys and a very elaborate set of metrics. One of the interviewees described that one should not want to exclude method fragments too early, since there is a risk of doing yourself short. Therefore, the dilemma arises that a reduction must be made, but the assessor also does not want to exclude method fragments that could potentially be helpful and interesting for an impact evaluation. It is discussed however that no simple solution for this problem exists, and that a longer survey needs to be accepted if a large set of method fragments is selected.
- A small point of attention was that the step named *Define project goals* should be renamed to *Identify project goals*. The project goals should be defined earlier, when the development project was started. For the impact assessment, they only need to be identified and mapped. They are not defined anew.
- Also, it is discussed that the method fragment named *education level* should be renamed to *satisfaction education level*. Some confusion arose while selecting the method fragment. The metrics all imply that the satisfaction of the education level is measured, not the education level itself.
- It was discussed that it might be of great value to also include the theory of change of a specific development project in the impact assessment method. This theory of change could be used as a supplement to the goal model. The reason for this, is that a goal model could be wishful thinking, for which the intermediate steps to reach certain goals are forgotten. With a theory of change it is identified how these goals can be reached. It is also investigated whether the goals are feasible. When the intermediate steps are identified, corresponding metrics can be selected. However, also the reason for not including the theory of change in the method are discussed. The reason that the first step of the novel method requires the identification of project goals, is to make the assessor and project provider aware of the boundaries of the project. In that way, it is assumed that the process of choosing the relevant method fragments is made less complicated. Also, defining the intermediate steps falls outside the scope of the method. The aim of the method is to measure the impact of a development project. It is assumed that the development project at

hand already includes documentation on how the project goals can be achieved, being in the form of a theory of change or another form of documentation. It is discussed that a relevant selection of method fragements can be made based on this documentation and the definition of the project goals.
- Furthermore, it is discussed that the performance of the evaluation with the evaluation questions as defined in the fourth phase of the method, can result in research questions that require follow up research for them to be answered fully. For example, if there is any doubt whether a method is actually desirable or not, a follow up research could be performed in order to further investigate this. However, this follow up research cannot be included within the impact assessment method, since this is very context and project specific.
- Lastly, it is discussed that it should be taken into account that socially desirable answers can be given in the surveys. Therefore, you do never know with certainty that the results of the surveys represent reality. On the other hand, it is clearly defined that the opinions and perceptions of individuals are captured. Moreover, factual data which is published by large institutions (e.g., United Nations, WorldBank) is a sensible supplementation. However, in practice such data is largely outdated. The most current data is often from multiple years earlier, which is not relevant for an impact assessment that evaluates current development projects.

7.2 Third iteration of the method

The results of the implementation evaluation show that some minor changes to the method need to be made. Therefore, a third and final iteration of the impact assessment method is developed, which is displayed in Figure 7.1. Two changes are made to the method:

- A new activity is included in the *project purpose definition* phase, named *Provide metric definitions.* As is discussed in the evaluation section, some metrics can be abstract or ambiguous. The definition of metrics can be project dependent. Therefore, each metric must be checked whether the definition is clear. It should be taken into account that the metrics all are translated into survey questions. The survey questions may provide a clearer description of each metric. However, in order to make sure that each metric is unambiguous, a definition should be written if deemed necessary. It should be mentioned however, that once a definition is set, that definition should be maintained through the entire evaluation process. Otherwise, the metric will result in incomparable results.
- The first activity in the *project purpose definition* phase is renamed from *define project goals* to *identify project goals.* The argumentation for this change is described in the first part of Chapter 7.

Since the second and third iteration of the method introduced novel activities and concepts, two additional tables are created in which these activities and concepts are displayed. These tables can be found in Appendix L. An overview of all the snapshots and their corresponding method increments are displayed in Appendix M.

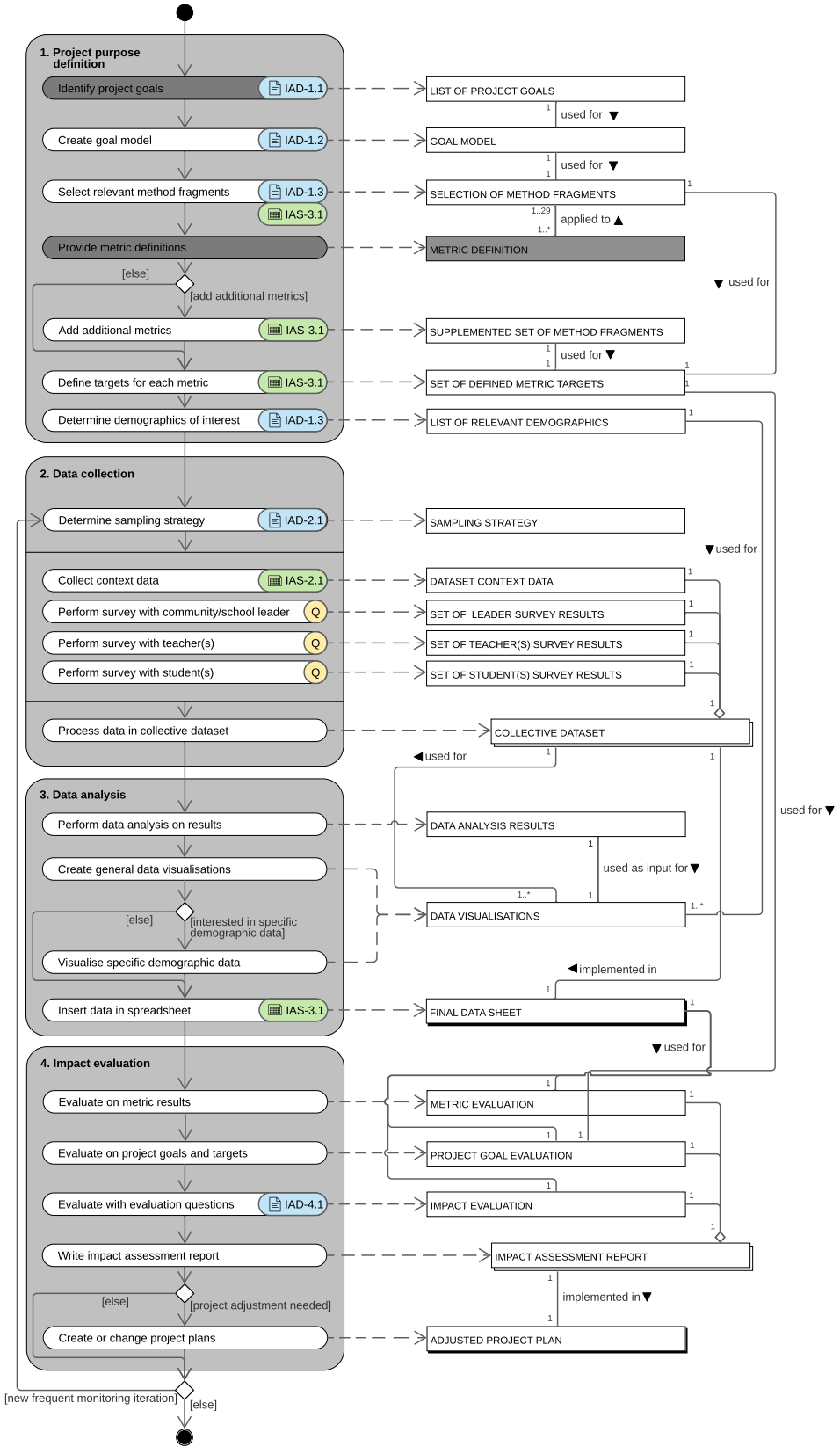

Figure 7.1: PDD of the third iteration of the situational impact assessment method

Chapter 8

Discussion

To the best of the researchers knowledge, there are few studies that focus on the evaluation of ICT4D projects. Moreover, there is a great call for comprehensive data that displays the quality of the outcomes of development programs. Many studies already exist that result in impact assessment methods. However, the scope of the existing impact assessments of ICTs in developing countries is determined to be too narrow. Furthermore, there is a lack of an impact assessment method that is exhaustive in every subject. Many existing impact assessment methods are developed based on a specific project context and only focus on a specific set of metrics. Also, most impact assessment are developed with standardisation in mind, but this is hardly ever accomplished in a sustainable manner. The reason for this is that the existing methods are often deprived of flexibility when standardisation is applied. This results in the fact that the methods are not applicable to a wide variety of development projects.

This research proposes a novel impact assessment method that is based on the concept of situational method engineering. The main goal of this research was to design a situational method, which can be applied in the process of evaluating educational programs in developing countries. Inspired by existing impact assessment methods and theories, and a large set of indicators and metrics, a novel impact assessment method is constructed. Stakeholders from development organisations, as well as local beneficiaries and stakeholders of local schools were approached in order to take all their organisational and personal goals and needs into account. This resulted in a method that requires the collection of data in four different ways. The type of data that is collected depends on the project context. Method fragments can be selected from a method base, after which all method fragments are aggregated in a cohesive method. In this way, the method is adaptable to different projects within the domain of education and ICT4D.

In this chapter the limitations of this research are discussed. Furthermore, the threats to validity that apply to this research are addressed.

8.1 Limitations

The research entails some limitations, which are described in this section. First, the impact assessment method that is proposed in this research is developed within the context of the NGO named Maxim Nyansa. Maxim Nyansa provided the opportunity to reach many stakeholders within the domain of their development projects. It is attempted to reduce the researcher bias to a minimum, but it should be taken into account that the results of the research are not actively tested within a problem context outside of the scope of the Maxim Nyansa foundation. Furthermore, the context data that is used as part

of the data to measure impact in the proposed method contains some metrics that are dependent from third parties. For example, national and regional numbers are required about unemployment ratios, poverty headcounts, and child enrolment in schools. Not for all countries in Africa this data is openly available. Moreover, if the data is available, it is often outdated or incomplete.

It is sought to develop a method that is independent from external factors. Such data can be highly valuable in the evaluation of a development project, but unfortunately these types of data cannot be collected privately. It also has to be mentioned that the pilot study as part of the treatment implementation was on a small scale. Due to the circumstances of COVID-19, no extensive implementation could be performed within the time frame of this research. However, more extensive testing is desirable before the method is applied in practice. Furthermore, the metrics that are part of the method base are limited. The method base consists of 29 method fragments (i.e., indicators) and 281 metrics. Although this is perceived as a large number, the method can still be improved by the addition of other metrics. Many different metrics can be used to assess the impact of a development project. It is sought to provide a set of metrics that is highly comprehensive and with a large variety. However, one should realise that the method base can always be expanded.

It also must be mentioned that the decision to use the PDD modelling language can be a limitation to individuals that want to perform the method in practice. During this research it came forward that the PDD modelling language is not often used by practitioners. The PDD modelling language has a learning curve, meaning that some effort is required to fully understand the model. This can affect the intention to use the method in practice, although this is not mentioned during the validation with experts in the field. Another limitation that must be discussed is that the method that is developed requires that the participants of the survey provide honest answers. It has to be taken into account that the risk remains that socially desirable answers are given in the surveys. Furthermore, the data that is a result from the impact assessment method should be interpreted with care. It should be taken into account that it cannot be concluded with certainty that the impact that is measured is the direct result of the development project at hand. The impact could have another origin, and thus caused by something other than the development project. However, these external factors cannot all be captured in a single impact assessment. Also, the current version of the method has little to no tool support, which can make the use of the method in practice a little overwhelming. Moreover, the current method does not include a manner to compare or benchmark the results of the impact assessment with other projects, which could be very insightful for development organisations. In Section 9.3 this is discussed more elaborately for future research.

8.2 Threats to Validity

In the discussion of the threats to validity, three types are reviewed: (1) internal validity, (2) construct validity, and (3) external validity (e.g., generalisability).

1. **Internal validity.** In order to meet the requirements of internal validity, several measures are taken. A systematic literature review is performed based on the results of an exploratory literature research. In this way, it is ensured that all the concepts that are relevant for this research are taken into account. It has to be mentioned however, that during the design of the novel impact assessment method some stakeholder bias has occured. An attempt was made to prevent stakeholder bias by approaching a wide variety of stakeholders. However, it cannot be stated with confidence that the same results will occur if the research is to be replicated. If another sample of experts of stakeholders is used for the elicitation of requirements and validation, other opinions might have come up.

2. **Construct validity.** For construct validity it is explored whether the novel impact assessment actually reports on the impact of educational development projects. This matter is also discussed during the first focus group in the validation phase. It was mentioned that it is very difficult the impact of a development project, and that for this reason one should always talk about outcomes instead of impacts. This however, is also a discussion of semantics. The impact assessment method that is proposed for this research does provide the opportunity to identify or derive the impact of development projects. However, the question arises if the correct metrics are available to prove the impact of a project over a longer period of time. The use of an interesting set of metrics is very project-specific. This is in line with the last threat to validity: external validity.

3. **External validity.** For the external validity, it is explored whether the results of the research is generalisable to other evaluation environments. Overall, the proposed method is designed in a way so that it can adapt to the project and project environment at hand. Method fragments that are relevant for the concerned project can be selected from the method base. Therefore, a situational method is designed for each development project for which this method is applied. However, it should be taken into account that the novel method is designed for development projects in the domain of education only. The method is not suited to other domains, since education-specific metrics are implemented in the current method base. Furthermore, the method is tested in practice during a pilot study. Data is collected at schools in Ghana. During the focus groups, already the issue of socially desirable answers is discussed. This can be related to the Hawthorne effect. The Hawthorne effect describes that participants in a study can have the tendency to change their behaviours or answers because they know they are studied (Jones, 1992). It should be taken into account that there is a chance that participants of the surveys provide socially desirable answers, because they are aware that a study is being done on the impact of the development project at hand.

Chapter 9

Conclusions

In this chapter the conclusions of this research are described. First, the research questions are answered. After that, the implications of the research are discussed and opportunities for future research are described.

9.1 Answering the Research Questions

First, the research questions that are formulated in Section 2.1 are answered. Before answering the main research question, the sub research questions are answered. The research questions are defined in a way to serve the development of a novel method. The answers of the sub research questions therefore conclude a short summary of the development process of the situational impact assessment method.

9.1.1 SRQ1: Current State-of-the-art of Impact Assessments

Before the development process of a novel impact assessment method is started, first the current state-of-the-art in impact assessments is mapped. An exhaustive literature review is performed in order to create an overview of existing impact assessment methods and the best practices in evaluating development projects. During the search for existing impact assessment methods, the literature that is found earlier is confirmed: most existing methods focus on one specific subject or problem context. For example, some methods only focus on the financial component, where other frameworks aim to map the impact on the livelihoods of beneficiaries. Also frameworks were found that mainly focus on the evaluation of information flows or personal perceptions of individuals. Tot he best of our knowledge, it can be concluded that to date no method exists that takes all indicators into account. Also, no impact assessment methods are found that have the ability to actively anticipate on novel developments and have a wide applicability at the same time.

Furthermore, the goal of this research is to develop an impact assessment method that can be applied to development projects in the educational domain. After a literature review on digital learning transformation, it came forward that an evaluation on educational projects in developing countries requires the inclusion of specific factors. For example, the TPACK model is identified as an important factor that needs to be taken into account in an evaluation on education. TPACK refers to the understanding of teachers about educational technologies and the importance of the interaction between different domains in order to apply technologies in education in an effective manner. Also, the educational system in developing countries differs tremendously from the education in most western countries. Not only there is a difference in the level of ICT use, but also the way education is performed is in contrast with the education in western countries. In most developing

countries, education is given in a traditional way. In other words, education is often teacher-centred. An assessment of the impact of a development project in the context of teacher-centred education differs from an education in the context of interactive education. In teacher-centred education, teachers have a significantly larger impact on the development of students than in interactive education.

In conclusion, many different impact assessment methods and frameworks already exist. However, an impact assessment method that is covering all relevant subjects for a development project in the domain of education is not available. Especially, a method that can be generalised to the use of multiple development projects and organisations in the same domain is not found. However, the existing impact assessment methods did present a variety of metrics and best practices that are adopted to the novel impact assessment method.

9.1.2 SRQ2: Metrics for Performing an Impact Assessment

The second sub-research question asks for research on which metrics can be used for the performance of an impact assessment. Metrics are adopted from already existing impact assessment methods, and novel metrics are defined based on other literature. During the literature research, a large set of impact assessment methods and frameworks is analysed. If the metrics that are used in these methods were deemed relevant and fitting for a novel method that focuses on education, the metrics were selected. Also, during the treatment design phase, numerous sources are approached for the collection of metrics. For example, research on e-readiness of technology in education is analysed for the identification of relevant metrics. Moreover, the literature review provided relevant insights in the best practices of impact assessments, but no concrete metrics were defined yet. An example is the technology acceptance model. In order to measure the technology acceptance of teachers and students in schools, metrics are adopted from a technology acceptance study. Furthermore, an unpublished report from Maxim Nyansa is used, which displays the relevance of certain metrics in local schools. Next to that, the experience of experts is applied by implementing metrics that are discussed to be essential during the expert interviews. It can be concluded there is a large variation in metrics that can be used for the performance of an impact assessment. Some metrics are more general, and are required to collect data about the context of the development project. Other data are more project- and domain-specific.

9.1.3 SRQ3: Methodologically Performing an Impact Assessment

The third sub-research question is drafted in order to conduct research about how impact assessments of educational ICT4D programs should be performed. In order to investigate this, best practices of impact assessment evaluations are analysed. Also, the concept of situational method engineering is investigated. It is studied how an impact assessment method could be standardised and made adaptable by means of situational method engineering. The conclusion that is drawn for this research question is that an impact assessment can be performed methodologically by standardising a large portion of the method. However, since the aim is to make the method generalisable and adaptable to multiple projects in the domain of education, situational method engineering is applied.

A method base is designed which contains a set of method fragments. A selection can be made out of these method fragments in order to construct the impact assessment dataset for a structured evaluation, shaped to the needs of the development project at hand.

9.1.4 SRQ4: Validation of a Novel Impact Assessment Method

This sub-research question has the aim to validate the situational method that is developed. In order to do this, two focus groups are performed with experts in the field of development projects, impact assessments, and education. It can be concluded that no major threats to the validity arose from the focus groups. During the validation, the stakeholder goals that were identified earlier in the development process are reviewed. With the exception of one, the novel impact assessment method does contribute to all stakeholder goals. The goal that prescribes that the method must confirm or disprove that impact is achieved without the influence of external factors cannot be fully satisfied. Without using randomised control trials, it cannot be concluded with the proposed impact assessment method that a development project is the only factor that leads to change. Furthermore, the evaluation model of Moody (2003) is applied to to investigate if the stakeholders actually have an intention to use the novel method. The results of this investigation were positive. A minor change to the method is made as a result of the validation. It was concluded that a guidance should be added for the decision of a sampling strategy. Therefore, an additional step was added in the second phase of the method.

9.1.5 SRQ5: Evaluating Impact Assessment Methods in Practice

The fifth sub-research question asks for the performance of an evaluation of the novel impact assessment in practice. First, the impact assessment method that is proposed in this research is tested as part of a pilot study for the school projects of Maxim Nyansa in Ghana. The implementation was less extensive than planned, due to COVID-19. However, the first three phases of the method are carried out successfully. The pilot study is evaluated with the co-founder of Maxim Nyansa, and an assistant of the enumerator which was responsible for data collection in Ghana. A variety of feedback is discussed, which resulted in a third iteration of the method development. Two minor changes are made to the method. One activity is renamed to make the activity more distinct. Furthermore, a novel activity is introduced that allows the user to provide definitions for each metric. In this way, the metrics are experienced less ambiguous.

9.1.6 Answering the Main Research Question

The main research question of this research is defined as: *What situational method can be designed to perform impact assessments on ICT4D programs in the educational domain?*. The answer to this question is essentially the accumulation of all five sub-research questions. By providing answers to each sub research question, a novel situational impact assessment method is developed. The proposed method aids the assessor in the performance of an impact assessment for development projects in the educational domain. The method is able to adapt to the characteristics of each specific development project by the selection of relevant method fragments. In short, the result of this research question is the development of a novel situational impact assessment method that can be applied in

practice. It is mentioned earlier that to date, no impact assessment method exists that can anticipate on novel developments in a flexible manner, while at the same time the method retains a wide applicability. The impact assessment that is proposed in this research has the option to anticipate on novel developments since the existing method base can be extended. Metrics that are deemed relevant to take into account for a project evaluation and are not included in the current version of the method base, can be implemented manually. In this way, novel developments can also be taken into account. Next to that, the method is designed in a way that it is applicable to all ICT development projects in the domain of education. Only relevant method fragments are selected for the project at hand. In that way, the method is shaped to the needs of the concerned development project. Therefore, it can be concluded that the impact assessment method that is proposed in this research contributes to the research domain of impact assessments by providing a method that is generalisable to all educational development projects, taking future developments into account.

It is decided to provide the proposed impact assessment with the following name: *SIAM-Ed*. SIAM-Ed stands for "Situational Impact Assessment Method for Education". A final version of SIAM-Ed is displayed in Appendix N. In this version, the novel method increments are not depicted, and the model is displayed as a whole.

9.2 Implications

To the knowledge of the researchers, currently no situational impact assessment for the evaluation of development projects in the educational sector exists. This research aims to contribute to the current field of study of impact assessments by providing novel insights about the way an impact assessment can be constructed. It was found in literature that there is often strived towards standardisation of evaluation practices. This research contributes as a step in the right direction with regard to standardisation. The method that is proposed in this research uses the concept of situational method engineering. In other words, the method can be altered in a way so that it matches the project characteristics of the project to be assessed.

Furthermore, this research provides an exhaustive literature review which couples the domains of ICT4D, education, and impact assessments. The impact assessment methods and frameworks that already exist are mostly focused on a more broader domain and divided in three categories: health, social, or environmental. Frameworks to measure e-readiness in education exist, but no methods were found that focus solely on the assessment of education projects in developing countries. Another implication of this research is the contribution to the transparency of development projects towards stakeholders, donors, and sponsors, and funders. By providing a means to evaluate on development projects, the impact that development projects have on their target populations is mapped. If the results are shared with the local governments, and ministries of education, awareness might be created or improved towards the importance of ICT adoption in education.

Next to that, the research results in an impact assessment that can directly be applied in practice. Maxim Nyansa has the goal to perform an exhaustive impact assessment on their school projects in Ghana and other countries in West-Africa, like Burkina Faso, Sierra Leone, and The Gambia. The method that is the result of this research will be applied at Maxim Nyansa for these projects. Moreover, if multiple projects apply the proposed method, the results could be compared. In that way, projects that use the method for an evaluation can benchmark their results based on similar projects. Lastly, an indirect implication of this research is the contribution to the project goals of the development projects that apply the proposed method. Since the impact assessment can support a development organisation in the improvement of their projects and the organisation itself, this research also indirectly aids in the performance of the development projects. Therefore, it can be carefully stated that this research contributes to the improvement of the education system in developing countries, and thus the future perspectives of students and young professionals.

9.3 Future Research

This research leaves a variety of opportunities for future research, which are discussed in this section. First, as the way the method is developed now, tool support is fairly simplistic. Various spreadsheet documents are provided, which can be used to select relevant method fragments, insert data, and create a base for data analysis. However, the performance of the impact assessment could be more efficient and user friendly if a tool is provided that automates parts of this process. With the way the method is developed currently, the survey needs to be manually implemented in a survey tool. After the survey is performed, the results of the survey need to be downloaded manually, so that they can be processed and data analysis can be performed. In order to make this process more user friendly, this entire process could be automated in one cohesive impact assessment tool. With this is meant that the steps from selecting the relevant method fragments, building the survey, performing the survey and analysing the results, could be executed in one place in the form of a software tool. The advantage of such a tool is that the performance of an impact assessment based on the method that is proposed in this research is more user friendly since the usability increases.

In addition to the tool that is described above, the method fragments and metrics could be arranged within an online method base tool. In that way, the selection of method fragments and metrics could be made with less effort. Another great advantage is that the method base could be expanded by the user itself. At the moment, an activity in the first phase of the method provides the opportunity to add additional metrics to the evaluation. This activity is optional, and can be carried out if the decision is made that some relevant metrics are missing in the current method base. However, as the method is developed right now, the addition of metrics is not shared. In other words, if the same situation occurs within another evaluation, the process of creating the additional method has to be performed over again. If a shared method base exists, in the form of an online tool, metrics that are provided by users could be accessed and implemented to other evaluations. In this way, the user is engaged in improving the method. A design challenge is however, that metrics should only be added to the shared method base if the metric is not project specific. For example, during the pilot study of the method in the context of Maxim Nyansa, a metric is added that measures if people have used the online call center of Maxim Nyansa. This metric is too specific to be used by other development organisations or projects. Therefore, some boundaries need to be set so that context dependent metrics are not included in the method base. Furthermore, the data analysis and creation of visualisations is now performed manually, by using the programming language R or Microsoft Excel. In order to improve usability, a Business Intelligence (BI) tool or dashboard could be developed which can effectively display the impacts of development projects. Furthermore, such a BI tool could be implemented in the websites of development organisations to increase transparency to stakeholders. Another advantage of standardised BI dashboard is that the results of evaluations on different development projects can be compared. Therefore, a BI tool can be used for bench-marking purposes.

As already mentioned in Section 4.1.3, the results of the method could be used to perform a prediction. If the impact assessment method is performed multiple times, a lot of training data can is collected. If a baseline study is performed for a novel project, the

baseline data could be used to predict the future course of the development project and the impact it will have on society. However, first research would need to be performed if current data is suited for prediction purposes. In the validation and evaluation of the method came forward that the list of method fragments and metrics can be experiences to be overwhelming. Therefore, it is experienced that the selection of method fragments is a bit complex. Future research could be performed in order to find a way to make the selection of these indicators less overwhelming. Furthermore, the results of the research are only tested in a pilot study for the Maxim Nyansa projects. Since the goal is to develop an impact assessment that can be generalised to other development projects in the domain of education, future research could focus on the implementation of the novel method in similar contexts. Future research could focus on the additional effects that are not captured within the project goals of the development project. Such goals are not captured in the current version of the impact assessment method. Examples of additional effects are social effects in local communities, or the increasement in motivation to use ICT in surrounding regions. Lastly, a novel iteration through the engineering cycle of Wieringa (2014) could be performed in order to optimise the proposed method.

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Appendices

Appendix A

Interview Protocol - Exploratory Interview 1

25-02-2020

Situational Method Engineering for ICT4D: Performing Impact Assessments for Educational Programs

Exploratory Interview 1

This research is performed in an early stage of the study. For this reason, this interview is carried out in a semi-structured manner. The goal of this interview is to identify relevant information that can be of added value to the research. The information that arises in this interview will be used as a supplement to an extensive literature review in order to build a fundamental base for the rest of the research. The questions that are mentioned below are drafted for this interview. However, the interview does not have to be limited to the questions drafted in this document.

Development Projects

1. Can you please elaborate on the development projects in which you were involved in West-Africa?
2. In which countries did those projects take place?
3. What was the main goal of these projects?
4. In what type of environment were these projects performed? Was this a rural environment, or urban areas?
5. On what scale were these projects performed?

Impact assessments

6. What type of impact assessments did you perform? (Social, Environment, Health, other?)
7. What were the specific goal(s) of these impact assessments?
8. Did you use a specific method or framework for the performance of these impact assessments?
9. Did you develop the method or framework for the impact assessment yourself, or did you use an existing method or framework?
    - Why did you choose for that method? Or why did you develop a novel method?
10. What factors had an influence on your decision / the development of this method?
    - So, why was the method suitable for your project(s)?
11. Which Key Performance Indicators are used in the method(s) you used?
    - So which concepts were measured?

- What method for data collection is used during the impact assessments you were involved with?

12. Could you please elaborate on the different steps of the impact assessment methods you used?
    - Were targets defined for each KPI?
    - Are the results of the evaluation compared with other development projects (benchmarking)?

13. Was the performance of the impact assessment supported by IT?
    - For example, are dashboards used for data visualisations?

14. In hindsight, would you have chosen for a different impact assessment method?
    - If yes, why?

15. What are the differences in performing an impact assessment method in developing countries than in western countries?

16. To what extent did you have to take cultural factors into account while performing impact assessments for developing projects?

Appendix B

Interview Protocol - Exploratory Interview 2

02-03-2020

Situational Method Engineering for ICT4D: Performing Impact Assessments for Educational Programs

Exploratory Interview 2

This research is performed in an early stage of the study. For this reason, this interview is carried out in a semi-structured manner. The goal of this interview is to identify relevant information that can be of added value to the research. The information that arises in this interview will be used as a supplement to an extensive literature review in order to build a fundamental base for the rest of the research. The questions that are mentioned below are drafted for this interview. However, the interview does not have to be limited to the questions drafted in this document.

---

1. Can you tell me a bit more about the way your are involved in digital teaching?
2. What is the reason why you are an advocate of ICT in education?
3. Do you think the use of ICT has a positive effect on education?
4. What do you think are the risks of integrating ICT in education?
5. How can these risks be reduced?
6. Are there any other problems you encounter with ICT in education?
7. Do you think this could have an impact on pupils or students in the longer term?
8. To what extent should a balance be brought between the use of ICT and face to face education? Where should this balance be placed? Or are you an advocate of only education in a digital environment?
9. In what ways should that be done?
10. What is your experience with the knowledge of educators in these technologies?

As I mentioned earlier, I am going to develop a method for carrying out an impact assessment of development projects in the field of education.

11. Which factors do you think are important to measure in education?
12. Do digital environments make it easier to maintain good quality in education? Does ICT provide a stable factor in education? Less fluctuations in results?

Appendix C

Interview Protocol - Stakeholder Interviews

MAXIM NYANSA IT SOLUTIONS

Utrecht University

Stakeholder Interview – Stakeholder Goals

My name is Maarten Smulders. I am doing research for my Master's Thesis as part of my study Business Informatics at Utrecht University. This research has the goal of developing a method with which an impact assessment can be performed on development projects. The focus of this impact assessment is on development projects in West-Africa in the educational domain.

This interview has the goal to identify stakeholder goals. Therefore, I conduct various interviews in order to discover what goals and needs the various stakeholders have. In this way I can make better decisions in the design process of the method, and therefore draft the requirements for the method.

- Can you tell me something about your role within development projects?
    - What kind of development projects are you involved in?
    - What are the general goals of these development projects?

- What would be your interest by performing an impact assessment on the development projects you are involved in?

- What are the main goals of an impact assessment from your perspective?

- Why is it important to reach those goals?

- About which factors would you like to see an impact assessment being performed? Especially when you look at the projects you are involved in, on what interventions or specific processes would you like to know if a demonstrable impact has been achieved?
    - What would be the specific case you would like to prove?

- If an impact assessment would be used within your organisation, who would be the end-users of the method? Who is going to perform the method?

- How easy should the method be executable? Should it be feasible for people outside the domain? (think of the use of technical terms)

- When impact is measured, there is of course a dependence on data and information. If a broad and complete picture of the impact of a project can be sketched using a method, then this method most likely has a high dependence on data. With less available data, a less reliable and less broad result can be delivered, but the dependence on data for the method is less. Of course, this is something that is not achievable entirely, but to what extent do you think it is important that a method is independent of the availability of data?
    - Should a method be executable if less data is available?

- Not everywhere in West-Africa, technology is widely available. To what extent do you think an impact assessment may depend on the use of technology?

- What is your definition of a successful impact assessment?

- If an impact assessment has been performed, how should the result look like in your opinion? What should be the end product?

Appendix D

Impact Assessment Document 1.1 - Project Goals Support

IAD-1.1 | Project Goals Support

Document purpose

This document is developed in order to support the assessor and the project provider in the first step of the educational impact assessment method: *Define project goals*. The goal of this first step is to specify the goals of the development project.

In most cases, a clear list of project goals is already in place. However, this list might be very brief or incomplete. This document has the aim to guide the assessor and the project provider to come up with an explicit list of project goals.

This document provides various questions which can be used to guide the assessor or project provider in a way of thinking, so that it might be easier to come up with specific project goals. In addition, this document provides a list of keywords which can also be used as an inspiration to identify more project goals.

Project Goal and Impact Assessment Questions

What are the project objectives in terms of education interventions?

- How is the project aiming to influence or change the regulatory environment, policies, legal framework, awareness among policy makers, or the public?
- How is the project aiming to encourage the provision of ICTs in public or private sectors in order to take up new ICT opportunities, providing ICT infrastructure and/or applications?
- How is the project seeking to enhance service delivery efficiencies through new technologies?
- How is the project seeking to create opportunities for direct use of ICTs by the poor to enhance their livelihoods? (Provision of market data, public use of ICTs)

This document is a component of the Impact Assessment Method which is developed as part of the Master's Thesis of M.J.M. Smulders - Situational Method Engineering for ICT4D: Performing Impact Assessments for Educational Programs - at Utrecht University, in collaboration with Maxim Nyansa IT Solutions (2020).

Keywords

- Accessibility
- Additional effects
- Affordability
- Career
- Cost & benefits
- Education level
- Hardware infrastructure
- ICT employment
- Information needs
- Internet availability
- Internet usage
- Livelihood
- Local economy support
- Network speed and quality
- Technology usage
- Security
- Self-efficacy
- Service and support
- Student performance
- Teacher efficacy
- Technology acceptance

This document is a component of the Impact Assessment Method which is developed as part of the Master's Thesis of M.J.M. Smulders - Situational Method Engineering for ICT4D: Performing Impact Assessments for Educational Programs - at Utrecht University, in collaboration with Maxim Nyansa IT Solutions (2020).

Appendix E

Impact Assessment Document 1.2 - Goal Modelling with GoalML

IAD-1.2 | Goal Modelling with GoalML

Document purpose

The purpose of this document is to guide the assessor and project provider in creating a goal model as part of the second step of the educational impact assessment method: *Create goal model*. The goals that are modelled in this step are identified during the previous step of the method, which is called *Define project goals*.

The goal model is made with the use of GoalML. GoalML is a modelling language which is very elaborate. However, only a specific set of functionalities is used for the goal model that will be created during this impact assessment. This document provides a step by step explanation of how to create a goal model with GoalML. Furthermore, an explanation of the semantics of the modelling language is given.

The GoalML specification is derived from Köhling (2013). Also, the various shapes and symbols are derived from Köhling (2013), or are created using the MS Visio Template.

Tool support

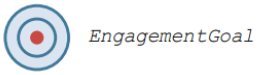
Creating a goal model using GoalML can be done using MS Visio. A GoalML template, which can be implemented in MS Visio, can be used in order to have access to the relevant icon set. The name of this document is *GoalML Template*, and can be found in the *SupportDocsIA* folder.

If you do not have access to MS Visio, you might also be able to implement the template in another free modelling tool (e.g. Lucidchart), or draw the model on paper.

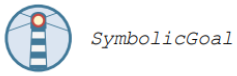
Creating a goal model

In order to create a goal model, first a set of project goals need to be in place. In the previous step of the impact assessment, such a list of project goals is composed. These goals can be split up in two different types of goals: Engagement goals, and Symbolic goals.

An engagement goal is visualised with the following symbol, and is used for the visualisation of specific goals, which can directly be measured using specific metrics. In other words, an engagement goal is a goal of which the desired result is quantifiable. An example of an engagement goal is “decrease risk costs”.



A symbolic goal is visualised with the symbol below. With symbolic goals are meant, goals where no specific metrics can be defined to measure that specific goal. In other words, a symbolic goal is a goal of which the desired result is not directly quantifiable and includes a qualitative aspect. An example of a symbolic goal is “increase customer satisfaction”.



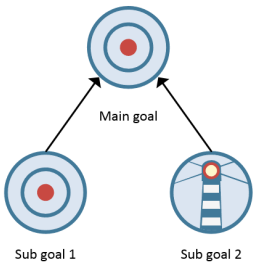
Therefore, the first step in creating a goal model is the following:

1. Divide your set of goals in engagement goals and symbolic goals.

After that, relations van be drawn between the goals. In most cases, there are different levels of abstraction in the set of goals. One goal might be the main goal of a project, with other goals being supportive of this main goal. It can also be the case that there are multiple main goals in place. The second step is as follows:

2. Create a goal structure with different levels and relations.

In order to do this, the main goal(s) should be identified. After that, the goals that directly support this main goal should be connected with an arrow. An example is shown in the figure below.



If all the goals are structured in this manner, the result will be a model containing all the project goals that were identified earlier.

Then, there are some specific small symbols that can be added to the various goals. Each addition will be explained here. The addition of these small symbols can be useful, but are not a necessary addition for every goal. Therefore, these symbols only need to be modelled if it has added value to the model.

The final step in creating the goal model is as follows:

3. Model additional features to each project goal.

The first addition is the *generalDirection*. With this, it can be indicated if the goal has the aim to increase, decrease, or stay the same. For example, if a project goal prescribes to improve the number of computers that are available in schools. The goal has the aim to increase this number. In that case, a + sign can be added in the top right of the goal. If the goal is to decrease, a – sign can be added to the top right of the goal. And if the goal is to keep something equal, the = sign can be added. How this is done is shown below.

generalDirection:
increase/keep/decrease

Goal

Another important factor in the goal model is the addition of targets. For every specific goal, a *value* can be described. This value defines the numeral target for the specific project goal. This target can be defined with a white box below the goal icon like shown below. It is of great importance to add a target value if these are defined. These values can be used to indicate the progress of the impact that has been made by the project. The block as seen below is used to indicate this value.

value (der fokalen *Abstract-SituationRelation*)

Together with such a target value, it should be indicated if the value should be achieved once at a time (en-bloc), as a minimum (satisfy), as exactly that specific value (exact), that the value should be maintained (maintain), or that the value should be improved upon (improve).

The different values of the value van be visualised with the following icons:

En-bloc

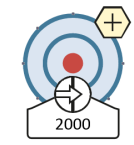
Satisfy

Exact

Maintain

Improve

This can be applied in the model as follows:

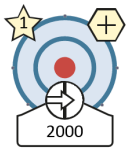


Increase number of PCs deployed

Lastly, it is possible to give some goals a priority. Therefore it can be the case that some goals need to be achieved before others. Priority can be indicated with a star shape, including the number of priority (with 1 being the highest priority). The visualisation for this is as follows:

absolutePriority

Furthermore, this can be visualised in the model as follows:



Increase number of PCs deployed

There are plenty more options to expand the goal model with. However, these are not necessary for the purpose of this impact assessment method. However, you are free to implement additional shapes as explained in

---

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Appendix F

Impact Assessment Document 1.3 - Method Fragment Selection

IAD-1.3 | Method Fragment Selection

Document purpose

This document is developed in order to guide the assessor and project provider in the selection of relevant method fragments (i.e. indicators) to be used during the impact assessment process. This document should be used during two steps of the method, the first one being *Select relevant method fragments*, and the second one being *Determine demographics of interest*.

Every development project is different. Therefore, not every method fragment/indicator that is listed below is relevant for each impact assessment and development project. Also, every impact assessment might focus on a different demographic part of the population to be assessed. This document gives an overview of the 29 different method fragments, and their corresponding metrics. In this way, the document might support the assessor and project provider in creating a better overview of the indicators of interest.

List of Method Fragments (i.e. Indicators)

The method fragments which are displayed in **green** are used as default. These method fragments should be applied in each impact assessment, as they form a foundation for the evaluation.

General project	**General national**
General regional	**Demographic**
Accessibility	Additional effects
Affordability	Career
Cost-Benefit	Education level
Hardware infrastructure	ICT employment
Information needs	Internet availability
Internet usage	Livelihood
Local economy support	Network speed and quality
PC usage	Security
Self-efficacy	Service and support
Smartphone usage	Tablet usage
Teacher efficacy	Technology acceptance PC
Technology acceptance smartphone	Technology acceptance tablet
TPACK (Pedagogical-, technological-, and content-knowledge in teachers)	

Overview of Method Fragments and their Corresponding Metrics

Again, the method fragments which are displayed in green are used as default. Furthermore, it should be mentioned that the metrics which are mentioned in the tables below are collected in various ways and with various individuals (project provider, community/school leader, teachers, students).

General project

Metric	Data type
Number of schools reached (number of projects)	Numeric
Number of students reached	Numeric
Deployment rate (per month)	Numeric
Number of employees in school/project environment	Numeric
Number of students in school/project environment	Numeric
Total number of courses offered by school	Numeric
Total number of teachers	Numeric
Number of teachers with ICT literacy skills	Numeric
Number of teachers with teaching certification	Numeric
Number of teachers with ICT certification	Numeric
Number of new teachers in past year	Numeric
Number of teachers left in past year	Numeric
Average student grade overall	Numeric
Average student grade ICT class	Numeric
Repeater ratio	Numeric

General national

Metric	Data type
Unemployment rate national	Numeric
Unemployment rate youth (ages 15-24) national	Numeric
Gross domestic product (GDP) per capita	Numeric
Most recent poverty headcount ratio at $1.90 a day (2011 PPP) (% of population)	Numeric
Average grade for target students (national)	Numeric
Child enrolment (number of children not in school ages 5-14) national	Numeric
Average student grade ICT class (national)	Numeric
Repeater ratio (national)	Numeric

General regional

Metric	Data type
Unemployment rate target region	Numeric
Unemployment rate youth (ages 15-24) target region	Numeric
Average grade for target students (regional)	Numeric
Child enrolment (number of children not in school ages 5-14) regional	Numeric
Average student grade ICT class (regional)	Numeric
Repeater ratio (regional)	Numeric

Demographic

Metric	Data type
Age	Num
Gender	MC Answer (Num)
Country	String
Place of residence	String
Place of school	String
School name	String
Education level	MC Answer (Num)
Number of times solicited	Num
Number of jobs	Num

Career

Metric	Data type
Graduated	Binary
Job	Binary
Happiness with job	Likert (Num)
Satisfaction salary	Likert (Num)
Hindsight help of project	Likert (Num)

Cost-Benefit

Metric	Data type
Recurring (variable) expenses of the ICT4D project per year (can include Internet subscriptions, stationery and other consumables, maintenance, phone connection costs, utilities, staff salary, etc)	Numeric
Direct income generated by the ICT4D project per year (if applicable)	Numeric
Money saved from using the ICT4D project per year(if applicable)	Numeric
One-off (initial) expenses of the ICT4D project (can include ICT hardware and software costs, building renovation costs, other physical infrastructure costs, initial training, set-up costs, etc.)	Numeric

Education level

Metric	Data type
Satisfaction ICT knowledge	Likert (Num)
Satisfaction level of education	Likert (Num)
Satisfaction ICT knowledge teacher	Likert (Num)
Satisfaction ICT level lessons	Likert (Num)
Satisfaction ICT quantity lessons	Likert (Num)
Education challenges	Likert (Num)

Accessibility

Metric	Data type
Number of students in school/project environment that make active use of ICT facilities	Numeric
Number of hours a week that computers are freely accessible	Numeric
Number of days a week that computers are freely accessible	Numeric
Number of hours of computers usage scheduled for lessons	Numeric
Number of hours a week that computers are accessible for outsiders	Numeric
Access to personal accounts for students	Binary
Access to personal accounts for employees	Binary

Additional effects

Metric	Data type
Wider effects community/personal	Binary
Type of effects community/personal	Binary

Affordability

Metric	Data type
Total expenditure of the school/project environment in US Dollars per year	Numeric
Internet costs in US Dollars per year	Numeric
Satisfaction internet costs	Binary
Maintenance costs of hardware in US Dollars per year	Numeric
Budget for ICT training teachers	Binary
Budget value for ICT training teachers in US Dollars per year	Numeric
Total revenue of the school/project environment in US Dollars per year	Numeric

Hardware infrastructure

Metric	Data type
Number of mobile phones available for staff (including personal mobile phones)	Numeric
Number of Personal Computers or laptops available	Numeric
Number of tablets available	Numeric
Number of printers available	Numeric

ICT employment

Metric	Data type
Motivation ICT professionals	Likert (Num)
Qualification ICT professionals	Likert (Num)
Retainment ICT professionals	Likert (Num)
Saturation ICT professionals	Likert (Num)
Importance of ICT literacy for career progression	Likert (Num)
Satisfaction with ICT lessons for career	Likert (Num)
Perceived chance of job	Likert (Num)

Information needs

Metric	Data type
Main sources of general information	Scale
Type of information needs	Scale
Availability digital educational material	Likert (Num)
Availability digital interactive educational content	Likert (Num)

Internet availability

Metric	Data type
Availability Internet connection	Binary
Internet download speed in MB per second	Numeric
Internet upload speed in MB per second	Numeric
Intranet availability	Binary
Number of PCs connected to Intranet	Numeric

Internet usage

Metric	Data type
Internet use before	Binary
Internet use importance	Scale
Satisfaction internet usage	Likert (Num)
Added value of internet in education	Likert (Num)
Added value of internet personal	Likert (Num)

This document is a component of the Impact Assessment Method which is developed as part of the Master's Thesis of M.J.M. Smulders - Situational Method Engineering for ICT4D: Performing Impact Assessments for Educational Programs - at Utrecht University, in collaboration with Maxim Nyansa IT Solutions (2020).

Livelihood

Metric	Data type
Survival threshold	Likert (Num)
Protection threshold (1-3)	Likert (Num)
New skills (1-2)	Likert (Num) & Scale
Availability of support services	Likert (Num)
Community participation	Likert (Num)
Personal empowerment	Likert (Num)

Local economy support

Metric	Data type
Percentage of hardware items supplied by local parties	Numeric
Percentage of supplemental accessories (e.g. furniture) supplied by local parties	Numeric

Network speed and quality

Metric	Data type
Restore time network failure	Scale
Type of Internet connection	Scale
Number of local telephone calls successful on first attempt	Binary
Satisfaction internet speed	Likert (Num)
Internet speed institution better than internet cafes	Likert (Num)
Internet speed frustration	Likert (Num)
Perception restore time	Likert (Num)

PC Usage

Metric	Data type
Number of courses that are supplemented with PC usage	Numeric
PC usage for word processing	Binary
PC usage for spreadsheets and DBMS	Binary
PC usage for communication	Binary
PC usage for resources on Internet	Binary
PC usage for instruction	Binary
Used a computer before	Binary
Accessibility PC/laptop	Binary
PC usage location	Scale
PC usage purpose	Scale
Satisfaction computer availability	Likert (Num)
Added value of PCs in education	Likert (Num)
Added value of PCs personal	Likert (Num)
Perception of increased productivity	Likert (Num)

Security

Metric	Data type
Use of anti-virus	Binary
Physical security in place	Binary
Number of data backups per year	Numeric

Self-efficacy

Metric	Data type
Self-efficacy using windows computer	Likert (Num)
Self-efficacy perform word processing tasks	Likert (Num)
Self-efficacy entertainment	Likert (Num)
Self-efficacy information searching	Likert (Num)
Self-efficacy confident at school	Likert (Num)
Self-efficacy good use of internet	Likert (Num)

Service and support

Metric	Data type
Number of employees with hardware maintenance skills	Numeric
Failure frequency computer	Scale
PC failure restore time	Scale
Most common type of computer failure	Scale
Frequency power failure	Scale

Smartphone usage

Metric	Data type
Used a smartphone before	Binary
Smartphone accessibility	Binary
Smartphone usage purpose	Scale
Added value of smartphones in education	Likert (Num)
Added value of smartphones personal	Likert (Num)

Tablet usage

Metric	Data type
Used a tablet before	Binary
Tablet accessibility	Binary
Tablet usage purpose	Scale
Added value of tablets in education	Likert (Num)
Added value of tablets personal	Likert (Num)

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Teacher efficacy

Metric	Data type
Efficacy for instructional strategies (1-4)	Likert (Num)
Efficacy for classroom management (1-4)	Likert (Num)
Efficacy for student engagement (1-4)	Likert (Num)

Technology acceptance PC

Metric	Data type
Perceived ease of use (1-2)	Likert (Num)
User satisfaction (1-4)	Likert (Num)

Technology acceptance tablet

Metric	Data type
Perceived ease of use (1-2)	Likert (Num)
User satisfaction (1-4)	Likert (Num)

Technology acceptance smartphone

Metric	Data type
Perceived ease of use (1-2)	Likert (Num)
User satisfaction (1-4)	Likert (Num)

T-PACK

Metric	Data type
Pedagogical knowledge (PK) (1-7)	Likert (Num)
Technological knowledge (TK) (1-4)	Likert (Num)
Content knowledge (1-4)	Likert (Num)
Interaction between pedagogical and content knowledge (PCK) (1-6)	Likert (Num)
Interaction between technological and pedagogical knowledge (TPK) (1-6)	Likert (Num)
Interaction between content and technological knowledge (TCK) (1-4)	Likert (Num)

Appendix G

Impact Assessment Document 4.1 - Impact Evaluation Questions

IAD-4.1 | Impact Evaluation Questions

Document purpose

This document has been drafted in order to guide the assessor and the project provider in the last phase of the impact assessment. More specifically, this document aims to guide in carrying out the step: *Evaluate with evaluation questions*.

This document prescribes various questions, which can be answered for every outcome of the measurements that have been performed earlier in the impact assessment. These questions can help in drafting conclusions about the impact of the project, and in making decisions about the future development of the project.

Evaluation questions

If possible, it would be highly beneficial to involve local parties in the evaluation of the results. This is not mandatory, but highly advised.

1. Is the impact desirable?
2. What is the time of the impact? (short term/long term?)
3. Is the impact sustainable over time?
4. What is the severity of the impact?
5. What is the number of beneficiaries of the impact?
6. What is the level of impact on different individuals in the community?
7. Is the impact in line with the goals of the development project?

Appendix H

Impact Assessment Document 2.1 - Defining Sampling Strategy

IAD-2.1 | Defining Sampling Strategy

Document purpose

This document is developed in order to guide the assessor and the project provider in the first step of the second phase of the impact assessment method. The goal of this step is to determine an appropriate sampling method for the evaluation of the development project.

This document provides two simple steps in order to make a decision on the sampling strategy for the performance of the surveys.

It can be decided to select the entire population as a sample for the surveys. If this is not desired or not feasible, a smaller sample can be chosen which represents the entire population. If this is the case, an appropriate sample size needs to be chosen.

Step 1: Defining sample size

It is suggested to use a confidence interval of 5, making the confidence level 95%. If you want to increase the precision level of the results, you may want to choose a confidence interval of 2. If you want to increase the accuracy of your survey results, you can use a confidence level of 99%.

In order to calculate your sample size, it is suggested to use an online tool[1].

Step 2: Defining sampling technique

Furthermore, a sampling technique needs to be chosen. It is suggested to use random sampling. However, it is assumed that it can be challenging to reach certain project environments, especially rural areas. Therefore, the decision can be made to use non-random sampling in the form of convenience sampling.

Reference

Gombitova, J., Soet, G., Poelert, A., Sarna, K., Mukherjee, R., Clerx, C., . . . Kraus, S.(2020).Capture reliable data in the international development sector. Akvo. Retrieved from https://datajourney.akvo.org/ebook-capture-reliable-data-in-the-international-development-sector

[1] https://www.surveysystem.com/sscalc.htm

Appendix I

Activity and Concept Table of Impact Assessment Method

Table I.1: Activity Table of the Impact Assessment Method PDD

Activity	**Description**
Define project goals	The project goals of the development project that is to be assessed should be defined. This can be done based on discussion between the assessor and the project provider, or existing project documentation. An additional document is drafted in order to stimulate the creative thinking of assessor and project provider. This document is named IAD-1.1. The activity results in a LIST OF PROJECT GOALS
Create goal model	A goal model should be created about the development project that is to be assessed. It is suggested to create a goal model using GoalML. A manual is drafted in order to aid the assessor and project provider in the process of creating a goal model. This manual can be found in IAD-1.2. The activity results in a GOAL MODEL.
Select relevant method fragments	A set of relevant method fragments should be defined. In an additional document (IAD-1.3) an exhaustive list of method fragments and their corresponding metrics is shown. These so-called method fragments are indicators which are used for the measurement of the impact of a development project. IAS-3.1 can be used in order to select the relevant method fragments at hand. This activity results in a SELECTION OF METHOD FRAGMENTS.
Add additional metrics	If it desirable or deemed necessary, a set of additional metrics can be added. If specific metrics are relevant or interesting for the project to be assessed, and these are not available in the already existing set of method fragments and metrics, they can be added manually. This results in a SUPPLEMENTED SET OF METHOD FRAGMENTS.

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Table I.1 – *Continued from previous page*

Activity	**Description**
Define targets for each metric	For each metric that is chosen to be relevant for the project to be assessed, a target should be defined. This results in a SET OF DEFINED METRIC TARGETS within IAS-3.1.
Determine demographics of interest	The demographics of interest should be defined. In order to collect data in a specific manner, the demographics of interest should be defined. IAD-1.3 is assigned to guide the assessor and project provider to see which differences in demographics could be used to filter the population and create a more narrow sample. This activity results in a LIST OF RELEVANT DEMOGRAPHICS.
Collect context data	Context data should be collected and processed in IAS-2.1, which results in a DATASET CONTEXT DATA.
Perform survey with community/school leader	A survey should be performed with community or school leaders in the project environment of the development project to be assessed, resulting in a SET OF LEADER SURVEY RESULTS.
Perform survey with teacher(s)	A survey should be performed with teachers in the project environment of the development project to be assessed, resulting in a SET OF TEACHER(S) SURVEY RESULTS.
Perform survey with student(s)	A survey should be performed with students in the project environment of the development project to be assessed, resulting in a SET OF STUDENT(S) SURVEY RESULTS.
Process data in collective dataset	The context data and the survey results data should be merged in a collective dataset, which results in a COLLECTIVE DATASET.
Perform data analysis on results	Data analysis should be performed on the data that is collected in the COLLECTIVE DATASET. This results in DATA ANALYSIS RESULTS.
Create general data visualisations	Data visualisations should be created based on the data analysis that is done in the previous activity. This results in DATA VISUALISATIONS.
Visualise specific demographic data	If there is an interest in a specific set of demographic data, it can be decided to visualise this data, which also results in DATA VISUALISATIONS.

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Table I.1 – *Continued from previous page*

Activity	**Description**
Insert data in spreadsheet	In order to perform an evaluation, all the data should be inserted in IAS-3.1. This results in a FINAL DATA SHEET with IAS-3.1 as a template.
Evaluate on metric results	A superficial evaluation on the results of the metrics should be performed. This evaluation consists of looking at the results of the statistical tests and concluding if the development project is following the right path. This results in a METRIC EVALUATION.
Evaluate on project goals and targets	A more in-depth evaluation should be performed, taken into account the goals and targets that are defined earlier. This results in a PROJECT GOAL EVALUATION.
Evaluate with evaluation questions	An evaluation should be performed based on the evaluation questions that are defined in the additional document named IAD-4.1. This results in an IMPACT EVALUATION.
Write impact assessment report	Based on the results of the evaluations performed in the previous activities, an IMPACT ASSESSMENT REPORT should be written.
Create or change project plans	If it is desirable, the IMPACT ASSESSMENT REPORT can be used to change the project plans. This results in an ADJUSTED PROJECT PLAN.

Table I.2: Concept Table of the Impact Assessment Method PDD

Concept	**Description**
LIST OF PROJECT GOALS	A basic list of project goals of the development project to be assessed.
GOAL MODEL	A goal model of the development project to be assessed, created with GoalML (or possibly another goal modelling language).
SELECTION OF METHOD FRAGMENTS	A selection of method fragments that is relevant for the development project to be assessed. Not all method fragments are interesting to take into account for every development project. Therefore a selection is defined for which indicators are relevant for the concerned project.

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Table I.2 – *Continued from previous page*

Concept	**Description**
SUPPLEMENTED SET OF METHOD FRAGMENTS	If the current method base does not suffice, extra method fragments can be supplemented. This is a set of method fragments which are defined for the specific development project at hand, which are not available in the already existing method base.
SET OF DEFINED METRIC TARGETS	A set of targets that is defined for each metric in IAS-3.1. These targets can be numeral or a value can be given for a likert scale statement. Also for a boolean question a value of yes or no can be denoted as a target.
LIST OF RELEVANT DEMOGRAPHICS	A list of demographic boundaries that are used for scoping the impact assessment.
DATASET CONTEXT DATA	A dataset based on the method fragments and metrics that are assigned to context data.
SET OF LEADER SURVEY RESULTS	A dataset based on the results of the community/school leaders survey.
SET OF TEACHER(S) SURVEY RESULTS	A dataset based on the results of the teachers survey.
SET OF STUDENT(S) SURVEY RESULTS	A dataset based on the results of the students survey.
COLLECTIVE DATASET	A dataset which combines the context data, and the results of the three surveys.
DATA ANALYSIS RESULTS	The results from performing the data analysis task. This can be in the form of statistical results, correlations, etc.
DATA VISUALISATIONS	Data visualisations based on the data analysis of the context data and the survey results.
FINAL DATASHEET	IAS-3.1, supplemented with all the data results (and the targets defined during the *define targets for each metric* activity.
METRIC EVALUATION	A textual representation of the superficial evaluation on the results of the metrics.
PROJECT GOAL EVALUATION	A textual representation of the evaluation on the project goals and targets.
IMPACT EVALUATION	A textual representation of the evaluation based on the evaluation questions.

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Table I.2 – *Continued from previous page*

Concept	**Description**
IMPACT ASSESSMENT REPORT	A report that describes the impact of the development project. The report is based on the METRIC EVALUATION, the PROJECT GOAL EVALUATION, and the IMPACT EVALUATION. This can be supplemented with other conclusions that are drawn from performing the impact assessment.
ADJUSTED PROJECT PLAN	A textual representation of plans to change the development project based on the impact assessment.

Appendix J

Overview of Sources per Method Fragment

Table J.1: Overview of sources per method fragment

Method Fragment	**Sources**
Cost-Benefit	Heeks and Alemayehu (2009)
General national	Stephens et al. (2020); The World Bank (2016); Heffernan et al. (2016)
General project	Stephens et al. (2020); Kashorda and Waema (2014)
General regional	Stephens et al. (2020); The World Bank (2016); Heffernan et al. (2016)
Accessibility	Kashorda and Waema (2014)
Additional effects	Heeks and Alemayehu (2009)
Affordability	Kashorda and Waema (2014); Stephens et al. (2020), Stakeholder interviews (Section 4.1.2)
Hardware infrastructure	Kashorda and Waema (2014)
Internet availability	Kashorda and Waema (2014)
Internet usage	Kashorda and Waema (2014)
Local economy support	Stakeholder interviews (Section 4.1.2)
Network speed and quality	Kashorda and Waema (2014); Stephens et al. (2020)
PC usage	Kashorda and Waema (2014); Stephens et al. (2020)
Security	Kashorda and Waema (2014), Personal communication with Maxim Nyansa employees
Service and support	Kashorda and Waema (2014)
Demographic	Das et al. (2007); Kashorda and Waema (2014), Stakeholder interviews (Section 4.1.2)
Information needs	Kashorda and Waema (2014); Stephens et al. (2020)
Smartphone usage	Stephens et al. (2020); Kashorda and Waema (2014)
Tablet usage	Stephens et al. (2020); Kashorda and Waema (2014)
Education level	Kashorda and Waema (2014); Stephens et al. (2020), Stakeholder interviews (Section 4.1.2)
ICT employment	Kashorda and Waema (2014)
Teacher efficacy	Tschannen-Moran and Hoy (2007)
Technology acceptance PC	Abu-Dalbouh (2013)
Technology acceptance tablet	Abu-Dalbouh (2013)

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Table J.1 – *Continued from previous page*

Method Fragments	**Sources**
Technology acceptance smartphone	Abu-Dalbouh (2013)
TPACK	Valtonen et al. (2017)
Self-efficacy	Tsai and Tsai (2003)
Career	Stakeholder interviews (Section 4.1.2)
Livelihood	Livelihoods Centre (n.d.); Mwenda and Turpin (2016)

Appendix K

Translation of Metrics into Survey Questions

Table K.1: Translation of metrics into survey questions - Community/School leader

Method Fragment	Metric	Survey Question
Accessibility	Number of students in school/project environment that make active use of ICT facilities	What is the number of students in the school/project environment that makes active use of ICT facilities (e.g., PCs)?
Accessibility	Number of hours a week that computers are freely accessible	How many hours a week are the computers at your school/project environment freely accessible?
Accessibility	Number of days a week that computers are freely accessible	How many days a week are the computers at your school/project environment freely accessible?
Accessibility	Number of hours of computers usage scheduled for lessons	How many hours a week are the computers at your school/project environment in use for scheduled lessons?
Accessibility	Number of hours a week that computers are accessible for outsiders	For how many hours a week are the computers at your school/project environment accessible for outsiders (excluding students/staff)?
Accessibility	Access to personal accounts for students	Do students all have a personal account which they can use to work on the computers?
Accessibility	Access to personal accounts for employees	Do employees all have a personal account which they can use to work on the computers?
Additional effects	Wider effects community/personal	Do you perceive wider effects in the community or your personal life after the project has been implemented?
Additional effects	Type of effects community/personal	Do you perceive these wider effects to be positive?
Affordability	Total expenditure of the school/project environment in US Dollars per year	What is the total expenditure of the school/project environment in US Dollars per year?
Affordability	Internet costs in US Dollars per year	What are the internet costs per year in US Dollars?

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Table K.1 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
Affordability	Satisfaction internet costs	Are you satisfied with the price for Internet?
Affordability	Maintenance costs of hardware in US Dollars per year	What are the maintenance costs of hardware per year in US Dollars?
Affordability	Budget for ICT training teachers	Is there a budget available to train teachers in ICT skills?
Affordability	Budget value for ICT training teachers in US Dollars per year	What is the budget for ICT training for teacher per year in US Dollars?
Affordability	Total revenue of the school/project environment in US Dollars per year	What is the total revenue of the school/project environment in US Dollars per year?
General project	Number of employees in school/project environment	What is the total number of employees in your school/project environment?
General project	Number of students in school/project environment	What is the total number of students in your school/project environment?
General project	Total number of courses offered by school	What is the total number of courses that is offered by the school?
General project	Total number of teachers	What is the total number of teachers that is active within the school/project environment?
General project	Number of teachers with ICT literacy skills	What is the number of employees (both staff and teachers) that has ICT literacy skills?
General project	Number of teachers with teaching certification	What is the number of teachers that has a teaching certification?
General project	Number of teachers with ICT certification	What is the number of teachers that has an ICT certification?
General project	Number of new teachers in past year	What is the number of new teachers that started working in your school in the past year?
General project	Number of teachers left in past year	What is the number of teachers that left your school in the past year?
General project	Average student grade overall	What is the overall average grade of the students in your school/project environment?

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Table K.1 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
General project	Average student grade ICT class	What is the average grade of the students for ICT class in your school/project environment?
General project	Repeater ratio	What is the number of students that repeats current year in your school/project environment?
Hardware infrastructure	Number of mobile phones available for staff (including personal mobile phones)	How many mobile phones are available for staff (including personal mobile phones)?
Hardware infrastructure	Number of Personal Computers or laptops available	What is the number of Personal Computers that is available within the school/project environment (for both staff and students)?
Hardware infrastructure	Number of tablets available	What is the number of tablets that is available within the school/project environment (for both staff and students)?
Hardware infrastructure	Number of printers available	What is the number of printers that is available within the school/project environment?
Hardware infrastructure	Connectivity to local network	Are the all the computers in the school/project environment connected through a local network?
Internet availability	Availability Internet connection	Is there a working internet connection available at the school/project environment?
Internet availability	Internet download speed in MB per second	What is the download speed of the internet at the school/project environment in MB per second?
Internet availability	Internet upload speed in MB per second	What is the upload speed of the internet at the school/project environment in MB per second?
Internet availability	Intranet availability	Is there an Intranet available at the school/project environment?
Internet availability	Number of PCs connected to Intranet	What is the number of personal computers that is connected to the Intranet network?
Local economy support	Percentage of hardware items supplied by local parties	What is the percentage of hardware items (PCs', laptops, mobile phones) that is supplied by local parties?

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Table K.1 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
Local economy support	Percentage of supplemental accessories (e.g., furniture) supplied by local parties	What is the percentage of supplemental accessories (furniture for example) that is supplied by local parties?
Network speed and quality	Restore time network failure	How long does it take to restore a internet network failure? (Answers: <1 hour; 1-5 hrs; 6-12 hrs; 1-2 days; >2days)
Network speed and quality	Type of Internet connection	What type of internet connection do you have available at your school/project environment? (Answers: 2g, 3g, 4g, adsl wifi)
PC usage	Number of courses that are supplemented with PC usage	What is the number of courses that are supplemented with PC usage?
PC usage	PC usage for word processing	Are PCs in the school/project environment used for word processing tasks?
PC usage	PC usage for spreadsheets and DBMS	Are PCs in the school/project environment used for spreadsheet and DBMS (Database Management) tasks?
PC usage	PC usage for communication	Are the PCs in the school/project environment used for communication purposes (e.g., email to students)?
PC usage	PC usage for resources on Internet	Are the PCs in the school/project environment used for accessing resources on the internet?
PC usage	PC usage for instruction	Are the PCs in the school/project environment used to incorporate ICTs in instruction and/or curricula?
Security	Use of anti-virus	Are all computers equipped with anti-virus software?
Security	Physical security in place	Is all hardware physically secured?
Security	Number of data backups per year	How many times per year is the data on the computers being backed up?
Service and support	Number of employees with hardware maintenance skills	What is the number of employees that has the skills to perform maintenance tasks on hardware?

Table K.2: Translation of metrics into survey questions - Teacher(s)

Method Fragment	**Metric**	**Survey Question**
Demographic	Age	What is your age?
Demographic	Gender	What is your gender?
Demographic	Country	In what country do you go to school?
Demographic	Place of residence	In what city, town or village do you live?
Demographic	Place of school	In what city, town or village do you teach at school?
Demographic	School name	What is the name of the school you teach at?
Demographic	Education level	What is currently your highest education level?
Demographic	Number of times sollicited	What is the number of times you had a job sollicitation?
Demographic	Number of jobs	What is the number of jobs you had in the past (including current job if applicable)?
Information needs	Main sources of general information	What is your main source of general information in order of importance? (1 – Most Important, 7 – Least Important) (Answers: Colleagues, Newspapers, Radio, Television, Internet, Lecturer, Books/Journals)
Information needs	Type of information needs	What type of information do you need in order of importance? (1- Most Important, 6 – Least Important) (Answers: Academic, Research, Administration, News/Entertainment/Shopping, Emergency/Help/Rescue, Banking/Investments)
Internet usage	Internet use before	Have you ever used internet services?
Internet usage	Internet use importance	In order of importance, what do you use the internet for? (Answers: E-mail; news/entertainment; business transactions/banking; general search for information; academic(learning, teaching, research)

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Table K.2 – *Continued from previous page*

Method Fragment	Metric	Survey Question
Network speed and quality	Number of local telephone calls successful on first attempt	Are most of your local telephone calls from your school/project environment successful on the first attempt?
PC usage	Used a computer before	Have you ever used a computer? (Deze linken met blauw aan een aantal pc usage vragen)
PC usage	Accessibility PC/laptop	Do you have access to a Personal Computer or laptop?
PC usage	PC usage location	Where do you make use of a computer in general? (Answers: Home; Workplace; Home & Workplace; Internet café)
PC usage	PC usage purpose	For what purpose did/do you use the computer? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)
Service and support	Failure frequency computer	What is the frequency of failure of the computer you use in the school/project environment? (Answers: Daily; Once per week; 2 times per week; once per month; hardly)
Service and support	PC failure restore time	When there is a failure with a PC, how long does it take to restore the fault? (Answers: <1 hour; 1-6 hrs; 1 day; >1 day)
Service and support	Most common type of computer failure	What is the most common type of computer failure? (Answers: unable to log in; no e-mail access or internet; unable to load applications; computer is dead)
Service and support	Frequency power failure	How often do you experience power failure and you are unable to use your computer? (Answers: Once a day; Once a week; Once a month; Never)
Smartphone usage	Used a smartphone before	Have you ever used a smartphone before?
Smartphone usage	Smartphone accessibility	Do you have access to a smartphone?

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Table K.2 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
Smartphone usage	Smartphone usage purpose	For what purpose did/do you use a smartphone? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)
Tablet usage	Used a tablet before	Have you ever used a tablet before?
Tablet usage	Tablet accessibility	Do you have access to a tablet?
Tablet usage	Tablet usage purpose	For what purpose did/do you use a tablet? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)
Additional effects	Wider effects community/personal	Do you perceive wider effects in the community or your personal life after the project has been implemented?
Additional effects	Type of effects community/personal	Do you perceive these wider effects to be positive

Table K.3: Translation of metrics into survey statements - Teacher(s)

Method Fragment	**Metric**	**Survey Statement**
Education level	Satisfaction ICT knowledge	I am satisfied with my own level of ICT knowledge and expertise.
ICT employment	Motivation ICT professionals	The ICT professionals at my school are motivated.
ICT employment	Qualification ICT professionals	The ICT professionals at my school are qualified and experienced.
ICT employment	Retainment ICT professionals	I recognise that my school retains experienced and qualified ICT professionals.
ICT employment	Saturation ICT professionals	I think that my school has enough ICT professionals to support me in my workplace.
ICT employment	Importance of ICT literacy for career progression	I think that ICT literacy is important for my career progression.
Information needs	Availability digital educational material	I think that there is enough digital educational material available at my school.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
Information needs	Availability digital interactive educational content	I think that there is enough digital interactive educational material available at my school.
Internet usage	Satisfaction internet usage	I am satisfied with the number of times I have access to the internet.
Internet usage	Added value of internet in education	I think that the availability of internet is of added value in education.
Internet usage	Added value of internet personal	I think that the availability of internet is of added value for personal development.
Network speed and quality	Satisfaction internet speed	I am satisfied with the internet speed that is available at my school.
Network speed and quality	Internet speed institution better than internet cafes	I think that the internet speeds from my school are better than the internet speeds from internet cafés that are close by.
Network speed and quality	Internet speed frustration	The internet speeds from my school frustrate me or slow down my work.
Network speed and quality	Perception restore time	I am satisfied with the time it takes to restore a network connection failure.
PC usage	Satisfaction computer availability	I am satisfied with the number of times I have access to a personal computer or laptop.
PC usage	Added value of PCs in education	I think that the availability of computers is of added value in education.
PC usage	Added value of PCs personal	I think that the availability of computers is of added value for personal development.
PC usage	Perception of increased productivity	Computers increase my productivity.
Smartphone usage	Added value of smartphones in education	I think that the availability of smartphones is of added value in education.
Smartphone usage	Added value of smartphones personal	I think that the availability of smartphones is of added value for personal development.
Tablet usage	Added value of tablets in education	I think that the availability of tablets is of added value in education.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
Tablet usage	Added value of tablets personal	I think that the availabillity of tablets is of added value for personal development.
Teacher efficacy	Efficacy for instructional strategies 1	To what extent can you use a variety of assessment strategies?
Teacher efficacy	Efficacy for instructional strategies 2	To what extent can you provide an alternative explanation or example when students are confused?
Teacher efficacy	Efficacy for instructional strategies 3	To what extent can you craft good questions for your students?
Teacher efficacy	Efficacy for instructional strategies 4	How well can you implement alternative strategies in your classroom?
Teacher efficacy	Efficacy for classroom management 1	How much can you do to control disruptive behavior in the classroom?
Teacher efficacy	Efficacy for classroom management 2	How much can you do to get children to follow classroom rules?
Teacher efficacy	Efficacy for classroom management 3	How much can you do to calm a student who is disruptive or noisy?
Teacher efficacy	Efficacy for classroom management 4	How well can you establish a classroom management system with each group of students?
Teacher efficacy	Efficacy for student engagement 1	How much can you do to get students to believe they can do well in schoolwork?
Teacher efficacy	Efficacy for student engagement 2	How much can you do to help your students value learning?
Teacher efficacy	Efficacy for student engagement 3	How much can you do to motivate students who show low interest in schoolwork?
Teacher efficacy	Efficacy for student engagement 4	How much can you assist families in helping their children do well in school?
Technology acceptance PC	Perceived ease of use 1	Learning to operate a PC in order to carry out simple tasks would be easy for me.
Technology acceptance PC	Perceived ease of use 2	I would find it easy to use a PC in order to perform simple tasks for school.
Technology acceptance PC	User satisfaction 1	I am completely satisfied in using PCs for performing simple tasks at school.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
Technology acceptance PC	User satisfaction 2	I feel very confident in using a PC at school.
Technology acceptance PC	User satisfaction 3	I can accomplish school tasks quickly using a PC.
Technology acceptance PC	User satisfaction 4	I believe that by using a PC the quality of the education increases.
Technology acceptance Tablet	Perceived ease of use 1	Learning to operate a tablet in order to carry out simple tasks would be easy for me.
Technology acceptance Tablet	Perceived ease of use 2	I would find it easy to use a tablet in order to perform simple tasks for school.
Technology acceptance Tablet	User satisfaction 1	I am completely satisfied in using tablets for performing simple tasks at school.
Technology acceptance Tablet	User satisfaction 2	I feel very confident in using a tablet at school.
Technology acceptance Tablet	User satisfaction 3	I can accomplish school tasks quickly using a tablet.
Technology acceptance Tablet	User satisfaction 4	I believe that by using a tablet the quality of the education increases.
Technology acceptance smartphone	Perceived ease of use 1	Learning to operate a smartphone in order to carry out simple tasks would be easy for me.
Technology acceptance smartphone	Perceived ease of use 2	I would find it easy to use a smartphone in order to perform simple tasks for school.
Technology acceptance smartphone	User satisfaction 1	I am completely satisfied in using smartphones for performing simple tasks at school.
Technology acceptance smartphone	User satisfaction 2	I feel very confident in using a smartphone at school.
Technology acceptance smartphone	User satisfaction 3	I can accomplish school tasks quickly using a smartphone.
Technology acceptance smartphone	User satisfaction 4	I believe that by using a smartphone the quality of the education increases.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
		First, think how well you believe you know the processes of learning on a general level. Also consider in which areas you feel you need more information and in which areas you feel your current knowledge is sufficient or strong. Evaluate your knowledge about the given topics:
TPACK	Pedagogical knowledge (PK) 1	Guiding students' discussions during group work (2-5 students).
TPACK	Pedagogical knowledge (PK) 2	Supporting students' critical thinking.
TPACK	Pedagogical knowledge (PK) 3	Guiding students in planning their own learning.
TPACK	Pedagogical knowledge (PK) 4	Supporting students' reflective thinking.
TPACK	Pedagogical knowledge (PK) 5	Guiding students to make use of each other's thoughts and ideas during group work (2-5 students).
TPACK	Pedagogical knowledge (PK) 6	Supporting students' problem-solving skills.
TPACK	Pedagogical knowledge (PK) 7	Supporting students' creative thinking.
		Next, consider your own relationship with information and communications technology (ICT). How do you perceive your knowledge and your skills? Evaluate your knowledge and skills in the given topics:
TPACK	Technological knowledge (TK) 1	I can solve ICT related problems.
TPACK	Technological knowledge (TK) 2	I am familiar with new technologies and their features.
TPACK	Technological knowledge (TK) 3	I can use new technologies.
TPACK	Technological knowledge (TK) 4	I know several websites about new technology.

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Table K.3 – *Continued from previous page*

Method Fragment	Metric	Survey Statement
		Next think about your content expertise in **ICT**. Please consider how well you believe you know the subject contents and in which areas you feel you need additional information or in which areas you feel your knowledge is sufficient or strong. Evaluate your knowledge in the given topics:
TPACK	Content knowledge (CK) 1	I have sufficient knowledge in developing contents for **ICT**.
TPACK	Content knowledge (CK) 2	I know the basic theories and concepts for **ICT**.
TPACK	Content knowledge (CK) 3	I know the history and development of important theories in **ICT**.
TPACK	Content knowledge (CK) 4	I am familiar with recent research in **ICT**.
		Now consider your pedagogical knowledge in ICT together. Please consider in which areas you feel you need additional information or in which areas you feel your knowledge is sufficient or strong. Evaluate your knowledge about the given topics:
TPACK	Interaction between pedagogical and content knowledge (PCK) 1	In **ICT**, I know how to guide students' content-related problem solving in groups (2-5 students).
TPACK	Interaction between pedagogical and content knowledge (PCK) 2	In **ICT**, I know how to guide students' critical thinking.
TPACK	Interaction between pedagogical and content knowledge (PCK) 3	In **ICT**, I know how to guide students to make use of each other's thoughts and ideas in group work (2-5 students).
TPACK	Interaction between pedagogical and content knowledge (PCK) 4	In **ICT**, I know how to guide students' reflective thinking.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
TPACK	Interaction between pedagogical and content knowledge (PCK) 5	In **ICT**, I know how to guide students in planning their own learning.
TPACK	Interaction between pedagogical and content knowledge (PCK) 6	In **ICT**, I know how to guide students' creative thinking.
		Next we consider the possibilities of using ICT in teaching. First think on a general level about how well you are familiar with using technology to realise your pedagogical goals. Please consider in which areas you feel you need additional information or in which areas you feel your knowledge is sufficient or strong. Evaluate your knowledge about the given topics:
TPACK	Interaction between technological and pedagogical knowledge (TPK) 1	I know how to use ICT in teaching as a tool for students' reflective thinking.
TPACK	Interaction between technological and pedagogical knowledge (TPK) 2	I know how to use ICT in teaching as a tool for students to plan their own learning.
TPACK	Interaction between technological and pedagogical knowledge (TPK) 3	I know how to use ICT in teaching as a tool for sharing ideas and thinking together.
TPACK	Interaction between technological and pedagogical knowledge (TPK) 4	I know how to use ICT in teaching as a tool for students' creative thinking.
TPACK	Interaction between technological and pedagogical knowledge (TPK) 5	I know how to use ICT in teaching as a tool for students' problem solving in groups (2-5 students).
TPACK	Interaction between technological and pedagogical knowledge (TPK) 6	I know how to use ICT in teaching as a tool for students' critical thinking.

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Table K.3 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Statement**
		Please consider now, how well you know the technologies that are used in professions related to **ICT**. Evaluate your knowledge about the given topics:
TPACK	Interaction between content and technological knowledge (TCK) 1	I know websites with online materials for studying **ICT**.
TPACK	Interaction between content and technological knowledge (TCK) 2	I know ICT-applications which are used by professionals in **ICT**.
TPACK	Interaction between content and technological knowledge (TCK) 3	I know ICT-applications which I can use to better understand the contents of **ICT**.
TPACK	Interaction between content and technological knowledge (TCK) 4	I know technologies which I can use to illustrate difficult contents in **ICT**.

Table K.4: Translation of metrics into survey questions - Student(s)

Method Fragment	**Metric**	**Survey Question**
Demographic	Age	What is your age?
Demographic	Gender	What is your gender?
Demographic	Country	In what country do you go to school?
Demographic	Place of residence	In what city, town or village do you live?
Demographic	Place of school	In what city, town or village do you go to school?
Demographic	School name	What is the name of the school you go to?
Demographic	Education level	What is currently your highest education level?
Demographic	Number of times sollicited	What is the number of times you had a job sollicitation?

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Table K.4 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
Demographic	Number of jobs	What is the number of jobs you had in the past (including current job if applicable)?
Information needs	Main sources of general information	What is your main source of general information in order of importance? (1 – Most Important, 7 – Least Important) (Answers: Colleagues, Newspapers, Radio, Television, Internet, Lecturer, Books/Journals)
Information needs	Type of imformation needs	What type of information do you need in order of importance? (1- Most Important, 6 – Least Important) (Answers: Academic, Research, Administration, News/Entertainment/Shopping, Emergency/Help/Rescue, Banking/Investments)
Internet usage	Internet use before	Have you ever used internet services?
Internet usage	Internet use importance	In order of importance, what do you use the internet for? (Answers: E-mail; news/entertainment; business transactions/banking; general search for information; academic(learning, teaching, research)
Network speed and quality	Number of local telephone calls successful on first attempt	Are most of your local telephone calls from your school/project environment successful on the first attempt?
PC usage	Used a computer before	Have you ever used a computer?
PC usage	Accessibility PC/laptop	Do you have access to a Personal Computer or laptop?
PC usage	PC usage location	Where do you make use of a computer in general? (Answers: Home; Workplace; Home & Workplace; Internet café)
PC usage	PC usage purpose	For what purpose did/do you use the computer? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)

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Table K.4 – *Continued from previous page*

Method Fragment	**Metric**	**Survey Question**
Service and support	Failure frequency computer	What is the frequency of failure of the computer you use in the school/project environment? (Answers: Daily; Once per week; 2 times per week; once per month; hardly)
Service and support	Failure restore time	When there is a failure, how long does it take to restore the fault? (Answers: <1 hour; 1-6 hrs; 1 day; >1 day)
Service and support	Most common type of computer failure	What is the most common type of computer failure? (Answers: unable to log in; no e-mail access or internet; unable to load applications; computer is dead)
Service and support	Frequency power failure	How often do you experience power failure and you are unable to use your computer? (Answers: Once a day; Once a week; Once a month; Never)
Smartphone usage	Used a smartphone before	Have you ever used a smartphone before?
Smartphone usage	Smartphone accessibility	Do you have access to a smartphone?
Smartphone usage	Smartphone usage purpose	For what purpose did/do you use a smartphone? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)
Tablet usage	Used a tablet before	Have you ever used a tablet before?
Tablet usage	Tablet accessibility	Do you have access to a tablet?
Tablet usage	Tablet usage purpose	For what purpose did/do you use a tablet? (Multiple answers possible) (Answers: Word Processing; Data Analysis; Email/Internet; Entertainment; other)
Additional effects	Wider effects community/personal	Do you perceive wider effects in the community or your personal life after the project has been implemented?
Additional effects	Type of effects community/personal	Do you perceive these wider effects to be positive?

Table K.5: Translation of metrics into survey statements - Student(s)

Method Fragment	**Statement**	**Survey Statement**
Education level	Satisfaction level of education	I think that the education I receive is too easy.
Education level	Satisfaction ICT knowledge teacher	I am satisfied with the level of ICT knowledge of my teacher(s).
Education level	Satisfaction ICT level lessons	I am satisfied with the difficulty level of ICT lessons that are provided.
Education level	Satisfaction ICT quantity lessons	I am satisfied with the quantity of ICT lessons that are provided.
ICT employment	Importance of ICT literacy for career progression	I think that ICT literacy is important for my career progression.
ICT employment	Satisfaction with ICT lessons for career	I think that the level of ICT lessons provided to me right now are satisfactory for a succesful career.
Information needs	Availability digital educational material	I think that there is enough digital educational material available at your school.
Information needs	Availability digital interactive educational content	I think that there is enough digital interactive educational material available at school.
Internet usage	Satisfaction internet usage	I am satisfied with the number of times I have access to the internet.
Internet usage	Added value of internet in education	I think that the availability of internet is of added value in education.
Internet usage	Added value of internet personal	I think that the availability of internet is of added value for personal development.
Network speed and quality	Satisfaction internet speed	I am satisfied with the internet speed that is available at school.
Network speed and quality	Internet speed institution better than internet cafes	I think that the internet speeds at school are better than the internet speeds from internet cafés that are close by.
Network speed and quality	Internet speed frustration	The internet speeds at my school frustrate me or slow down my work.
Network speed and quality	Perception restore time	I am satisfied with the time it takes to restore a network connection failure.

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Table K.5 – *Continued from previous page*

Method Fragment	Statement	Survey Statement
PC usage	Satisfaction computer availability	I am satisfied with the number of times I have access to a personal computer or laptop.
PC usage	Added value PCs education	I think that the availability of computers is of added value in education.
PC usage	Added value PCs personal	I think that the availability of computers is of added value for personal development.
PC usage	Increased productivity	Computers increase my productivity in learning.
Self-efficacy	Self-efficacy using windows computer	I think I know how to properly use a Windows computer.
Self-efficacy	Self-efficacy perform word processing tasks	I am able to perform simple word processing tasks on a computer.
Self-efficacy	Self-efficacy entertainment	I am capable of using a computer for entertainment purposes.
Self-efficacy	Self-efficacy information searching	I am good at searching for information on the internet.
Self-efficacy	Self-efficacy confident at school	I am confident in using a computer at school.
Self-efficacy	Self-efficacy good use of internet	I think I am the kind of person who can make good use of the internet.
Smartphone usage	Added value of smartphones in education	I think that the availability of smartphones is of added value in education.
Smartphone usage	Added value of smartphones personal	I think that the availability of smartphones is of added value for personal development.
Tablet usage	Added value of tablets education	I think that the availability of tablets is of added value in education.
Tablet usage	Added value of tablets personal	I think that the availabillity of tablets is of added value for personal development.
Technology acceptance PC	Perceived ease of use 1	Learning to operate a PC in order to carry out simple tasks would be easy for me.
Technology acceptance PC	Perceived ease of use 2	I would find it easy to use a PC in order to perform simple tasks for school.

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Table K.5 – *Continued from previous page*

Method Fragment	**Statement**	**Survey Statement**
Technology acceptance PC	User satisfaction 1	I am completely satisfied in using PCs for performing simple tasks at school.
Technology acceptance PC	User satisfaction 2	I feel very confident in using a PC at school.
Technology acceptance PC	User satisfaction 3	I can accomplish school tasks quickly using a PC.
Technology acceptance PC	User satisfaction 4	I believe that by using a PC the quality of the education increases.
Technology acceptance Tablet	Perceived ease of use 1	Learning to operate a tablet in order to carry out simple tasks would be easy for me.
Technology acceptance Tablet	Perceived ease of use 2	I would find it easy to use a tablet in order to perform simple tasks for school.
Technology acceptance Tablet	User satisfaction 1	I am completely satisfied in using tablets for performing simple tasks at school.
Technology acceptance Tablet	User satisfaction 2	I feel very confident in using a tablet at school.
Technology acceptance Tablet	User satisfaction 3	I can accomplish school tasks quickly using a tablet.
Technology acceptance Tablet	User satisfaction 4	I believe that by using a tablet the quality of the education increases.
Technology acceptance smartphone	Perceived ease of use 1	Learning to operate a smartphone in order to carry out simple tasks would be easy for me.
Technology acceptance smartphone	Perceived ease of use 2	I would find it easy to use a smartphone in order to perform simple tasks for school.
Technology acceptance smartphone	User satisfaction 1	I am completely satisfied in using smartphones for performing simple tasks at school.
Technology acceptance smartphone	User satisfaction 2	I feel very confident in using a smartphone at school.
Technology acceptance smartphone	User satisfaction 3	I can accomplish school tasks quickly using a smartphone.
Technology acceptance smartphone	User satisfaction 4	I believe that by using a smartphone the quality of the education increases.
ICT employment	Perceived chance of job	I believe I have a high chance of getting a well-paid job.

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Table K.5 – *Continued from previous page*

Method Fragment	**Statement**	**Survey Statement**
Education level	Education challenges	I would like the education to be more challenging.
Career	Graduated	Are you graduated?
Career	Job	Do you have a job?
Career	Happiness with job	I am happy with my job.
Career	Satisfaction salary	I am satisfied with my salary.
Career	Hindsight help of project	In hindsight, I think [**name project**] has helped with persuing a good career.
Livelihood	Survival threshold	My family has enough income to cover costs for food and food preparation (firewood and cooking materials, basic lightning) and water.
Livelihood	Protection threshold 1	My family has enough income to cover costs to ensure basic survival needs.
Livelihood	Protection threshold 2	My family has enough income to cover costs to maintain access to basic services (routine medical services and schooling expenses).
Livelihood	Protection threshold 3	My family has enough income to purchase basic clothing.
Livelihood	New skills	In what sense do you think you learned new skills in the past 6 months?
Livelihood	New skills 2	What type of new skills did you learn? (Answers: Skills to grow/launch a business, Skills to get a paid job, Skills to compete in the job market)
Livelihood	Availability of support services	In what sense is the availability of livelihood support services (e.g., financial services, better education, medical services) increased in the past 6 months?
Livelihood	Community participation	I perceive a sense of community participation in the project and school?
Livelihood	Personal empowerment	I feel like I can have influence on the way things are regulated at school?

Appendix L

Activity and Concept Tables - Additional Activities and Concepts

Table L.1: Addition of activities to Activity Table

Activity	**Description**
Provide metric definitions	Some metrics can be abstract or ambiguous. The definition of metrics can be project dependent. Therefore, each metric must be checked whether the definition is clear. In order to make sure that each metric is unambiguous, a definition should be written if deemed necessary.
Determine sampling strategy	This step guides the assessor in choosing the most appropriate sampling strategy. An additional document, named IAD-2.1 is developed in order to support the assessor in this decision.

Table L.2: Addition of concepts to Concept Table

Concept	**Description**
METRIC DEFINITION	If a metric is deemed ambiguous, a definition can be provided so that no confusion can arise during the data collection process. The metric definition consists of a short description of the boundaries of the metric.
SAMPLING STRATEGY	A SAMPLING STRATEGY is the approach with which the sample for the implementation of the evaluation is designated.

Appendix M

Overview of Method Increments

Table M.1: Overview of method increments per snapshot

Snapshot	Increment	Figure
2	Introduction of activity: *Determine sampling strategy*	Figure 5.2
2	Introduction of concept: *SAMPLING STRATEGY*	Figure 5.2
3	Modification of activity: *Define project goals* to *Identify project goals*	Figure 7.1
3	Introduction of activity: *Provide metric definitions*	Figure 7.1
3	Introduction of concept: *METRIC DEFINITION*	Figure 7.1

Appendix N

SIAM-Ed

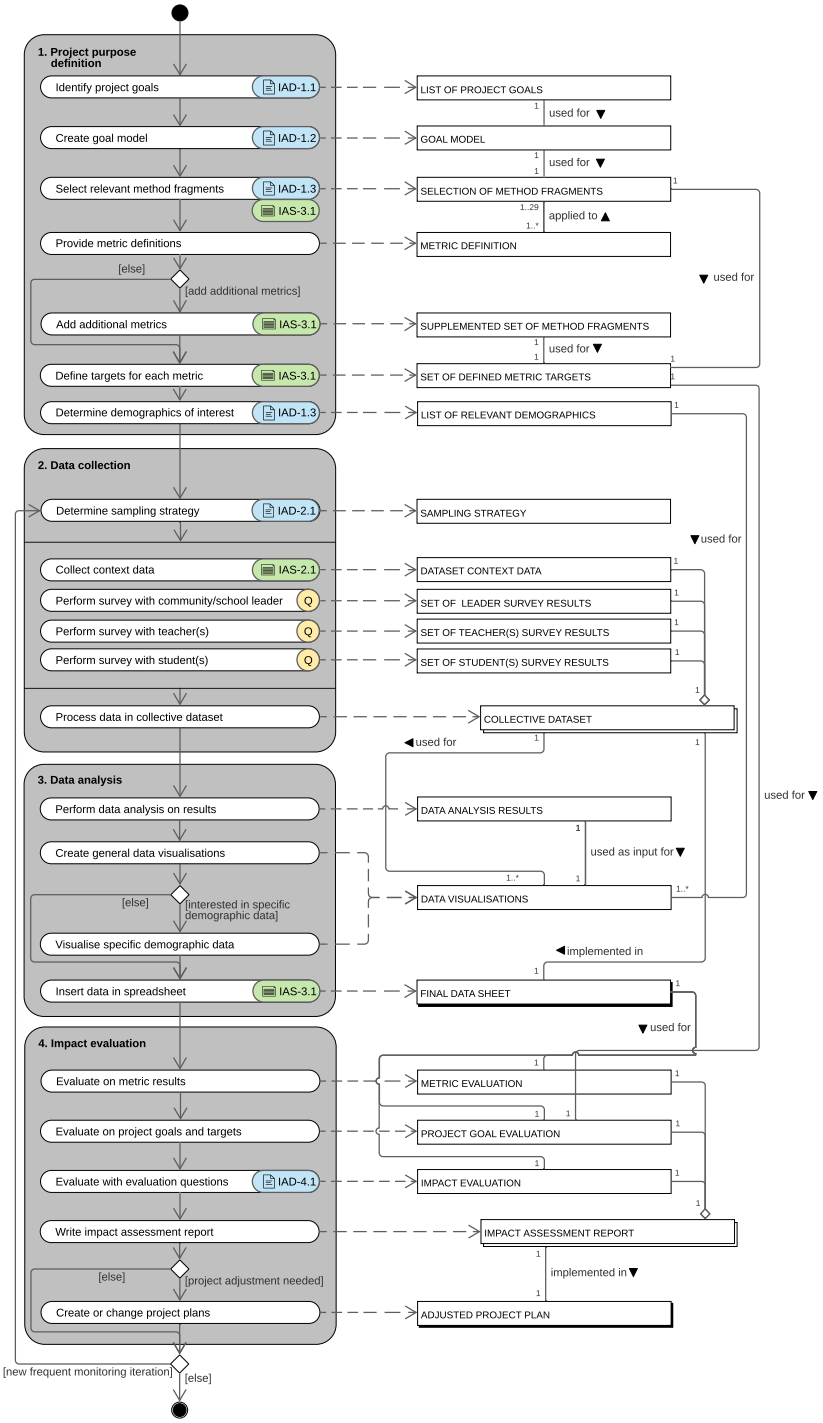

Figure N.1: Final version of the proposed impact assessment method: SIAM-Ed