Designing an Education Management Information System

A case study on the introduction of a digital, mobile-to-web Education Management Information System in Zambia

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II

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"Namwala was picked. We see it as a blessing,
and do not want to throw away this opportunity."

- District Education Board Secretary on the EMIS-pilot

Abstract

Measuring the quality of education in a timely and reliable manner is at the core of social development of any country. To solve this pressing issue, the Ministry of General Education in Zambia has initiated a pilot project to strengthen their Education Management Information System (EMIS) by implementing a digital report structure to complement their annual, paper-based system. As is well documented in the literature of Information Systems and Health Management Information Systems, contextual conditions in low resource countries often challenge best practice approaches for implementing functioning, large-scale management information systems. Using the case from Zambia, this study shows how centralized approaches to EMIS-implementation can be used to simultaneously assess multiple implementation models, but also how this might increase the gap between local and national data needs.

This thesis is an exploratory, interpretive case study of Zambia's first year of implementing a mobile to web EMIS, designed to overcome the many infrastructural challenges present in Zambia. The case study emphasizes school and teacher level data needs and objectives through a bottom-up participatory approach to understand the enabling and constraining conditions of an EMIS-implementation, and how to best design it for timely and decentralized decision making.

The study concludes that an EMIS that supports timely, decentralized decision-making needs to support multiple user objectives and needs, and be flexible enough to fit various work processes and tasks, while the technology needs to overcome infrastructural challenges and fit with staff skills.

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Abbreviations

ASC	Annual School Census
DEBS	District Education Board Secretary
DHIS2	District Health Information System 2
EMIS	Education Management Information Systems
ESB	Educational Statistical Bulletin
HMIS	Health Management Information Systems
IS	Information Systems
M2W	Mobile-to-web
MIS	Management Information Systems
MoGE	Ministry of General Education
PEBS	Province Education Board Secretary
R-SNDP	Revised Sixth National Development Plan
UNICEF	United Nations Children's Fund
WASH	Water, Sanitation and Health
WFP	World Food Programme

1 Introduction

This thesis is a study of Zambia's effort to digitize their Education Management Information System (EMIS) during the first year of implementation. The effort is a mobile-to-web (M2W) pilot project, which we'll call the *EMIS-pilot*, or simply *the pilot*. Though a naturally resourceful country, Zambia's lack of infrastructure has hindered development of distributed, IT-based government systems to handle information from collection to analysis. As mobile-to-web (M2W) solutions have become a viable option for low resource contexts (Labrique, Vasudevan, Chang, & Mehl, 2013; Mechael, 2009; Sanner, Roland, & Braa, 2012), a digital EMIS has become a realistic possibility. While literature on EMIS-development in low resource contexts is limited, common challenges are lack of infrastructure and skilled staff, and little faith in the merits of an EMIS (Bhatti & Adnan, 2010; Damin, Kadry, & Hamed, 2014; Ellison, 2004; Iyengar et al., 2016).

This thesis is an exploratory, interpretive case study of Zambia's first year of implementing a mobile to web EMIS, designed to overcome the many infrastructural challenges present in Zambia. The case study emphasizes school and teacher level data needs and objectives through a bottom-up participatory approach to understand the enabling and constraining conditions of an EMIS-implementation, and how to best design it for timely and decentralized decision making.

Data collection and analysis is informed by the ITPOSMO-framework and design-reality gap model developed by Heeks (2006a), which categorises an information system into a set of dimensions from which a failing implementation is likely to occur. The study concludes that there are a set of trade-offs that enables or constrains the design, and that an EMIS that supports timely, decentralized decision-making needs to support multiple user objectives and needs, and be flexible enough to fit various work processes and tasks while the technology needs to overcome infrastructural challenges and fit with staff skills.

1.1   Motivation

Evidence-based decision making is the key output of any management information system. The EMIS in Zambia has been paper-based since its introduction, rendering decision-making inefficient and the information produced outdated. Key to developing a new, digital information infrastructure, this pilot has interesting facets from both an academic as well as a practical stance.

1.1.1   Knowledge motivation

A large body of literature exists in relation to the strengthening of Health Management Information Systems (IS) in low resource contexts (Berntsen, 2015; J. Braa & Sahay, 2012b; Kossi, Sæbø, Braa, Jalloh, & Manya, 2012; Sæbø, Kossi, Titlestad, Tohouri, & Braa, 2011). The widespread development of HMIS in developing countries is largely a result of pressure from international donors providing funds and technical assistance. The same investments have been lacking in the education sector, which is why there is a need to broaden the empirical basis on education management in low resource context within the field of IS research.

The research has been conducted as an exploratory case study providing a rich description on the context of how the digital EMIS-pilot fits into the education management structure, which stakeholders are involved and what contextual challenges are present. The pilot is implemented using two different software which differ greatly in terms of strengths and weaknesses, challenges and opportunities, choice of technology and costs, as well as possibilities and need for training and data analysis.

Through a bottom-up, participatory process, the research tries to understand the rationalities of decision-making from a school perspective through focus groups and design workshops with teachers enrolled in the pilot, and how this might conflict with other stakeholder's objectives. This has helped broaden the understanding of what data an EMIS should collect, and what decisions teachers make in their day-to-day work.

1.1.2 Practical motivation

Key objectives for the MoGE is to learn how much resources the introduction of a digitized EMIS will require on behalf of the government, including human and material resources. A digital, M2W EMIS enables decentralized data analysis and usage. Currently, the process of choosing data elements and developing indicators to measure the quality of education is highly centralized and under political influence from stakeholders and NGOs. As a consequence, limited knowledge exists at administrative levels on the relevance of data collection at schools, and how this data is used at school level.

1.2 Research context

This thesis is written with the Information Systems (IS) research group at the Department for Informatics, University of Oslo. The IS-group is part of the Health Information Systems Program Network, and the main developer behind the DHIS2-platform. The platform is a widely used software within HMIS, currently implemented in over 42 countries ("DHIS 2 In Action," 2017). Akros, a member of the HISP-network, use DHIS2 in their collaboration on school sanitation with UNICEF, and my access to the field was through this affiliation. The empirical study was thus conducted over a three-month period between September – November 2016 in Namwala District in the Southern Province of Zambia.

1.3 Research question

The aim of this thesis is to provide a rich description of the pilot's context, and arrive at design principles for digital EMIS in low resource contexts. The research question is presented below.

How can digitized EMIS be designed to support timely and decentralized decision making in the Zambia education sector?

What are the enabling and constraining conditions for implementing a digital EMIS in Zambia?

1.4 Chapter overview

Chapter 2 describes the analytical approach which this thesis draws upon. As little research exists on EMIS in low resource contexts, I have chosen to focus on literature from IS in general and HMIS in particular, under the assumption that concepts and frameworks are transferable to the education sector.

Chapter 3 describes the country context in which the system is implemented. Figures on the quality of education are bleak, and though resourceful, the country has infrastructural challenges that makes it difficult to scale ICT-solutions.

Chapter 4 provides an introduction to the status quo, and how the government currently handles data collection and distribution of information. The current process is paper-based, and takes approximately 9 months to carry through. Lastly, the chapter gives an introduction to the EMIS-pilot that is currently being implemented.

Chapter 5 presents my philosophical foundation, methodology and data collection methods during the field work, as well as my sources of information. As my focus changed drastically during the research, I have tried to emphasize this change.

Chapter 6 presents the empirical findings from the field work conducted. The chapter focus on findings related to infrastructure, human resources, decision making processes and usability of the system.

Chapter 7 emphasizes some key findings for a further discussion through the lens of the analytical foundation. Here I present some challenges in the applicability of using HMIS literature when understanding EMIS, and try to outline which conditions enable and constrain the EMIS implementation.

Chapter 8 concludes the thesis, and summarizes which topics that should be researched further.

2 Analytical approach and related research

This chapter will describe the literature which provides the thesis' foundation of understanding the enabling and constraining conditions for implementing a digitized EMIS. As will become evident, there is limited research conducted on EMIS in low resource contexts.

2.1 Information systems as socio-technical networks

During the 1970s and 1980s computerization of organizations were at its beginning. The major assessments of their efficiency was often coined as a deterministic impact seeking to understand how organizational behavior would change given a certain implementation (Kling, 2000). To fully understand the complexities of information systems, it is however important to recognize that they are not merely tools used by an organization, but a socio-technical network that is constantly evolving. By looking at information systems as socio-technical, one recognizes that they are socially shaped through context, people in various roles, hardware, software, techniques, support resources and existing information structures.

Through the term "social informatics" Kling (ibid.) shows the paradigmatic shift in understanding the application of ICT in organizations; The same information system will have different outcomes in different contexts, varying upon the organizational, political and existing work processes. An organization is a configuration influenced by the distribution of power existing within that specific organization. Social informatics illustrates that an information system is not inherently decentralizing or centralizing, nor does it inherently empower or discourage workers to make decisions or be more efficient. This thesis seeks to understand the contextual configurations of the public education sector in Zambia, and describe enabling and constraining conditions for digitizing their information system.
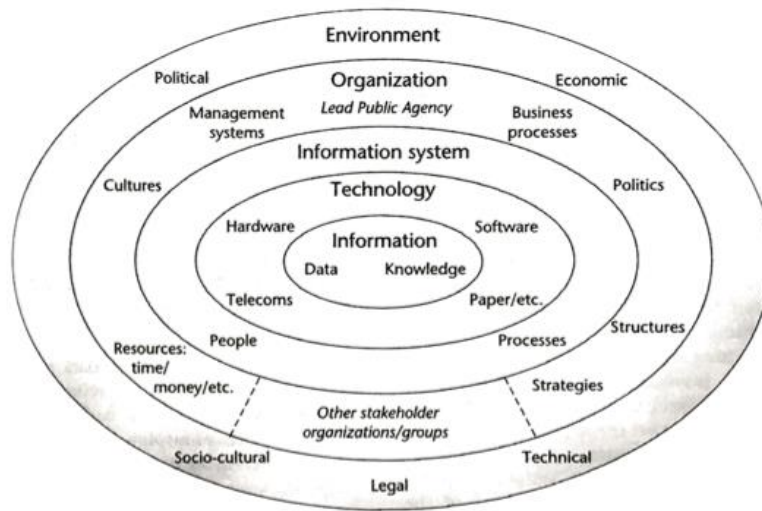
Figure 2.1 Full model of government information systems (Heeks, 2006b)

2.2 Design-reality gap

Following the socio-technical implications mentioned above, the design of an information system does not always match the reality in which it is intended to function, what Heeks (2006a) calls a design-reality gap. This may have long term consequences on the sustainability of the system, particularly in new, pilot implementations initiated by external donors like the Zambia-case. The strategy for adaptation, assimilation and use greatly affect the sustainability of capacities of a project's life-cycle (Baark & Heeks, 1999). Inherent in implementing an information system is some sort of organizational change e.g. increased transparency or accountability, meaning there will always be a slight degree of mismatch between the current system and the envisioned future. The design of an information system should therefore focus on the *"mismatch and match between and within factors and of the need to change in order to adapt systems so that there is more match than mismatch"* (Heeks, 2006a, p. 127).

The degree of success in terms of the information systems' likelihood to be sustained and achieve most users' desired objectives, is defined as the gap size between design and reality. Concluding this is often a challenging effort, as each stakeholder by

definition could be seen as a designer with their own subjective interpretation of how the system should be, as well as how reality is constructed. Heeks refers to this as a hard-soft gap, a gap where different stakeholder groups try to inscribe different rationalities, including hardware, software and management styles (Heeks, 2006b).

To structure the process of assessing the design-reality gap, Heeks provides a set of key dimensions along which a gap is likely to occur, called ITPOSMO-dimensions (Heeks, 1999, 2002, 2006a, 2006b). For the purpose of this thesis, the last dimension "Other resources" have been left out, as it is deemed too open and inclusive:

1. **Information**
   The formal information held by the digital system and the informal information used by the people involved with the system
2. **Technology**
   Mainly focuses on digital IT but can also cover other information-handling technologies such as paper or analogue telephones
3. **Processes**
   The activities undertaken by the relevant stakeholders for whom the e-government system operates, both information-related processes and broader business processes
4. **Objectives and values**
   Often the most important dimension since the objectives component covers issues of self-interest and organizational politics, and can even be seen to incorporate formal organizational strategies; the values component covers culture: what stakeholders feel are the right and wrong ways to do things
5. **Staffing and skills**
   Covers the number of staff involved with the system, and the competencies of those staff and other users
6. **Management systems and structures**
   The overall management systems required to organize operation and use of the system, plus the way in which stakeholder agencies/groups are structured, both formally and informally

Figure 2.2 shows the model of design-reality gap, while Table 2.1 shows the dimensions with examples from the current Zambia education sector.
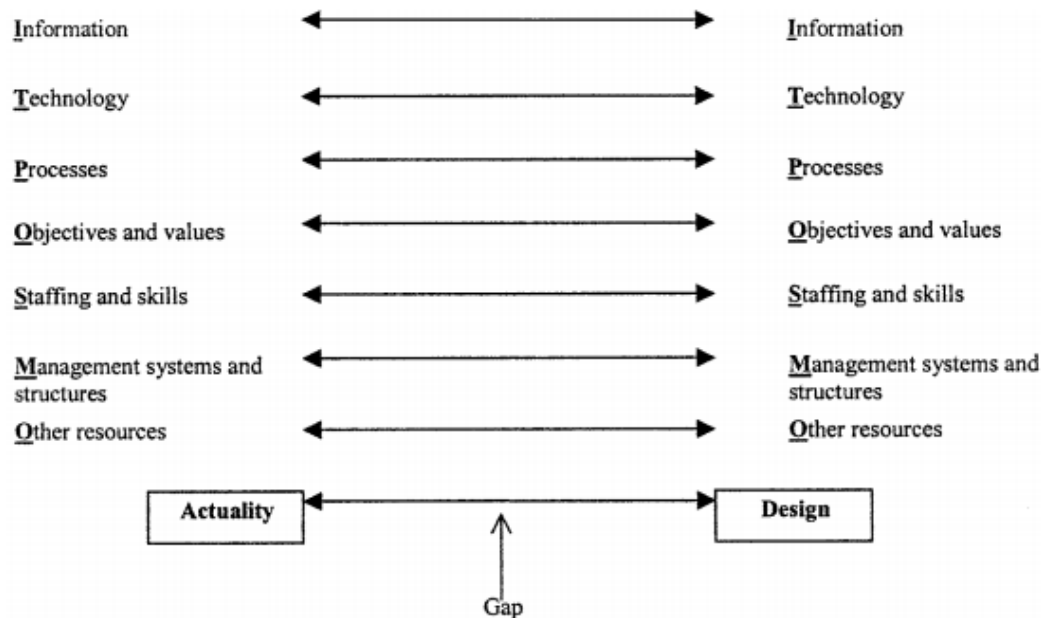
Figure 2.2 Design-reality gap model (Heeks, 2006a)

Information system design can be particularly problematic in developing countries when using methods and best-practices from developed countries without considering local socio-economic context (Avgerou, 2008; Ciborra, 2005; Dada, 2006; Iyengar et al., 2016). Stakeholders might have conflicting objectives, and work processes can be entangled in complex ways that are difficult to take into consideration when following a top-down approach. This can render the system counter-productive; producing dual work or neglect units in the organization (Chilundo & Aanestad, 2005; Gasser, 1986). Assessing all factors of an information system can be a painful task, as complexity increases quickly.

The ITPOSMO-framework and design-reality gap model lacks rigidity on how to systematically conduct the assessment, and the resulting interpretation is prone to subjectivity. It has however proved useful for post-hoc or risk assessments in multiple

e-government projects (Dada, 2006; Furuholt & Wahid, 2008; Yucel, Cebi, Hoege, & Ozok, 2012).

Table 2.1 ITPOSMO-checklist with examples from Zambia (adapted from Heeks, 2006b)

Dimension	Zambia education sector
Information	Class registers, teacher attendance, test and examination scores, facilities, sanitation, school feeding, inventory, housing, work routines, family relations
Technology	Book registers, paper forms, tablets, phones (mobile, analogue), computers, MS Access databases …
Processes	Distribution of food and sanitary products/guidelines, school construction/maintenance, reporting to census, hiring teachers, feedback of information to schools
Objectives and values	Provide quality education for all children (government), reduce disease and improve health (stakeholder), ensure feeding to keep children in school (stakeholder), avoid drop-outs
Staffing and skills	Training of staff in use of reporting tools, establish data management committees
Management systems and structures	Decentralized government structure, DEBS responsible in district, hierarchical and culture sensitive

2.3 EMIS

EMIS is a management information system that provide decision makers and relevant stakeholders with information to improve the quality of education. An integrated EMIS will rely on involvement from multiple ministries and department who perform different functions and roles in providing education. These include staffing of teachers, health initiatives, logistics and finance. EMIS-implementations in developed countries have focused on governance perspectives, and a school management perspective. From a governance perspective, allows for comparisons of schools within and across nations (e.g. the OECD's PISA-evaluations). From a school-management perspective output-level data has been more important (e.g. pupil achievements and inventory). This has resulted in research emphasizing on e.g. school self-evaluation through system feedback (Visscher & Coe, 2003) and data analysis for structural changes in the overall system (Tolley & Shulruf, 2009).

The existing research on EMIS-implementations in developing countries mostly focus on generalizing implementation strategies (Bhatti & Adnan, 2010; Damin et al., 2014;

Ellison, 2004; Iyengar et al., 2016), which are strikingly similar to literature within HMIS mentioned above. Though useful in their conceptualization of an EMIS, their underlying assumption of a functioning socio-technical system and working infrastructure has implication on their applicability in a Zambian context. Iyengar et al. (2016) identifies six main challenges that are often underestimated when approaching EMIS in developing countries, which fit well within the concept of design-reality gaps:

1) A strong technological background (social and technical) is needed to host the data, something which is often lacking

2) Bandwidth is not sufficient to distribute the software or sustain use at school level

3) Training and capacity building at all levels is extensive and resource demanding. This results in too much effort spent collecting data rather than utilizing it

4) Information is not being used for active decision-making

5) Country context makes target groups inaccessible, as well as organizational faith of the merits of an EMIS are doubted

6) Budgets prevent sustainable operation of the EMIS on a long term basis

While most publications agree on the strategy of how to implement an EMIS in a low resource context (create timely and reliable production of data, integrate towards other departments and create a culture of information use), reflections on data relevancy and the interplay of objectives between organizational levels are absent. I find this gap important, as how producers of data perceive its relevancy is of high importance of whether or not the EMIS is sustainable and produces quality data.

2.3.1 Measuring school functioning

Developing indicators that measure quality, or effectiveness, of a school is a challenging endeavor as various levels of government require different types of information to make their decisions. The most common output to determine quality of

education is through achievement scores, usually the result of standardized tests or examinations, which are implemented in all Zambian schools. Test scores unfortunately provide little insights into which aspects of the education system which is failing or working well. In order to improve the quality of education, one needs to discover school characteristics which are positively associated with student's achievements (Scheerens, 1990).

National, province and district level are interested in aggregated, quantitative low inference measures like achievement scores, financial data, materials, pupil enrolment and number of staff. This allows them to make evidence based human and material resource allocations. Using these figures to judge the performance of the education sector might however lead to the conclusion of the "operation successful, patient deceased" kind (Scheerens, 1990). Therefore, School level is dependent on high inference measures in the form of process indicators. Process indicators measure characteristics of the educational system that can be directly manipulated, including teacher's expectations of student's scores, school environment or evaluation of students. Combining high and low inference measures allows you to hypothesize why certain schools outperform others, and thus adjust national policies of e.g. how curricula should be used better. Process indicators play a limited role in high level analysis, but is crucial for school self-evaluation (Scheerens, 1990).

2.4   Summary

I use Heeks' IS/MIS framework as it is broad in nature and fits well with exploratory research on information systems design. The design-reality gap provides a flexible, yet operational framework to guide data collection and analysis in an exploratory research process aiming to provide rich description with limited supporting literature. The ITPOSMO-dimensions will allow me to focus on the contextual configurations of the EMIS-pilot to assess its design and enabling and constraining conditions.

Analytical approach and related research

3   Background and context

The mango tree is one of the largest in Chief Mukobela's village, looming high next to the palace, providing shadow and sanctuary for the women preparing the day's dinner. The subtle, but sweet smell of nshima and ifisashi covered the area. Children were running around playing with sticks and a worn out football, their families scattered under the smaller trees talking or resting. We were invited inside the Chief's palace. My Western connotations of a palace; monumental castles with extravagant embroideries, gold and gems are difficult to abandon. The modesty of this palace in comparison is striking, its appearance like an ordinary house. Nevertheless, its solemn atmosphere leaves no less impression of royalty.

We are guided in by the Chief's second hand. "His royal highness awaits you inside, he's very excited to meet you". Chief Mukobela keeps his eye until you look away, but is welcoming nevertheless. "You don't need to kneel or bow in my audience, I find it old fashioned", he says when we enter. The room is covered with leather couches and armchairs, fit together like a game of Tetris. The walls are covered with photos of Mukobela and his wife - from their inauguration when he was a young man until today. All photos are of him, except the obligatory photo of President Edgar Lungu. We take our seats, and wait for him to say the first word.

Following the formal presentations, Chief Mukobela proudly informs us on his efforts in improving menstrual hygiene for the women in his Chiefdom. How he, together with UNICEF had made a huge difference in making sanitary products and facilities accessible. How they over a short time became open defecation free, and that people acts as he preaches. He rhetorically asks us if a woman should be expected to work in a school if she is on her period? How many shops in this area sell pads that make it possible for women to work if they are menstruating? This was improved because of his personal efforts, backed by the money provided by UNICEF.

It becomes very clear that no effort is worth it unless the Chief is onboard.

NB: A quick Google search on "Chief Mukobela" reveals he might be slightly more controversial than what he himself expressed during our meeting.

- Excerpt from field diary, September 27th 2016

This chapter will give an overview of the Zambian context, and highlight the main factors influencing their education sector from a digital infrastructural point of view. First, a brief country summary as well as governing strategies and main infrastructural challenges will be presented. The socio-economic and infrastructural factors in Zambia greatly influences challenges and opportunities when implementing information systems. Following this, a closer look will be given into the education system and the current state of efforts within the education sector.

3.1   Zambia overview

Zambia is an Eastern African country with a lot of natural resources, striving for prosperity and social development. Its main industries consist of agriculture and mining, particularly copper, which makes Zambia's economy highly sensitive to changes in the global economy. The country is divided into 10 provinces which is further divided into 103 districts. In accordance with their decentralization policies, the districts have the overall responsibility for public service provision within domains like health, education and infrastructure development (National Planning Department, 2014). The country is landlocked, and borders to Malawi and Tanzania to the East, D.R. Congo to the north, Mozambique, Botswana, Namibia and Zimbabwe to the south, and Angola to the west.

Population
16 million
^ 3.1 % annual growth

Languages
English, Bemba, Nyanja, Tonga, Lozi and Chewa

Population in urban areas
40 %

Land area
750 000 sq km

Figure 3.1 Zambia in numbers

(Central Statistics Office of Zambia, 2016; United Nations, Department of Economic and Social Affairs, Population Division, 2015)

The overall governing strategy for Zambia is outlined in the Revised Sixth National Development Plan (R-SNDP), which aims at achieving the objectives of the Vision 2030 of Zambia becoming a *"prosperous middle-income country by 2030"* (National Planning Department, 2014, p. ii). The document is an investment plan to inform sector planning and budgeting within the fields of *"[...] Skills Development, Science and Technology, Agriculture, Livestock and Fisheries, Energy and Infrastructure Development particularly transport infrastructure while enhancing human development related Sectors of Water and Sanitation, Education and Health"* (National Planning Department, 2014, p. ii).

In addition to their public government, Zambia has a traditional system of Chiefs, a system which is highly operational and well respected in local communities. The 288 Chiefs are represented in the House of Chiefs, who advises the Government on traditional, customary and related matters. Issues concerning Chiefs and Chiefdoms are situated in the Ministry of Chief's Affairs ("House of Chiefs," 2016). Chiefdoms are passed down through male inheritance, and have massive influence on local communities, as well as business operations and social development. They can impose punishments and sanctions to their population, e.g. in the form of having them work in or with maintenance of the Chief's palace. The Chief resides in the Chief's Palace where he accepts audience with any government officials or NGOs who wish to intervene in communities within his Chiefdom. They are considered royalties, and during my visits to Chiefs it was common to kneel, refer to him as "your royal highness", and bring gifts like maize meal or cooking oil. Interventions in local communities will most likely fail if the Chief is not engaged.

3.2 Infrastructure

The Zambian infrastructure has a lot of challenges and a lot of work is still required to reach out to the rural population living without electricity, ICT, water and road connections. In many cases the lack of infrastructure, like roads or proper hygienic conditions, prevents children from reaching or staying at their school on a daily basis.

3.2.1 Roads

Zambia made most of their infrastructure investments during the early 2000's. Well maintained roads connect all major cities and international borders. Zambia was ranked 22 of 54 in the African Infrastructure Development Index for 2016, mostly due to their lack of rural coverage (Lufumpa, Mubila, & Lawson, 2016). Infrastructure development is at the core of social development strategies in Zambia. However, recent years has had a strong bias towards mining areas, continuing to neglect rural areas where people live. (The World Bank, 2011). Dirt roads are widespread, causing difficulties in accessibility and mobility, particularly during the rainy seasons. As distances are vast and population is widespread, a large number of primary schools is required to make education accessible without transporting children long distances on a daily basis. 81 % of all primary schools are located in rural areas (Directorate of Planning and Information, 2016).

3.2.2 Water and sanitation

Zambia has made a lot of progress in providing water, with over 65 % of the population having access to improved water sources[1], though most of these are in urban areas ("Zambia," 2017). Intermediate options like boreholes and surface water is rapidly built out, but suffer challenges from e.g. open defecation in rural areas, causing potential health risks (The World Bank, 2011). Public figures from 2004 indicate that more than 25 % of basic schools lack access to safe water and improved sanitation facilities ("Resources - Water, Sanitation, and Hygiene," 2017).

3.2.3 Energy and ICT coverage

Zambia mostly relies on solar energy and hydroelectricity. The latter has caused a power shortage for years, as there has been little rain during rain seasons. Most of the energy production is however centered around mining and copper production, leaving

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[1] Improved drinking water - use of any of the following sources: piped water into dwelling, yard, or plot; public tap or standpipe; tubewell or borehole; protected dug well; protected spring; or rainwater collection.

only 22 % of the population with access to electricity ("Access to electricity (% of population)," 2017). Only an estimated 21 % of Zambia's population use Internet. Mobile subscriptions are however relatively high, estimating approximately 77 subscriptions per 100 inhabitants. ("Zambia," 2017)

3.3   Education status

Children in Zambia have a constitutional right to equal quality education through the country's ratification of the Convention on the Rights of the Child. Despite efforts made to reform the educational system, achievement scores are declining.

The education system in Zambia is divided into early childhood (ages 3-6), primary (ages 7-13), secondary (ages 14-18) and tertiary education (professional, university and college). Basic education (early childhood through grade 9) is provided for free, while high school and tertiary education is subject to school fees (National Assembly of Zambia, 2011). There is a total of 9636 primary and secondary schools nationwide with over 4 million students enrolled[2]. 91 % of these are primary schools. (Directorate of Planning and Information, 2016) The R-SNDP proposes increased focus on secondary education which is noticeable through increased number of teachers and permanent classroom spaces afforded secondary schools in the last years.

3.3.1   Enrollment

The gross enrollment ratio[3] of primary schools is above 120 %, indicating a large body of students in repetition after drop-out or failed years. The net enrolment ratio[4] for primary schools is at 89 %, while in secondary schools it's only a mere 28.1 %. The

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[2] Indicators in the Educational Statistical Bulletin use estimated population figures for 2015 as denominator

[3] "Gross Enrollment Ratio - The number of children enrolled in a level (primary or secondary), regardless of age, divided by the population of the age group that officially corresponds to the same level."
 (https://www.unicef.org/infobycountry/stats_popup5.html)

[4] "Net Enrollment Ratio - The number of children enrolled in primary school who belong to the age group that officially corresponds to primary schooling, divided by the total population of the same age group." (https://www.unicef.org/infobycountry/stats_popup5.html)

national dropout rate is 1.6 % for primary and 1.1 % for secondary schools. Dropout rates are higher for girls than for boys with the most common reasons for dropouts including early marriage and farming (Directorate of Planning and Information, 2016).

3.3.2   Learning outcomes and quality of education

Even though the country has seen a steady increase in school construction and investment in education, the quality of education has not improved. Learning outcomes has been declining, and mean scores from national assessments are currently at their lowest since the late 90's (Table 3.1). Due to the multiple languages being used across the country, all curriculum and teaching is in English after grade 4. Teachers are placed in schools to ensure staffing at rural schools, and often do not speak the local language taught in the first years (Cole, 2016). This causes a large body of students to fall behind during the most crucial first year of school, drastically affecting the outcomes and quality of their education. In addition to this, other factors like a high pupil teacher ratio, reduced contact time, poor quality of teacher housing, low pupil-book ratio and high absenteeism further contributes to the poor results.
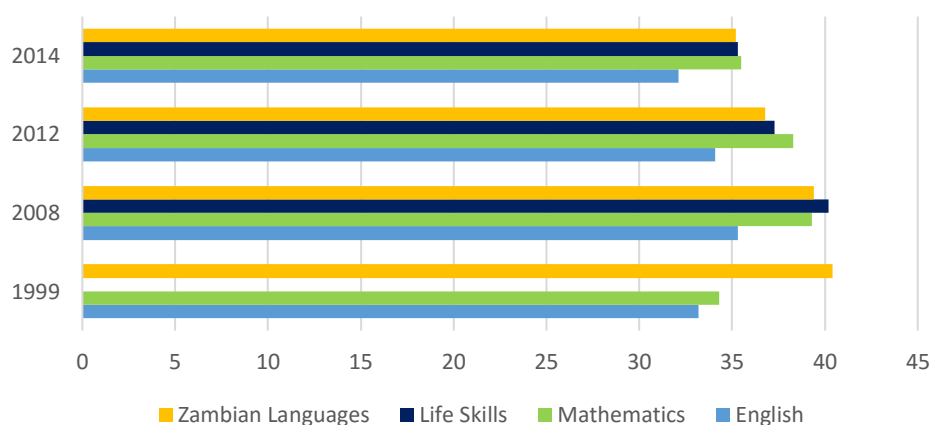
Table 3.1 % of pupils scoring desirable in National Assessments (Directorate of Planning and Information, 2016)

3.4   Structure of education system

The responsibility to oversee development of curriculum, national tests, school inventory and monitoring of quality assurance of basic education lies with the MoGE.

The annual expenditure on education in 2016 was 17.2 % of the national budget, a decrease by almost 3 % from previous years. The Ministry is operationally structured into 6 operational directorates under the permanent secretary (Figure 3.2). EMIS and all data collection is located at the Directorate for Planning and Information whom gather information on education quality, inventory and infrastructure needs on behalf of the other directorates. Even though Zambia has decentralized the provision of education, The Directorate for Standards and Curriculum is the central hub not only for developing, but also providing books, desk and other inventory on order from all schools. Learning achievement is considered as the most critical indicator in assessing the quality of education delivery and thus the outputs of the education system.
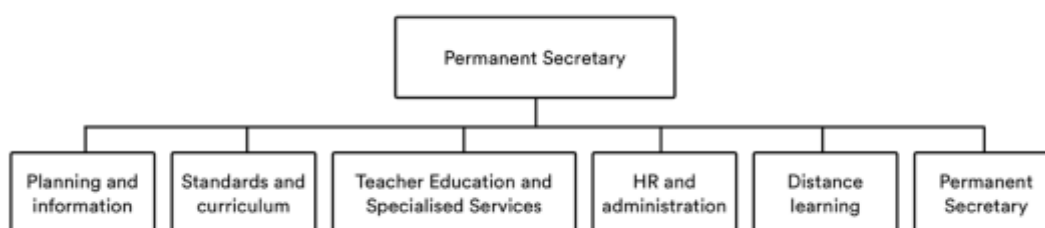
Figure 3.2 Organizational structure of the Ministry of Education (Ministry of General Education, 2015)

3.4.1 Data management

Collecting data from the Zambian education sector is organized through Data Management Committees, which exist in District, Provincial and National level. Any inquiries to collect data from schools are approved by them, so they can check if the data requested already exist, and if the data is of value for the Ministry. This applies to government bodies as well as international NGOs, and is an effort to prevent duplication of and harmonize data collection.

3.4.2 School provision

School provision is mostly provided through the formal system by the government or private institutions, but a non-formal system consisting of community schools also exists. The non-formal system is primarily for at-risk children, drop-outs or children who never attended formal schools. Teachers at the community schools do not

necessarily have a teaching degree, and often rely on international volunteers or committed people from the communities. These schools do however require a certificate of registration from the MoGE in order to operate legally, and must report to the Annual School Census like other schools.

The majority of schools are however run by the government, with only a small percentage of private schools (Figure 3.3). Private schools are generally considered to be of much higher quality than public schools, making them the preferred choice among middle and upper-class people who can afford it.
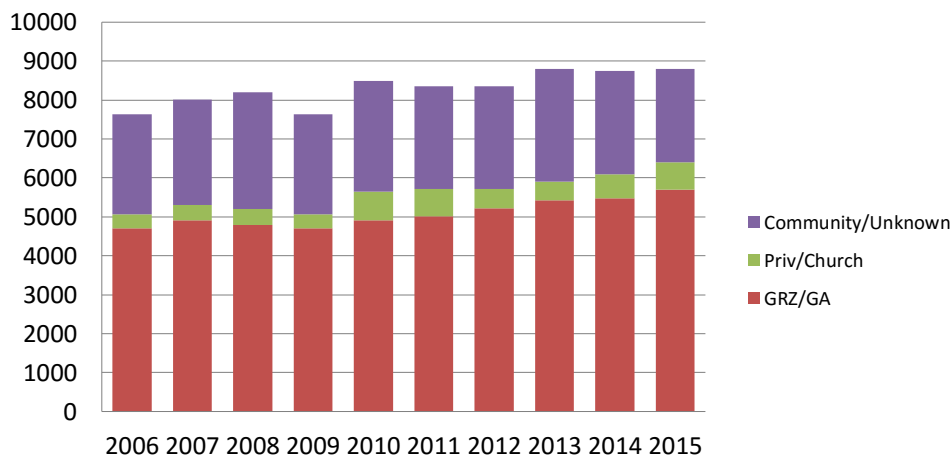
Figure 3.3 Number of primary schools by agency: 2006-2015

4 Current EMIS in Zambia

"The good thing is once we review [the EMIS-pilot] we will look at all those aspects [cost, human resources, training etc.] and how feasible they are to sustain. So I think this pilot will give us knowledge, in terms of cost and what is required of the ministry. The experience will let us make an informed decision."

- Ministry employee

The EMIS in Zambia consists of a large number of government bodies, who's tasks range from service provision, quality assurance, data collectors to policy makers. A variety of NGOs operate with a broad set of interventions within health, sanitation, school feeding, technical support for feedback, as well as advocacy towards policies and curriculum. Parent-Teacher Associations (PTAs) exist in most schools, and have a lot of influence on school management and the School Board. Chiefs have a lot of authority to see interventions carried through, and promote awareness around the importance of education in the community.

4.1 Information flow

Most routine data is collected on a daily basis by each teacher in their classrooms. The most frequently collected data is student attendance, kept in registers – one for each class with entries for each pupil. Separate registers keep track of examination and test scores for each pupil, which is assessed to set their final mark by the end of each term. Each school also keeps track of teacher attendance, registering if they are absent from work or not, regardless of reason. In most all cases, particularly in rural schools, these registers are physical books.

Class registries and teacher attendance is aggregated on a monthly basis into school registries. Once a year, the school registries are aggregated again so the data can be entered into the Annual School Census. The annual data is supplemented with non-routine data which includes infrastructure (e.g. school structure, teacher housing and sanitary facilities), inventory (e.g. computers, books, supplies and desks) as well as

detailed statistics on the pupils (e.g. roll-overs, number of orphans and gender ratio). During interviews it became evident that the data collected seldom was used to inform decisions during regular staff meetings, which will be further elaborated in Chapter *6.3 Decision-making in the Zambia education sector*. The data is sent to the Directorate for Planning and Information for digitization. Figure 4.1 illustrates the sources of information and where it is collected and stored.
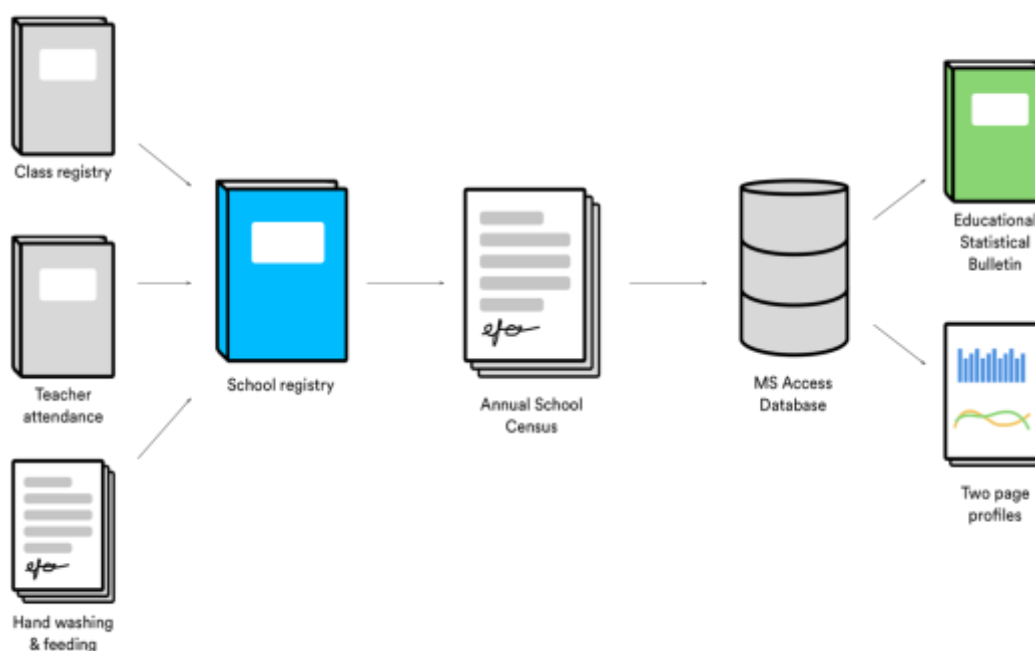
Figure 4.1 Sources of data collection and storage

The following section provides a description of how the data collection and feedback to schools is organized from school level, to national headquarters and back to the schools again.

4.2   Annual School Census

Once a year the Annual School Census (ASC) is conducted to collect data from all schools into the national database. The ASC is a 25-page paper form, including questionnaires and guidelines. Every year in April, the Directorate distributes the paper forms by mail to each Province Education Office (PEBS) who has the responsibility to distribute them to their respective District Education Offices (DEBS). The district

then distributes them to their respective schools. This activity alone takes several weeks to carry through, and is particularly difficult during rainy season when transport to rural areas is challenging.

Each school fills out the ASC by hand, based on the aggregated routine and non-routine data mentioned above. The head teacher is responsible for filling in the ASC, but the task is often assigned to another staff member at the school as it is very time consuming. Regardless of who fills out the form, the head teacher signs it off after checking that the data seems correct.

Following the head teacher's sign-off, the forms are sent back to the District. The DEBS will then conduct a second quality control, before she signs it, and sends it to the Province. Once again, it will be checked for errors before it's signed off and sent back to Directorate of Planning and Information. This entire process takes approximately 9 months to carry through, and is illustrated in Figure 4.2 below.

Back in the capital Lusaka, all forms are manually entered into a Microsoft Access-database for storage and processing by Directorate of Planning and Information. During processing data is verified for errors (e.g. sum of boys and girls not exceeding the total number of pupils), outliers and deviating data points. If errors are found, efforts will be made to call the schools or Districts directly to clarify and correct them.

The data from the ASC is used to produce the Educational Statistical Bulletin (ESB), a printed document containing all indicators and figures on national level. The ESB is used as basis for decision making comparing all national indicators with previous years. In recent years, a two-page profile for each province, district and school has also been produced as a response to the demand for more relevant data at various levels (See Appendix A for school profile example). This is the only document providing analyzed and comparable information on a single school, district or province rather than nationally aggregated data. The Directorate of Planning and Information under the MoGE is responsible for the whole process of disseminating and analyzing the data.

The ESB and two-page profiles are both Excel workbooks that pulls data from the Access-database into pre-defined templates using macros. They are both printed and disseminated in the same manner as the ASC, and the ESB is also published online as an Excel-file[5]. As will later become evident, none of the teachers involved in this research had seen or heard of the two-page school summary, indicating that they might never reach the head teacher's office. The PTAs currently do not receive any data, and must rely on verbal reports in meeting with school staff.
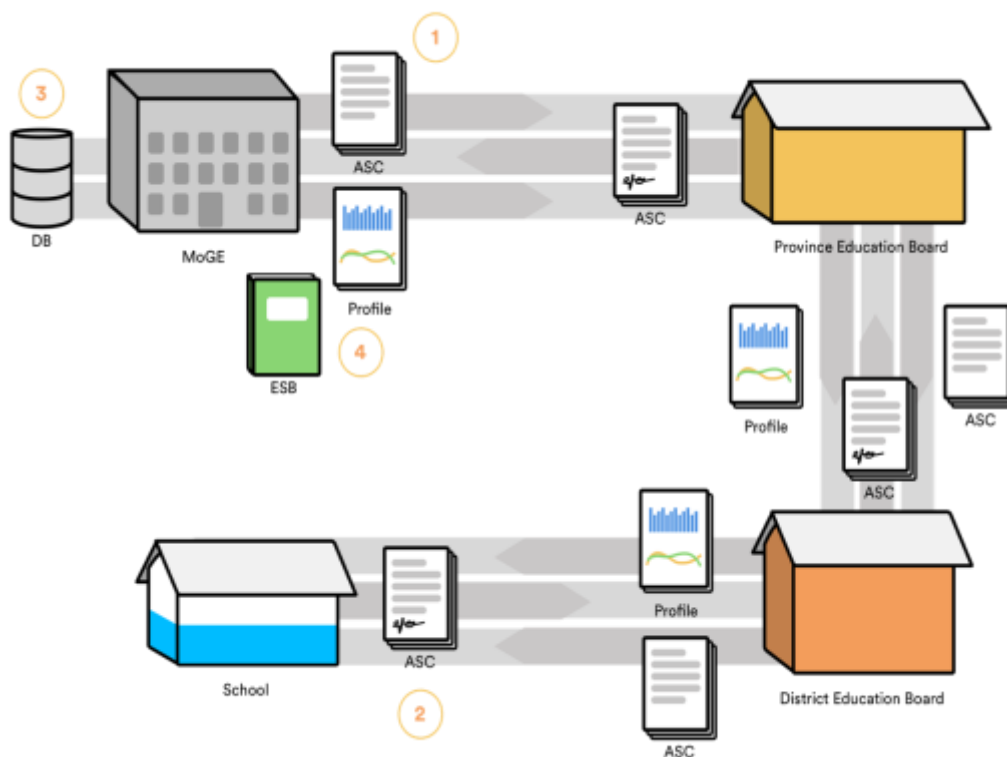
Figure 4.2 Information flow and feedback

(1) ASC is distributed to schools, (2) It is filled out, signed and sent back, (3) Data entered in database, (4) Profiles and ESB printed

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[5] Educational Statistical Bulletin is available for download through
http://www.moe.gov.zm/index.php/documentation-a-information-center/planging-a-information

4.3   Pilot background

As might become evident from the information collection process described above, the mere time aspect renders timely decision making in Zambia impossible. Stakeholders that were interviewed also noted that a lot of the information captured made little to no sense in its current form:

> *"So things like attendance, which is a critical piece of information for school managers, you obviously can't capture that on an annual basis because it doesn't make a lot of sense. It's an interesting piece of information, but it's not going to do you any good."*
> *- NGO Stakeholder*

The current data elements that are captured in the ASC has also been noted to be a result of decades with stakeholder interventions, who have had a lot of influence on what to collect:

> *"So you're not asking the questions that would actually help base decisions. And there's a lot of stuff about very specific programs like HIV/AIDS, which are probably from programs that were around at a time, but now are applicable to maybe a handful of schools. So the majority of schools would just write 'Not applicable' or not write anything at all and get really frustrated by the fact that there's a question that they don't understand why is there."*
> *- NGO stakeholder*

This background has been one of the motivations to initiate the first attempt at digitizing the entire report flow within education management in Zambia. The overall goal of the pilot has been to gather experiences and knowledge on how to transition from annual reporting towards monthly and termly reporting, starting with primary and secondary schools. The pilot has emerged from the current partnerships of two NGOs with specific domain interest in the Zambian education sector; UNICEF,

working with water and sanitation, and the World Food Program (WFP), working with school feeding. The two organizations have chosen different software and approaches in their respective pilot districts. This will be further elaborated in *Chapter 6.4 EMIS-pilot.*

During the time of research, implementation was done in four districts across Zambia, with a total of 327 schools participating. Schools started reporting in May 2016, following months of planning and assessing hardware and software between stakeholders.

4.3.1   UNICEF and DHIS2

UNICEF is a UN program, providing humanitarian aid to children and their mothers in developing countries. Their work focus around early childhood education, gender equality and safe, inclusive learning environments ("Education," 2017). UNICEF are collaborating with the Zambian government on providing adequate water and sanitation in schools, through the Community Lead Total Sanitation program (CLTS) and School Lead Total Sanitation program, which they monitor closely. The technical implementation, support and training is outsourced to Akros, a public health informatics organization.

DHIS2 is an open source software produced by a global network of academics and practitioners within Health Management Information Systems. DHIS2 allows users to collect, process, analyze and visualize data from multiple sources for various user groups. The software is web-based and can be used with Android and J2ME-applications to collect data. DHIS2 comes with data visualization tools and GIS' built in for data analysis.

4.3.2   WFP and DataWinners

The WFP is also a UN program, working on addressing hunger and providing food security. Their School Meals Program in Zambia is currently providing food for over 1 million Zambian pupils in more than 2700 schools. WFP objectives in their school

efforts are to increase enrolment, reduce gender inequality and promote nutritional knowledge. (Sakwiya, 2016)

WFP utilize DataWinners, an open source, mobile data capturing software developed by the Human Network International. The software can use smartphones or SMS to collect data, which can be visualized in a web application.

4.4   Past digitization efforts

At the time of research, the MoGE was ending a five-year project with the USAID-funded project Strengthening Educational Performance-Up (STEP-Up). As a part of this strengthening, STEP-Up has aimed at decentralizing data entry and analysis to district and provincial level, to promote accountability for learning outcomes. The project supported local learner performance tracking, only collecting data on assessment scores for the standardized exams. The system was paper-based on school level, and each district in the project ran their own Excel/MS Access database which also included macros that displayed the data as a graph. The data was not meant to be utilized by national or provincial level, unless they made specific requests for data, but to help districts track performance data.

In addition to the IT-systems introduced, the project also focused on training and empowerment of information officers and data management committees at district and province level, working in ten provinces and 81 districts across the country. Throughout their policy and advocacy work, they worked with the Directorate for Standards and Curriculum to develop a learner performance improvement strategy.

On a general level, the STEP-Up project seems to have been well received in the different districts, as employees at district and province level has gained a lot of experience and increased knowledge on data collection and utilization. During the interviews with stakeholders and national level, however, little was said on how the pilot was received at schools. At the time this field study was conducted, no plans were made to keep the project running with support from USAID. It is likely to be discontinued, but the Directorate of Planning and Information notes that experiences

will be brought into the new EMIS-pilot. The software is apparently still in use in some districts, but there is no overview on who still use it.

5   Research approach

This chapter outlines the methodology and methods used to collect data which constitutes the empirical basis for this research. Following this, the chapter will discuss how the data have been analyzed, and in which way findings are intended for further use. Lastly, ethical considerations will be discussed along with my reflections on the research process.

5.1   Philosophical foundation

> *"What we call our data are really our own constructions of other people's constructions of what they and their compatriots are up to".*
> (Geertz, 1973, p. 9)

The philosophical foundation of this thesis is interpretive, as I ascribe to the notion that reality is accessible through social constructs like language, consciousness and shared meanings (Klein & Myers, 1999). The process of interpretation can be seen as a hermeneutic circle where *"[…]the process of interpretation moves from a precursory understanding of the parts to the whole and from a global understanding of the whole context back to an improved understanding of each part"* (Klein & Myers, 1999, p. 71).

Interpretivist research is often seen as an opposition to *positivist research*, which assumes an objectively given reality wherein the subject of research has measurable properties independent of the researcher observing (Klein & Myers, 1999). A positivist foundation would be insufficient to provide an understanding of the user context, their objectives and how they are enabled or constrained. To address the research question, it is important to note that what might be an enabling factor for one subject, might be considered constraining for another. E.g. the use of M2W-technologies like tablets can by stakeholders be seen as enabling as they allow for inexpensive immediate data

transfer, but for a school employee with little experience in use of tablets can pose numerous challenges.

The thesis does however contain a significant element of descriptiveness, which is considered positivist (Orlikowski & Baroudi, 1991). Descriptive studies assume no underlying theories, and does not try to interpret the events studied, but merely provide factual and objective descriptions of what has occurred. However, it is not the researcher's belief that any social phenomena are, or can be, studied or described completely objectively, as the mere act of describing the phenomena is a form of interpretation. Secondly, the descriptions provided in this thesis is the result of formal and informal interviews and observations, which is again based on the subject's own interpretation of a situation.

5.2   Research methodology

The data collection conducted and the following analysis changed quite dramatically during the research process. It is worth mentioning that the initial plan for this study was to conduct an Action Design Research seeking to improve feedback mechanisms for schools, PTAs, Chiefs and School Boards. However, this changed into a case study on the EMIS-pilot's design. This has been a major learning process, and will be elaborated further in *Chapter 5.6 - Reflections on the study conducted*. The philosophical foundation mentioned above has however remained the same during the entire process.

5.2.1   Case study

Though implicitly positivist in his stance, Yin (2009, p. 4) notes that a case study *"allows investigators to retain the holistic and meaningful characteristics of real-life events – such as […] organizational and managerial processes […]"*, and are appropriate when answering "how" and "what" research questions. This is particularly true when examining contemporary events where there is little or no control over behavioral events. He further defines the goal of a case study as the endeavor *"[…] to illuminate a decision or set of decisions: why they were taken, how they were*

implemented, and with what result (Schramm, 1971)" (Yin, 2009, p. 17), while noting the above also apply for interpretivist studies.

Case studies can be *explanatory*, *descriptive* or *exploratory*, and can further be designed to study a *single* or *multiple cases*. This study uses a single case due to its inherent limitations in scope from being a pilot project. Both the type of study and design affect approaches and methods used to collect data, as well as how to approach data analysis. Exploratory case study hypothesizes observations for further research endeavors.

Interpretive case studies form their contributions through the process of using theory, conducting the field work and generalizing the data through analysis. Unlike positivist research, interpretive generalization must be seen as *"explanations of particular phenomena derived from empirical interpretive research in specific IS settings, which may be valuable in the future in other organizations and contexts"* (Walsham, 1995, p. 79). Throughout the research, I have relied on the ITPOSMO-framework by Heeks rather than complex, social theories as a way to structure/design data collection, and to guide the final product of the thesis. (Walsham, 1995).

5.3   Data collection

This section will outline the different sources of data collection, as well as the methods used. Part from the workshops and field observations, most of the data has been collected through formal and informal interviews, as they enable researchers to access participants interpretations and to examine these interpretations at a later point in time (Walsham, 1995). Due to the EMIS-pilot's defined scope, participants and sources of information has been somewhat restricted. Multiple sources of opinion have been insured by including relevant stakeholders at various levels of participation in the pilot. Table 5.2 provides a complete list of all sources of data and the methods used to collect it. As can be seen not all stakeholders were accessible. To compensate, document analysis of meeting minutes and existing documentation has been conducted. The

study has therefore used a combination of documentation, interviews, direct observations, focus groups and design workshops.

To support the process of interpretation and data analysis, field logs and diaries have been written after each visit to the field, summarizing first impressions. These notes have been revised and discussed with stakeholders after the visits.

5.3.1 Study

The research was conducted in collaboration with Akros, one of the HISP-network partners affiliated with the University of Oslo. Data was collected during two trips to Zambia, one preliminary trip lasting two weeks in May 2016, and one field trip lasting three months from September to November 2016. During the preliminary trip no research question or topic had been chosen, and I followed Akros to Sinazongwe in the Southern Province, participating in trainings of community champions in their CLTS program ("Water & Sanitation," 2016). The objective was to explore and understand the culture and context as a preparation for the main fieldwork, as well as getting an overview over current projects and needs. This proved very useful, and by the end of the trip it was determined that EMIS would be an appropriate case to research as it was a new effort with little knowledge to inform its further development.

Before embarking on the three-months field work, documents and project plans were gathered in order to identify where and at what times field visits could be scheduled. This made it easier to develop interview guides and questions that could be explored further. In order to understand decision-making processes, participants should represent the groups of people at various levels involved in these processes. A complete list of users is provided in Table 5.2.

Figure 5.1 Training community champions on mobile CLTS reporting at a health facility during first field visit

At the time of my second visit to Zambia, the pilot had been operating for approximately 5 months, since May 2016. Participating districts and their respective schools had been defined, hardware and software had been purchased and configured, and relevant stakeholders had been involved. Reports had started coming in, and users had started to get an understanding of what was working well, and what was lacking in the system. Future meetings and trainings had mostly been scheduled, which made it convenient to plan where to go, and at what times.

Due to pilot's scope, and the University of Oslo's affiliation with the DHIS2-software, field work was conducted in the province and district chosen by UNICEF. A major challenge when conducting research in the Zambian context are the vast distances and poor infrastructure, making both coordinating and travelling expensive and time consuming. Government officials lawfully have the right to per diems, food allowance and coverage of travel expenses when they are participating in activities related to

work. This was not known until after arrival in Zambia, and made visiting numerous schools and users a challenge. The sampling was therefore highly based on what was most convenient, trying to tag along on already planned field visits and activities. The implications on paying allowances is further elaborated in *Chapter 5.5*, while the solution to this issue, conducting focus groups, is presented in *Chapter 5.3.2.5*.

The sample does not fully represent each user group, as they will have varying needs and conditions across the country, and in the districts using the DataWinners software. However, as this study is qualitative and seeks to understand decision-making processes thorough interviews can still provide useful insights on geographical contexts that have not been visited in person, and can be verified by e.g. District and Province who have good insight into their respective districts and provinces.

User group	Role in EMIS
National level Ministry of General Education/Directorate for Planning and Information	Overall EMIS-responsibility, final decision on indicators and production of feedback
Stakeholders UNICEF / WFP	Responsible for implementation (software, hardware, training) and funding
Province level Province Education Board Secretary's Office	Strategic decision-making in their respective province
District level District Education Board Secretary's Office	Strategic and operational decision-making for schools in their respective wards. Ensuring quality and hiring of staff
Chiefdom Chief	"Approval" of local initiatives and engaging communities in volunteer efforts to improve health and education
School level Administration, head- and guidance teacher	Implementing efforts, responsible for following up on data collection

Table 5.1 User groups and their role in the EMIS

5.3.2   Data collection methods

As mentioned, the data collection methods have mostly been qualitative to provide a contextual description of each stakeholder's involvement. Some general insights have been provided from statistics mentioned in *Chapter 3 - Background and context.*

5.3.2.1   Document analysis

The initial data collection started before going to Zambia. The documentation included pilot plan documentation, EMIS data collection forms, system specifications and plans for roll-out during the first round of implementation. These documents provided a good insight into the technical architecture, as well as which software and hardware was being used by each sub-pilot. This was mostly interesting from a design-perspective, but reduced the amount of insight required upon arrival. These documents were provided by Akros, who are collaborating with the University of Oslo in the HISP-network.

5.3.2.2   Pictures

Pictures were taken throughout the research process to document the context as well as guide memory for later analysis. It was important to ask for consent to take pictures of people, particularly during trainings and meetings, where they could easily be identified. Efforts were made to take pictures where people's faces weren't shown, rather than the situation they were in.

5.3.2.3   Observations – field diary and field log

Observations were made throughout all fieldwork, and mostly consisted of unstructured notes as well as drawings of different sites in a notebook. Specifically, observation notes were made during; field visits (e.g. to schools or the Chief's Palace), trainings and during stakeholder's meeting where I acted as an outsider participant. This makes it easier to remember locations and specific events when reflecting upon the interpretations during analysis. Every day raw notes were written out in full into two documents:

- Field log – what did I do throughout the day and who did I talk with?
- Field diary – elaborated and chronologically written diary, including my personal thoughts, impressions and potential follow-up questions

Excerpts[6] from the field diary is presented as introductions to selected chapters throughout the thesis to provide a richer context of my observations and interpretations.
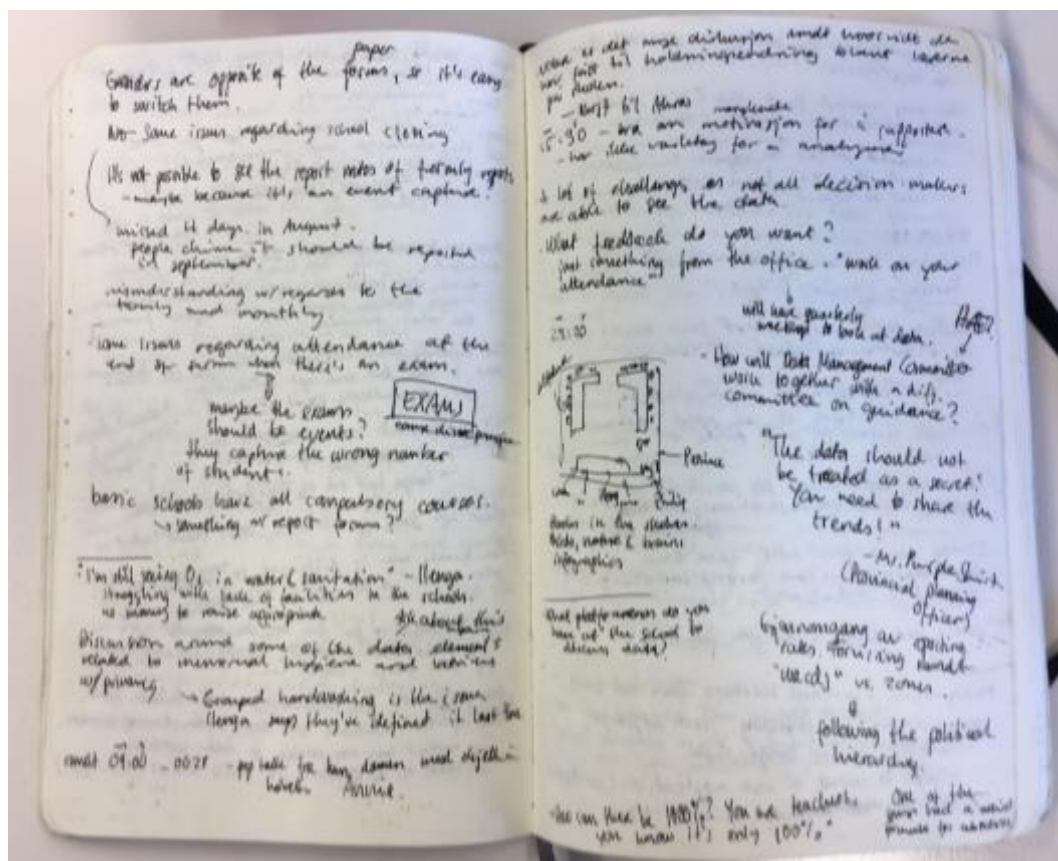
Figure 5.2 Field notes, including site drawings, quotes and thoughts

5.3.2.4 Interviews

Interviews were conducted with almost all stakeholders, as they allow for the ability to explore topics in depth with single subjects, and get subjective interpretations (Lazar, Feng, & Hochheiser, 2010). The overall objectives of the interviews were to understand each stakeholder's rationale for conducting the pilot, and provide the

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[6] The excerpts have been slightly modified to suit the length and place emphasis of most relevant issues

context from which they were operating in regards to their own strategies and governance. While central level interviews were conducted as semi-structured, most of lower level interviews (province and district) were informal interviews. One-to-one interviews were transcribed immediately after the interviews.

5.3.2.5 Focus groups

A major challenge when conducting fieldwork in rural Zambia is the vast distances between people. Travelling to each school would be extremely time consuming, as well as very expensive as one would have to pay for a driver, fuel and accommodation – commodities that aren't necessarily available everywhere. To solve these issues, it seemed best to conduct focus groups with teachers at the district capital.

The advantage that made me chose focus groups, was being able to gather a broad range of opinions in a cost effective manner (Lazar et al., 2010). Discussions provided new insights that would not be possible by interviewing teachers one at a time. The group size was reduced to five teachers in two groups, to avoid some participants might speak louder than others, making a false consensus based on their opinions. The focus groups were transcribed after returning to Norway, as I suffered an elbow fracture that prevented me from typing with both hands for several weeks.

5.3.2.6 Design workshop

The design workshop was held with the original ambition of conducting a bottom-up focused ADR-process. The core methodology behind the workshop stems from Design Thinking, a term coined by the world famous design studio IDEO. Design Thinking emphasizes what is desirable from a human perspective, with what is technically feasible and economically viable, while focusing on our ability to be intuitive and able to construct patterns to guide design ("Design Thinking," 2017).

The workshop followed an initial focus group described above, and aimed at making the teachers reflect on what data they wanted to monitor, and in what format (graphs, text, charts) that made most sense to them. They worked in pairs of two, and were to

discuss what decisions they make on a day to day basis, and write down how a prioritized list of what data they felt most important to monitor if they could receive visual feedback that showed the information from one month to the other. Part of the original intention was possibly to implement an SMS-based feedback system. A second task of writing out these texts was conducted. Following the workshop, presentations were made so everyone involved could see what the others had designed, and ask questions. In total ten teachers from around the District participated, as well as two employees from the DEBS office. The workshop and focus group results are presented in full in *Chapter 6.7 – Teacher needs – design workshop results.*

5.3.3   Sources for data collection

The following table presents the full list of sources used for data collection in this thesis.

Source of data collection	Method	Frequency
Akros employees	Interview Meeting observation	5 employees 6 meetings
UNICEF	Interview	1 employee
WFP	Interview	Attempted, no response Met in stakeholder's meeting
Step-UP	Interview	Attempted, no response
District Education Board Secretary	Meeting Informal interview	5 DEBS 1 DEBS (x2 in same District)
Province Board Education Secretary	Meeting & Informal interview	1 PEBS (x2 in same Province)
Chief	Meeting & Informal interview	1
Directorate of Planning and Information	Interview Informal interview	1 1 (in stakeholder's meeting)
Guidance teacher training	Observation Informal interviews	34 5
Guidance teachers	Focus group Focus group	10 teachers 10 teachers (Cancelled)
Stakeholder's meeting	Meeting	1

Table 5.2 List of sources for data collection

5.4   Data analysis

Data analysis shows the process of how findings have been revealed throughout the research process. Interpretive case studies rely on rich descriptions from the field to form their contribution, as use of theory often follows an emergent process (Walsham, 2006). As described above, I have used multiple methods of data collection to reduce the likelihood of misinterpreting the data. To aid memory, field notes and summaries were written continuously to jot down impressions of the visits, main topics of interest, as well as being a source of information that could be revised and discussed with stakeholders at a later time. These notes functioned as a within-case analysis (Eisenhardt, 1989) which allowed for recurring topics to emerge and be made more easily available to cross-reference. This approach was very useful to identify challenges e.g. related to usability, positive feedback and critique on the EMIS-pilot.

The largest body of data, part from field observations, consists of interviews which have all been transcribed in full. Quotes throughout the thesis are excerpts from these transcripts. However, the accuracy of the transcripts is of varying quality, due to numerous factors like audio quality and the dialect of participants. One example is the focus groups. The session was held in a school classroom with no glass in the windows, resulting in a lot of background noise like wind and children playing. Additional challenges are the local English accents that make some words or sentences unintelligible for a foreigner.

Transcripts were coded using the software Atlas.ti. This was mostly conducted as an effort to make it easier to revise data and interpret the data, rather than construct theories to build upon. It also made it easier to find specific quotes on subjects related to e.g. indicators, training, positive and negative thoughts on the EMIS. Field notes were revised and coded by topics that emerged through the notes, and were organized according to the design-reality gap framework outlined by Heeks. An example from my field notes that was written down during a training is "ZIC-challenge: untimely from teachers, therefore late" which initially was coded with the label "Late submission". As late submission is an issue concerning the process of reporting, it was

grouped under the category "Reporting", along with other labels like "Organizing reporting" and "Unclear deadlines". Comparing this to the ITPOSMO-framework, it was apparent that the category "Reporting" was part of the dimension "Processes", as they are related to activities supporting the EMIS. This category was then renamed "Work processes and tasks" as it was a more precise description of the findings it categorized. Some categories like "Usability" and "Infrastructure" emerged in addition to the ITPOSMO-dimensions. By knowing the contents of the categories, it was possible to map out all the categories and their labels on post-its and then visualize the relationships and dependencies between them on a single sheet of paper. Figure 5.3 shows an excerpt from the map where it is clear to see that the system's usability is a direct result of technology, staffing and skills and requires training to overcome. The categories, their dependencies and main findings identified is presented in Table 5.3 below.
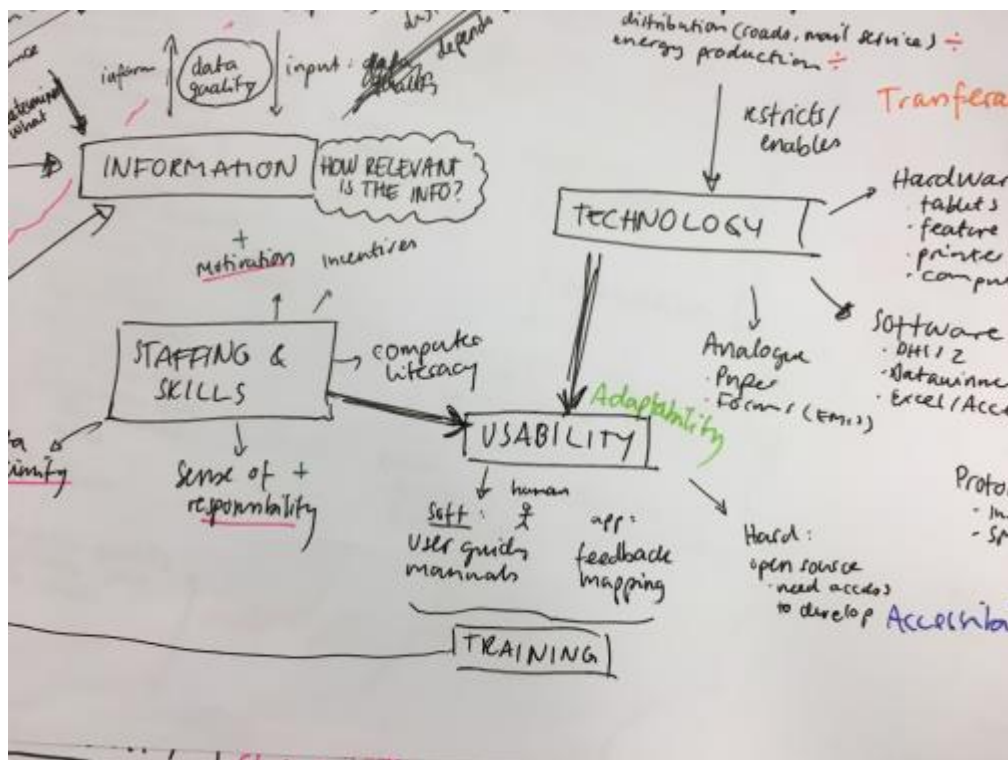
Figure 5.3 Mapping of categories and labels

By looking at the mapping of categories it became evident that there was a need to simplify the map in a way that allowed for a more structured discussion. The analysis revealed stronger relationships between (1) user objectives and organizational

structure, (2) infrastructure and technology, (3) technology and staff skills and (4) which formed the basis of the digital EMIS design themes presented in *Chapter 7 – Discussion*. Figure 5.4 shows my coded notebook, labeled and categorized post-its, the sheet with categories and resulting map of dependencies between the various dimensions.
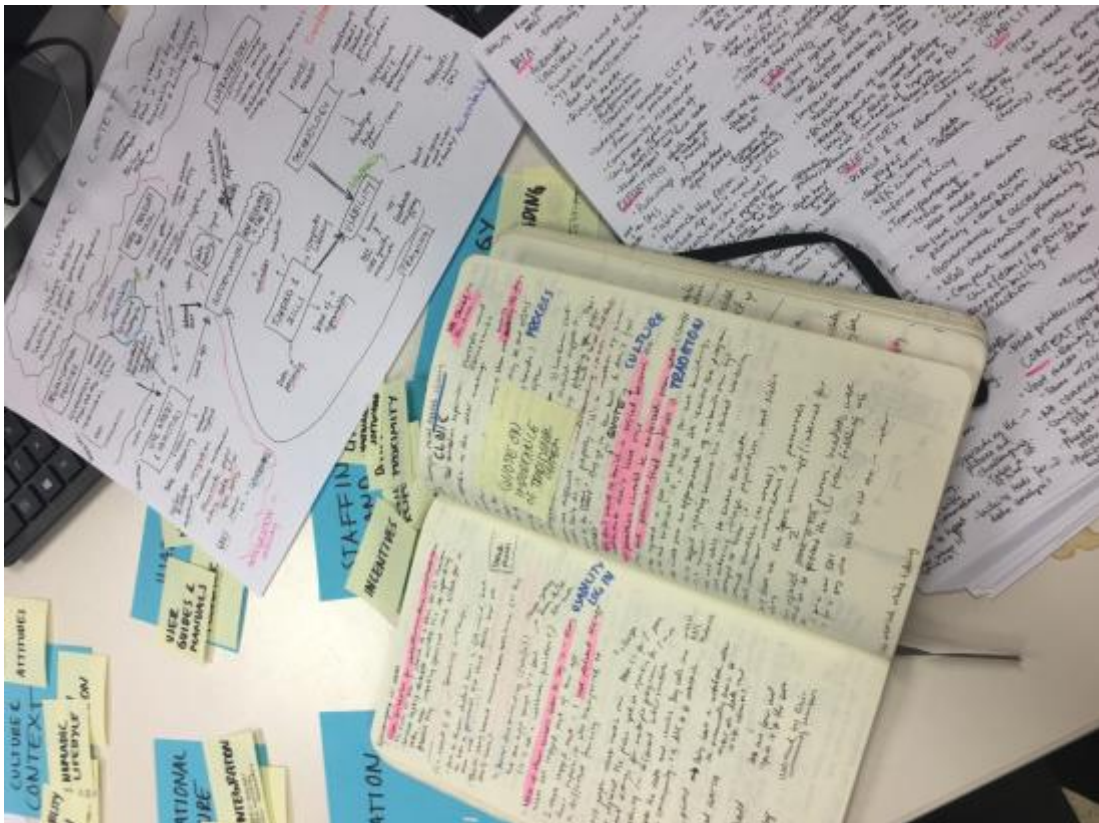
Figure 5.4 Data analysis of field notes to identify topics and relationships

Dimension	Dependency	Key observation
Culture and context	Affects the overall possibility to implement the system	Respect for higher levels Vast distances Chiefs
Infrastructure	Lack of cellular coverage restricts and enables choice of technology	Teachers can't submit reports
Organizational structure	Various levels with different roles and responsibilities cause plethora of objectives and tasks	Government levels and stakeholders determines what is important to collect
Processes and tasks	Depends on organizational structure, needs and objectives and is the input to information	Reporting aligned with school year School meetings don't use data to inform decisions
User needs and objectives	Are based on information and depend on work tasks and processes for various levels	Reduce data error Informed decision Monitor interventions Follow up pupils
Relevancy of information	Is constrained by user objectives and infrastructure for distribution	Stakeholder centric data collection
Staffing and skills	Determines the usability and need of training around a certain technology	Highly motivated staff Low computer literacy Incentives
Technology	Depends on infrastructure and what information the system should produce	Use of tablets vs. feature phones Other existing (or lack of) hardware at schools Paper-based materials
Usability	Result of the choice of technology, staff skills and amount of training	Touch interfaces are difficult to use and require training
Training	Amount and necessity depends on the aboce	Extensive and frequent to ensure reports are submitted

Table 5.3 Overview of categories from analysis

5.5   Ethical considerations

Ethical considerations are important when embarking on field studies. It is important to not do any harm in the environment one is researching. As noted by Stake (in Denzin & Lincoln, 1994, chapter 17), qualitative case studies shares interest in personal views and circumstances. It has been important throughout the research to keep informants as anonymous as possible by not noting down any names or storing names in relation to audio recordings of interviews. In reality it would be quite easy to identify several of the stakeholders involved in the study due to its limited scope.

All informants were presented with consent forms that we went through verbally. None of the informants signed the forms, but gave consent verbally in the recordings. The aversion to signing documents, but still consenting might be a cultural difference, and is still unknown to me.

5.5.1   Recruiting teachers for interviews

Recruiting teachers for interviews is not straight forward. As teachers have to be absent from their teaching, pulling them away from school for longer periods of time should be kept to a minimum. To mitigate this, an official inquiry needs to be placed and approved at District level, and it is custom to visit the District (and preferably Province) before meeting with the respective schools and teachers, to inform them of your intentions. To compensate for the teacher's absence and travels, they have to be reimbursed for their travel costs as well as receive per diems at a rate regulated by the government. Paying your research informants is a debated issue, as it can affect the information provided. However, in this context it seemed appropriate as it is important to follow local laws, and it would be unfair for low-salaried teachers to pay out of pocket for participating in the study.

5.5.2   Storage of information

All audio recordings were kept on a dedicated memory stick and were transcribed without using any names or affiliation. The transcripts were then stored on a cloud

service. As there is no sensitive information collected in the study, and all relevant stakeholders and informants were well aware of the study and its intent by participating in the pilot, no extra measures have been put in place to secure the transcripts and pictures taken.

5.5.3   Role of the researcher

The degree of involvement is an important decision to make when conducting research, as it can affect both the relationship with participants, as well as bias the data collected and how it's interpreted. Walsham initially positioned researcher involvement into two categories; outside observer and involved observer, but modified them into an evolving spectrum with a neutral, though not unbiased, observer at one end, and a full action researcher in the other (Walsham, 1995, 2006). In the context of this research, the latter seems more appropriate.

To a certain extent, I have been very involved in the process, working closely with external consultants trying to solve a specific, practical motivation posited by both the MoGE as well as NGOs. I have thus engaged in participatory discussions about systems design with end users as part of the field work for this study in order to understand work processes and systems design in low resource contexts (Berntsen, 2015; J. Braa & Sahay, 2012b; Kossi et al., 2012; Rogers, Sharp, & Preece, 2011; Sæbø et al., 2011). This close involvement has made it easier to arrange field trips and meet with teachers, who have to take time off work. It has also made it possible to engage with ministry officials This involvement would likely be even stronger if the entire ADR process had been carried through as originally planned. However, it has remained important to emphasize my independent role as a researcher and confidentiality in order to get honest feedback during interviews, as well as a realistic and comprehensive overview of all EMIS user groups. Thus, large amounts of data were collected as an outsider, not involving myself in trainings or engaging with participants, part from conducting interviews and writing notes.

5.6 Reflections on the study conducted

As mentioned above, the research was initially intended as an ADR, which is a combination of action- and design research that emphasizes the emergence of artifacts from interactions in organizational contexts (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011). Thus it is heavily dependent on contextual, qualitative data from multiple sources. ADR is well suited to inscribe theoretical or practice inspired context into artifacts through an iterative and cyclical process of;

1. Problem formulation
2. Building, intervention and evaluation
3. Reflection and learning
4. Formalization of learning

This process is closely linked to user centered design-processes, emphasizing a bottom up approach to gain insights into what the users need, based on understanding their and other's work, before designing interventions. This was however not possible to carry through, due to practical and financial reasons, rendering none of the prototypes to be tested. Any interpretation, analysis or discussions would thus be meaningless. Figure 5.5 illustrates the ADR process, and where it stopped during the EMIS-research in Zambia.
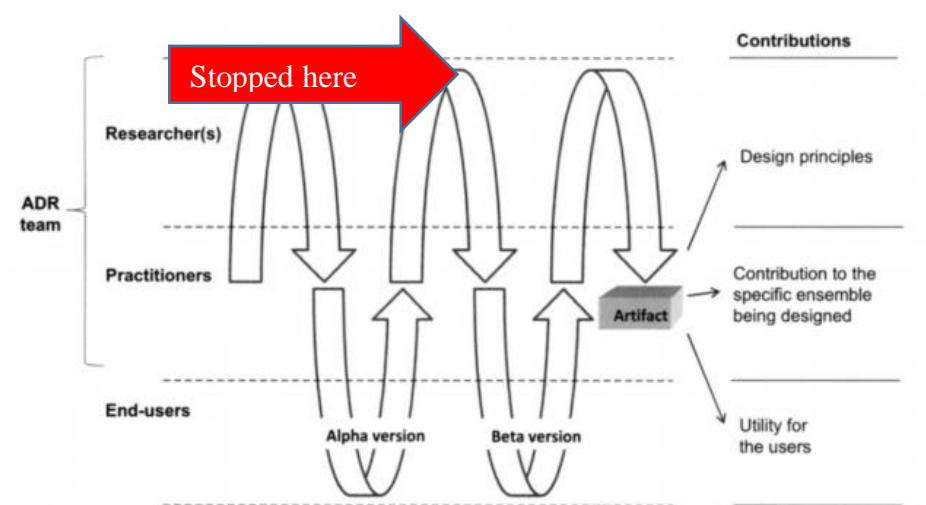

Figure 5.5 Process of ADR (adapted from K. Braa & Vigden, 1999)

During the process of formulating a problem, a rich and descriptive body of data was collected to understand how various users of the system collected, used, or wanted to use data from the EMIS, and what objectives they were trying to achieve.

6   Empirical findings

It was an early morning in Ndola, and the morning rains had left the air hot and humid. The hot and dry season was over this far north, leaving the hilly area green and fertile, much like how I imagine central Africa to look like in a travel magazine. Silas, my German friend who spent a year volunteering through his family connections, and I were preparing for a day of teaching math at the Children in Distress (CINDI) school in Ndola. The school is a government approved community school under the Education for All initiative, thus they are required to report to the Annual School Census as any other school in the country. I knew the students in community schools were worse off than children in public schools, and felt nervous for having the responsibility of educating them, particularly in a subject which I'm not comfortable with.

We were picked up in a pickup truck by one of the teachers. We sat in the open cargo area, which is legal as long as the driver is sober and wearing a seat belt. The school was small, but with every necessary facility, as well as built in water and toilets - better than a large number of rural public schools I'd seen. I was showed around the premises, and introduced to the head teacher who told me the history of the school, and how they work. That most of the students consisted of drop outs, too old to be enrolled in public schools and orphans from around the district. How they were all lagging behind, and had nowhere else to get help.

We entered the classroom which was fully packed with approximately 40 students. They were approximately 10 years old, some younger, some older. They were working on an English assignment given by the teacher who was currently in the neighboring room teaching older students before our math section. Their notebooks looked like recycled paper, folded into small pamphlets. The pencils were stubs, lasting a week more at best. Some of the students had neither books or pens. Most of them had their hands buried in their faces without their notebooks opened, others joking around, looking at us and giggling.

"Today we will work on multiplying small numbers", Silas said when we were back from recess. "Yes teacher," the class replied. Silas wrote some calculations on the blackboard. 2x3, 4x4, 5x7... and so on. "What is 2 times 3?". The class went silent. Some were looking around at each other, others were noting something down in their books. After a while a small hand rose from the back of the classroom. "5?" the student said.

I walked over to assist the student in correcting the error, trying to explain the we were multiplying, not adding the numbers. When I looked down in the notebook I could see two rows of lines, three lines in each. Five lines. I tried asking if the student knew the difference between multiplication and addition. He didn't speak English, none of them did.

- Excerpt from field diary, 18th November 2017

In this chapter I will provide the empirical insights gathered during the fieldwork. These experiences are drawn from trainings, focus groups and workshops conducted with teachers. It is supplemented with quotes from interviews with other stakeholders. Observations revealed a wide range of issues related to usability and computer literacy. However, the new pilot project has had positive effects on how data is seen at schools, and teachers now collaborate more closely in the data collection and reporting process.

While the main focus is on the EMIS-implementation, I find it important to highlight some of the surrounding challenges teachers face on a daily basis. The excerpt introducing this chapter provides an image of how language barriers and insufficient supplies, amongst others, affect the quality of education. Challenges like these reach beyond what the current and piloted EMIS can solve, but are nevertheless an important part of the background of how pupils actually achieve. This chapter will therefore start with a description on infrastructural issues mentioned in Chapter 3.2, before embarking on the structure of the pilot and how the teachers performed reporting.

Lastly I will present the results from the design workshop. The results illustrate a mismatch between what different levels, as well as stakeholders, need from the system.

6.1 School infrastructure

6.1.1 School structures, facilities and infrastructure

There are huge variations in the quality of school structures across the country. This will vary if the school is publicly or privately funded, if the structure is new or old, and if it's a rural or urban school. The latter greatly matters in terms of electricity and sewage systems, as there might not be adequate coverage in the rural areas. The school I visited most frequently had no electricity to the main student facilities (see Figure 6.1). Many areas that do have electricity, will often find it unstable and unreliable. This will in turn affect to what extent they have computers or not for administrative and teaching purposes. Most inhabited places in Zambia does however have cellular

coverage provided by at least one of the three telecom-providers AirTel, ZamTel or MTN.

Figure 6.1 Public school in rural Zambia

6.1.2 Water and sanitation

The schools without electricity or functional sewage systems, relying on latrine construction and *tippy-taps* [7] for hand washing. Permanent latrine structures are common, and efforts have the recent years been made to raise awareness on menstrual hygiene to prevent girls from dropping out. Though aware of their shortcomings in e.g. menstrual hygiene, several of the teachers interviewed noted that it is largely due to financial and managerial issues that improvements have stagnated. Community efforts in collaboration with NGOs, local government and Chiefs have led to more awareness around, and left communities and schools free from open defecation. Data

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[7] A tippy-tap is a small jerry-can filled with water and suspended from a wooden frame.

on water and sanitation is collected on a daily basis through the Daily Sanitation Reporting Form (See Appendix F).

6.1.3   School feeding

School feeding is considered an important step in providing equitable access to education for all. It works as an incentive to send children to school, and keeps them energized and able to concentrate throughout the day (Sakwiya, 2016). Not all schools have the necessary facilities and resources to support a functioning school feeding system. Where electricity is not available, food is cooked over open fire on the school premises (See Figure 6.2). NGOs support schools with basic foods, such as nshima[8], to ease the economic burden from the school budgets. During the interviews, schools

Figure 6.2 Drinking station and cooking area (behind) at a rural school

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[8] Nshima is a corn-based dish made of maize flour, a staple food in Zambia and nearby countries

also noted that school feeding is sometimes not carried out because the school chef simply hadn't shown for work without giving notice.

6.2   Staff and teachers

There are no digital registers of staffing at the schools, but manual lists of current staff exist for internal usage. All teaching staff is however required to register their attendance on a daily basis, something which is monitored closely by the administration to ensure all classrooms are staffed. District level keeps track of how many teachers are employed at each school at any given time, which is important to keep a sufficient pupil-to-teacher ratio.

One of the major challenges facing the quality of education in Zambia, is the process of teacher employment. To ensure enough teachers in rural areas, teachers are placed where there are vacancies and need for them. They are provided with accommodation, teacher housing, which are often modest facilities. The maintenance of teacher housing is under the school budgets, which are already limited. Some of the interviewed teachers reported incidents of staff quitting due to poor housing conditions, saying it imposed a health risk.

An issue concerning education quality, which is elaborated in the excerpt to this chapter, is the language barriers often present between teachers and pupils. Most teachers learn how to teach in English, as curricula from grade 4 is in English, or in their native tongue using English terms and expressions. Students, particularly in the first grades of elementary school, only speak their native tongue, which in many cases differ from that of their teacher (Cole, 2016).

6.3   Decision-making in the Zambia education sector

Decision making in Zambian schools follow a strict hierarchy, and decisions are usually made top-down. Numerous stakeholders have varying interests into which decisions are made.

The head teacher is in charge and have the overall responsibility for quality assurance at the schools, which is monitored on three different categories: pupils, teachers and inventory/infrastructure. Decisions are made on a monthly basis involving all staff in the planning:

> *"Usually each term, we have a plan. How are we going to run that term? So at the end of the term we look at what we have done and not done, and also at the activities that have been planned. So we have the collection of data at each term."*
> *- Guidance teacher*

Information on pupils include, but is not limited to, gender, attendance, enrolment, drop-outs, examination and test scores, health, school feeding and hand washing. Teacher information includes which topics they teach, attendance, housing and teacher deaths. Inventory and infrastructure encompasses books and supplies, desks, sanitary facilities and structures. The frequency of collection varies from daily (attendance) to monthly (aggregates) to yearly (school structures, inventory and sanitary facilities), as well as after specific events (examinations). Regardless of the difference in frequency, the data collection is predictable as it follows predefined, national schedules, e.g. after national standard assessments which always take place in week 5, 10 and 13 in 1st and 2nd grade of primary school. Other examples include non-routine data which is collected as part of the Annual School Census reporting after a school year.

The curriculum and inventory follows national standards, and schools have to order new inventory and supplies from the Directorate for Standards and Curriculum. Distribution is cumbersome and expensive and is thus carried out yearly based on data from the annual school census.

Figure 6.3 Annual School Census data in DEBS office

6.3.1 Use of School Profiles

The information provided for decision-making to schools is the two-page School Profile (see Appendix A). The profile is addressed directly to the school head teacher, and a corresponding profile is also made for the District and Province. The School Profiles serves as a key instrument in the decentralization efforts of schools, and are supposed to enable them to make evidence-based decisions:

> *"We are currently trying to support the closing of that feedback loop [School Profiles], so instead of data just flowing up, which is what it does at the moment, it will start flowing back down. And that is really just to support capacity and evidence based decision-making and increased accountability at the school level for learning outcomes."*
> *- NGO stakeholder*

The School Profiles were very well perceived at both National and District level. They also reported that most all head teachers were very happy with the school profiles, as they were clear to understand and not only contained graphs and charts, but also natural language. During the introduction of the school profiles, emphasis was placed on the importance of making the profiles available for the staff and not keeping them secret at the head teacher's office. However, during the focus group discussions none of the participating teachers had ever seen or heard of the school profiles, indicating they might not reach past the head teacher or even reach the school at all.

6.3.2 Meetings and forums for discussion

Even though teaching staff have weekly meetings, data from registries are seldom used to inform future interventions, as they are based off day to day observations.

> *"We have regular meetings on Wednesdays, what is called teacher group meetings, but we mainly discuss different kinds of things. How the teaching, tests and assessments is going. There are a lot of things involved, but not necessarily on the reporting or the data. Even in the school as a whole there is no such use [of data]."*
> *- Guidance teacher*

The same was true for meetings with the PTA. Most of the decisions were based on observations teachers and staff had done between each meeting, well aware of which students had been absent, which courses they were struggling with, and how often they had cooked meals available.

As noted by teachers during the interviews, challenges with planning school interventions to prevent reduced attendance and increasing drop-outs to a large extent relies on the pupil-teacher relationships, and how the community value education:

> *"Usually the contributing factor for dropouts is parents not valuing education."*
> *- Guidance teacher*

There is a need to inform the PTA and Chiefs with real time information, so they can see the scope of the matter, raise awareness in communities and address the relevant people when it is happening. The teachers don't need an indicator calculated on a monthly basis to inform them three of the pupils aren't attending class. The indicators do however matter greatly in measuring district/provincial and national historic "snapshots" of how the school has been progressing. For this purpose, the school profiles work great as a tool for discussion between staff, as well as between school and stakeholders, to compare the impact of efforts over time.

6.4   EMIS-pilot

> *"In the annual school census, data is collected once every year, and will report for the year that has passed. This one, it's real-time data. That is the best about this one."*
> *- Guidance teacher*

The EMIS-pilot is Zambia's first effort in digitizing their entire EMIS from data collection and entry to analysis and feedback on a monthly basis, across organizational levels. According to the Directorate of Planning and Information, main objectives were to increase the knowledge on what different approaches will cost the ministry in terms of money and effort:

> *"The good thing is once we review we will look at all those aspects [cost, human resources and training] and how feasible they are to sustain. So I think this pilot will give us, in terms of cost and what is required of the ministry. The experience will let us make an informed decision."*
> *- MoGE employee*

The pilot was funded by UNICEF and WFP respectively, with an original duration of 1 year which was extended for 2 more years during the research. The MoGE will at some point have to choose one, both or none of the models and software. The pilot utilizes two different software and hardware systems, and have differing reporting pathways[9]. This has enabled a comparison between them to determine which one produces the best reporting rates and completeness, as well as which is most cost effective in terms of human resources and technology.

Indicators and data elements collected in the pilot is based on experiences with a previous attempt at collecting monthly data on paper, as well as through discussions between MoGE, WFP and Akros/UNICEF. They are to a large extent in coherence with what is currently collected in the ASC, as a long term goal might be to replace the census, or reduce the information it collects. As both NGOs had interests in monitoring their school efforts, it was important to harmonize the data collection:

> *"We sat together and said which indicators? We didn't want to use different data collection instruments, so we harmonized and agreed on what type of information. It was useful also to the ministry."*
> *- MoGE employee*

During its first phase of implementation, a lot of effort has gone into training teachers in how to use the reporting tools. At the time of research, trainings were scheduled on a monthly basis on location, in order to provide proper training and ask questions face to face. Several of these trainings were however cancelled, due to financial reasons.

6.4.1   Alignment with current work processes
The pilot has been well received in the schools. One of the reasons for this, was the decision to align the reporting around existing reporting activities, thus reducing

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[9] "Report pathway" is a term coined by all involved stakeholders regarding how the data collection process is managed, both in terms of human and material resources

duplicate work. Schools aggregate registries into the monthly EMIS-form (see Appendix B and C), which are digitized and submitted between the 1st and 10th the following month. The ASC has to be filled out in between terms, which makes it difficult for the teachers to correct errors and verify data, as most staff is unavailable. This is not the case with the EMIS-pilot, which is received as very positive.

The data collection is also aligned with the school year which is divided into three terms from January to April, May to August and September to December. During the trainings there were some confusion around whether or not the termly reports were to be submitted instead of or in addition to the monthly reports. There was also confusion around reporting on the last days of the second term as it ended on the 5th of August, and the report in September thus only included five days, making the figures look odd.

6.4.2   Software and hardware

The pilot use two different models for software and hardware, which will be described below. The strengths and weaknesses of these two approaches will be discussed in further details as they vary significantly in terms of cost, scaling and resources required for training.

6.4.2.1   DataWinners

DataWinners utilizes SMS to collect data from a designated staff member, typically guidance teachers, at each school. The system keeps a register of all phone numbers that have access to add data to the cloud based database. This is managed by a project coordinator from WFP. The project coordinator also performs manual quality assurance of the data submitted, as there is limited data validation upon entry. The phones used in the pilot were the teacher's private feature phones, and they pay for sending the texts themselves. No reimbursements or incentives are given to ensure reports were submitted. Forms are set up through the DataWinners web-based administration tool, and can contain any alphanumeric data. Each form is automatically assigned a number by the system, which must be referenced when submitting the data. The SMS containing the data follows a structured format; starting

with the form number, followed by each answer in a given order, followed by a space (See Figure 6.4). If a given answer is of the wrong data type (e.g. text instead of a number) or the reporter has given too many or too few answers, an SMS with an error will be sent, calling for a resubmission. If a given answer is of the correct data type, but in the wrong order (e.g. number of girls instead of boys), no error will be given. The number and type of data elements that can be added is limited by the length of an SMS.
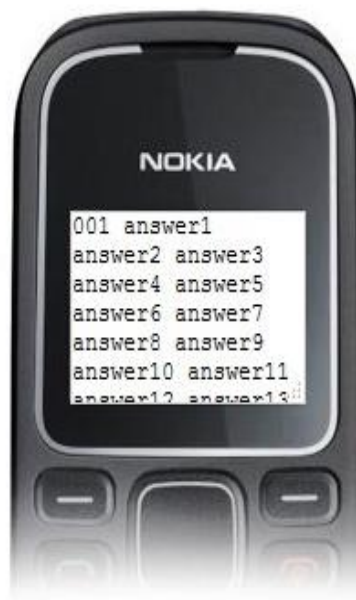
Figure 6.4 Feature phone with DataWinners data entry format

The data that is reported can be viewed in the DataWinners web-application. During the pilot, only selected people had access to view this data. The application has limited possibilities to analyze the data properly, and therefore a consultant had been hired to export the data into an MS Access database and create an Excel-workbook that had visualizations tailored to the needs of the Ministry and the NGOs extracting data from it. This was intended to be printed out and distributed to the Districts and schools on a monthly basis so they could view their own data.

6.4.2.2 DHIS2

The DHIS2 based implementation utilized Samsung Galaxy tablets for data collection, transmitting reports over cellular network. The tablets have two open source applications installed called DHIS2 Data Capture (monthly reports) and DHIS2 Event Capture (termly reports), which displays the forms that are set up in the DHIS2 web application. Each school is provided with unique log in credentials, and it's possible to fill out the form without internet connectivity. The data will be stored locally on the device, and submitted once the tablet is online. In the DHIS2 web application, each user is organized into a pre-defined user group according to the organizational hierarchy of the MoGE. Forms that are available for each user group is set up in the DHIS2 web application. There are no limits to how many forms or data elements can be added, and it is also possible to fill out the form via a web browser on any device (See Figure 6.5).

The tablets are equipped with an AirTel[10] SIM-card that is topped up with airtime[11] when the teachers receive them. To incentivize timely data collection, a small amount of airtime is automatically distributed to the SIM-cards if the report is submitted on time. Enough money to purchase a data bundle for reporting is also provided automatically. This cost has currently been covered by UNICEF through the pilot, but needs to be covered by the MoGE if the model is to be adapted by the government.

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[10] AirTel is one of the three telecom providers in Zambia.
[11] Airtime is credit that can be used to purchase data bundles

Figure 6.5 DHIS2 web browser report form

6.5 Reporting pathways

The pilot has tried two different reporting pathways, which are different modes of collecting the data in terms of how to organize human resources. One pathway is the Zonal Information Champion (ZIC)-led pathway, and the other is teacher-led. The two pathways were developed to assess the costs and reporting efficiency. The DHIS2-district used both pathways in the same district, while the DataWinners-districts used the teacher-led in all three districts.

6.5.1 ZIC-led pathway

A ZIC is a teacher provided a zone for which he is responsible to report. A zone is a formal grouping of schools that is used at district level, and usually consists of 5-7 schools. Thus a ZIC collects the EMIS-forms filled out at each school in his zone and

enters the data into the phone or tablet. In the DHIS2-application, the ZIC had available the form for each school in his zone. This is possibly one of the reasons why this pathway was not adopted in the DataWinners-model, where each school is identified by phone number. The data is entered for each individual school the same way it would be in the teacher-led pathway. To avoid travelling, the ZICs would often call their respective schools and collect the data verbally over the phone.

6.5.2 Teacher-led pathway

In the teacher-led pathway the guidance teacher at each school is responsible for entering the data collected that month via SMS or the DHIS2 Data Capture application. In the pilot project this role was given to the guidance teacher, even though it hypothetically could have been any staff member at the school.
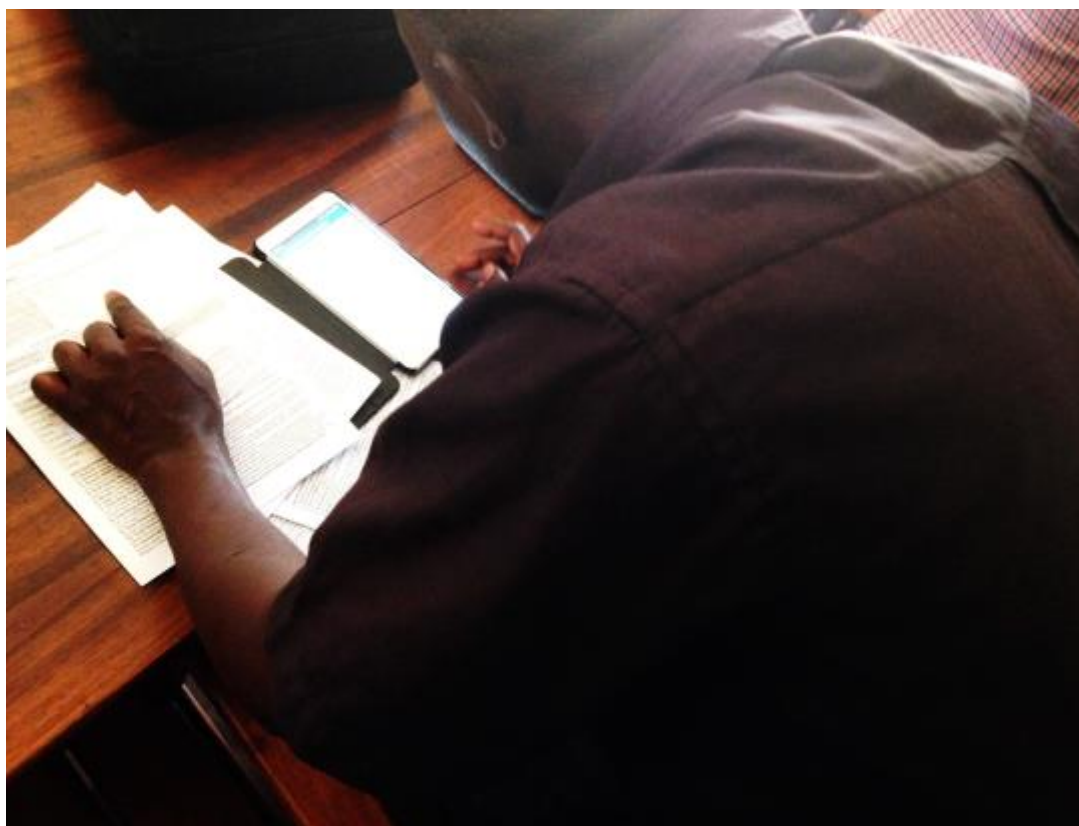
Figure 6.6 ZIC capturing data from multiple schools

6.5.3 Comparing reporting pathways

Prior to a Stakeholder's meeting organized in Lusaka on November 3[d], both pilots conducted a baseline assessment of how the programs had progressed. As the UNICEF-pilot was the only one using both pathways, an additional comparison was added to their report. The results were presented for the MoGE, stakeholders as well as the DEBS from each participating District.

As the ZIC-led reporting pathway requires fewer people and less hardware, it was considered to be a lesser risk for a potential scaling as initial costs is significantly lower than the teacher-led. An expected disadvantage was that the schools were disconnected from the data entry process, which might make them lose ownership to the data, which in turn effects the timeliness of report submission. Data from the DHIS2 web application shows that there is a difference between the two reporting pathways, where the ZIC-led on average is the most efficient one (See Figure 6.7). This is likely because one ZIC submits data for several schools, thus increasing the total number of reports submitted on time. The opposite will however be the case if the ZICs doesn't report on time.

Data	EMIS Monthly Reporting Form: Primary Schools		EMIS Monthly Reporting Form: Secondary Schools	
Periods / REPORTING PATHWAY	ZIC LED REPORTING ⇕	TEACHER LED REPORTING ⇕	ZIC LED REPORTING ⇕	TEACHER LED REPORTING ⇕
April 2016		3.7	12.5	11.1
May 2016	100	92.6	100	88.9
June 2016	100	100	100	100
July 2016	100	88.9	100	94.4
August 2016	100	55.6	100	66.7
September 2016	100	92.6	100	94.4
October 2016	91.7	96.3	87.5	100
November 2016	75	81.5	100	88.9
December 2016	75	59.3	100	55.6
January 2017	100	88.9	100	83.3
February 2017	100	96.3	100	94.4

Figure 6.7 Reporting rates for ZIC and teacher led reporting

A proper assessment of whether or not the schools felt less ownership to the data has not been conducted, but some discussion on this will be presented in *Chapter 6.7 – Teacher needs- design workshop results.*

An important observation made from the DEBS was that the selected ZICs were very motivated and met with their schools to develop routines for how to submit the data on time, and how to handle situations where delays were expected. Examples included clear deadlines and delegating the responsibility to other teachers if necessary. If the ZICs had been less motivated, results might not have been as successful as they were.

In the UNICEF-pilot 80 % of all reports were submitted on time, while 100 % of the reports were submitted within the end of the month. WFP reported an increase in reporting rates from as low as 4 % in one school to 81 % from the first month to the end of September. The termly reports however had not been adopted to a desired degree in the WFP-pilot, and they had no good explanation for why this was the case. The UNICEF-pilot did not mention any issues with the termly reports, part from some usability errors which will be described later.

6.6 Using software to report – observations from trainings

Training has been essential in making the pilot function properly. The insights provided below is only based on DHIS2-trainings, called routine surveillance visits. The objective of the visits is to check in on the participants, get feedback on how the reporting is working and how it can be improved. During the two training sessions, a lot of common issues were brought up, which I have categorized into the following; computer literacy, usability, reporting, and mobile technology.

6.6.1 Computer literacy

Prior to the training we had printed out the reporting rates for each school so we could follow up the ones with low rates. This was also presented in plenary, so everyone could see the status of their zone, compared to the others. Several of the teachers had been logged out of the system due to inactivity over a certain period of time. They did not remember their login credentials, and had lost the note were it was written down. Instead of contacting support via phone, they had simply waited for the training to submit their report. Four of the teachers had also deleted the entire application from the tablet, and did not know how to download it and log back in again.

Many of the teachers had not used tablets or touch interfaces before joining the pilot. This was evident as their mental models of how to navigate the tablet were relatively error prone – they only knew how to perform the functions they'd been trained to do. This meant troubleshooting was difficult, e.g. when one of the teachers by accident had switched off cellular data. Some teachers also did not know how to purchase data bundles or refill their airtime on the tablet, which differed from the regular feature phones they already used.

6.6.2   Usability

The teachers found the monthly reporting to be easy, and there were little comments on its usability once they had learned how to use it. However, there were a lot of inputs on the termly report, which is done through a different application with different navigation flow and interface. In addition, an error in the layout of the termly form was discovered during one of the trainings, where a teacher noted that the gender inputs for pupil drop outs were mapped opposite on the EMIS-form in relation to the application. It's possible that these data elements have been entered incorrectly for several months.

6.6.3   Reporting

As is evident from the report rates in Figure 6.7 on page 62, the reporting has been quite successful, even though some reports have come in late. When asked what caused late submissions, it was mostly attributed to other teachers being late, as they have to collect and verify data from every teacher. Needless to say, this can be a time consuming task, depending on the school and how many classes there are to report on:

> *"We need to work with all the teachers on the data collection. Now the thing is you have to keep on reminding them that the data will be reported. They are somewhat lazy and don't enjoy this work, so I need to run around asking 'I need the register, I need the register!'"*
> *- Guidance teacher*

Despite these challenges, the new EMIS-pilot has brought about a new way of looking at data collection at the schools in a positive way. While reporting to the ASC feels like a tedious and isolated task that requires little involvement from the staff as a whole, the new reporting format includes all the teachers and requires them to continually verify and reflect upon the data they logged in the registries.

> *"Initially, different stakeholders would gather information in the school. Then give to one person to compile during the filling in of the annual census form. But this time, the teachers come, then they do the work together. He just enters after he has verified the information that the teachers brought to him. It's not a one-man show where he sits and compiles. He has to verify certain things. In the Annual School Census reporting system, where we just filled in the information, you can't verify it, the people are not there. With this type, even the guidance teachers can verify where they need clarity from one or two things."*
> *- Guidance teacher*

During the old reporting structure, little effort was put in place to verify the information that was aggregated every month. It was conducted as a routine task. When the time to report in the ASC finally came, correcting errors and obvious outliers was very difficult, as it required teachers to verify e.g. attendance from months back in time. This was considered a challenging job at best. There was a wide consensus that the piloted reporting format made the data elements more reliable, and that they were more confident in using any information processed with these figures.

6.6.4 Mobile technology and coverage

As part of providing feedback to the teachers, a widget application pulling data from DHIS2 was to be installed on the teachers' tablets. The installation proved difficult when the mobile coverage at the school where the training was held was too poor to download the application. A similar experience happened during the first exploratory

visit, where the cellular coverage inside was so poor that the training had to be conducted outside (See Figure 6.8).

Figure 6.8 Training conducted outside to get cellular coverage

Several of the guidance teachers have had coverage issues when they tried to submit their reports. This was mainly ascribed to the fact that the SIM-cards were provided by AirTel, who didn't have coverage in the respective areas. In those cases, the teachers had to travel to an area with AirTel coverage for the sole purpose of uploading the data. This form of vendor lock-in was mainly put in place because of the system reimbursing airtime. The system for reimbursing them with airtime had however been down for months. They commented that they didn't have enough funds on their SIM-cards to purchase data bundles, and therefore couldn't submit the reports on time.

6.7 Teacher needs - design workshop results

It is common that different levels in an organizational hierarchy has different needs of information. School level will need more granulated data, while the Ministry needs aggregated figures (J. Braa & Sahay, 2012a). Following the focus groups, a design workshop was conducted in order to let teachers formulate what data they found useful for decision making, as the process of developing indicators had been driven from the top down. Ten teachers, where three were ZICs, from different schools participated, as well as two staff members from the DEBS Office. The workshop was fruitful and engaging, and it did not take long before comparisons between schools arose, and how the different topics were managed differently at each school. Two tasks were given: prioritize most important information to receive as visual feedback and as SMS feedback.

From the workshop it was apparent that school and District objectives are differing. While District level measures monitor national objectives, like guaranteeing education for all children in Zambia, schools face all the societal and cultural challenges and thus need information to encourage communities to emphasize the importance of education and to assess their own performance.

6.7.1 Visual feedback

The results displayed in Table 6.1, shows that attendance, both teacher and pupil, is considered the most important indicator to monitor at the schools. This data is also collected most frequently which makes it easier to monitor closely. Teachers made a point that decreasing attendance is very difficult to handle through school led interventions, as there are cultural and societal reasons for why this occurs, as previously mentioned:

> *"The thing is they have that in mind that all they want is getting married. If they see that one of their friends is getting married, they also want to. But that is the most important factor and pregnancies. You try to sit down with the girls, look at what is there. They say 'ah, that madam she talks too much*

on this it's because she's not married. She's just jealous, that's what they

think, but it's not that. That's what's contributing to drop-outs.''

- Guidance teacher

Menstrual hygiene is also a contributing factor to low attendance, and only a few of the schools thought they had adequate facilities to support menstrual hygiene, causing many girls to stay home from school several days each month. This was attributed to management and budgetary issues, and a point was made that no single interventions can solve decreasing attendance, and often calls for the inclusion of the communities, PTAs and home visits. Thus transparency and availability of the information to share with others were considered more important than the teachers following up the data for their own sake.

Group 1	Group 2	Group 3	Group 4	District
Pupil attendance	Pupil enrollment	Pupil attendance	Pupil attendance	Pupil performance, school level
Teacher attendance	Pupil attendance	Teacher attendance	Teacher attendance	Pupil enrollment
Water and sanitation	Teacher attendance		Assessments	Teacher attendance
Examination test scores	Pupil performance		Food consumed	Water and sanitation
			Attendance in feeding	Pupil attendance

Table 6.1 Workshop results - Most relevant data categories for decision-making

Registering teacher attendance was however not always straight forward, and the teachers discussed whether or not the data was a reliable source of information:

> *"On the teacher attendance – at times information we send does not reflect the true picture of what is happening. The source of our data is the log books, but at times they don't log in, which means at the end of the month they will not be captured and seem like more teachers were absent than present. For pupils this is not the case, but I have seen discrepancies for teachers."*
> *- Guidance teacher*

Another quite important issue was the fact that some data elements, like attendance rates would get "messed up" during exams. As not all students have all exams, particularly in secondary school, some students aren't supposed to be at school. There is no way of entering how many students were supposed to be there on any given day, making the figures deviate and being ambiguous to interpret. Following this discussion, it became evident that the data was aggregated too early in the data collection process. It was requested that all data on pupils should be entered on class level, preferably by even by subject, if it was to make any sense for decision making at schools.

Similar problems were noted on other data elements like handwashing and school feeding (See Appendix B and C). In order to capture this data, a teacher literally needs to stand observing the students conduct a group handwashing. The mere fact that a group washing occurred gives little indication to whether or not all of the students washed their hands. Also, a group handwashing could have occurred without the teacher being there to register it.

6.7.2 SMS feedback

The SMS-based feedback told a rather different story than what the data visualization did. Not all SMS-suggestions have been entered in their exact phrasing, but have been compressed to fit the tables from e.g. "Please note that there has been a decline in attendance".

Group 1	Group 2	Group 3	Group 4	District
Decline in attendance	Report rates (on time, late, not submitted)	Daily sanitation	Improved on data submission	"Report is due in three days"
Decline in enrollment	Performance up/down	Pupil attendance	Reading levels still low	"All schools successfully submitted reports for [month]"
	Enrollment up/down	Teacher attendance		"Ask (school or ZIC) to revise [data element]"
	Attendance up/down			
	Group handwashing up/down			
	Menstrual Hygiene Management up/down			

Table 6.2 Workshop results - SMS feedback

District level were only concerned with information reminding them to follow up schools not reporting, or correcting data. This was motivated by the fact that it was often challenging to know which ones were not submitting on time, even though both DHIS2 and DataWinners can generate this type of repot. Schools on the other hand are rather mixed in their results. While attendance is still the highest ranking one, mentioned by three groups, reporting rates, sanitation and performance were all mentioned twice. School feeding was not brought up as important by any of the groups.

The groups in the first session stated that they didn't find it necessary to receive an SMS if they had performed better than the previous month. The groups in the second session appreciated positive reinforcements, and thought it would be a motivating factor.

It seems that the limiting format of an SMS made it less obvious what feedback to receive and how, as answers were not as consistent. Most suggestions were of the form "Enrollment has declined", which may be to over-simplify the reality which the information is trying to portray, and the usefulness vs cost of distributing the SMSs can be discussed.

Empirical findings

7 Discussion

We sat quietly waiting for the District Education Board Secretary (DEBS) in her office. This was our second day of training the guidance teachers and ZICs, and we had noted some issues we wanted to discuss with her. The Akros team and I made ourselves comfortable in the brown leather couches along the walls, facing the DEBS' desk sideways. Above the desk, the green photo of president Edgar Lungu looked down on the DEBS empty chair. Sheets of paper with lists, tables and numbers covered the office walls, the words "Annual School Census Data" fastened to the top. She had multiple calendars with pictures of priests and their preaches marked in bright colors. The room was hot and humid, so we asked if the fans could be switched on before we started sweating. We were told the office was on its second day of power outage, which is quite common during the hot and dry season. The aggregate was broken, and the guy intended to fix it hadn't showed up. All computerized work had been put on hold.

The DEBS suddenly arrived, smiling and laughing loudly. There was an immediate change of ambience in the room as if the DEBS brought with her enough energy for us all. The impression of her being busy was confirmed through her apology for leaving us waiting: "I am in the middle of inviting the head teachers in our zone to discuss recent findings in the data we are collecting on education quality. They need a new sense of responsibility; it seems some head teachers think they cannot use information because they don't have a tablet".

She was a strong, wise, humored and opinionated woman. When we explained our worries and observations she listened, smiled, laughed and reassured us that she would handle it. She offered to come by the training later on to give a motivational speech for the guidance teachers and ZICs. "Namwala was picked. We see it as a blessing, and do not want to throw away this opportunity. Good luck with your training. As we say in our district, you better leave a place better than you found it."

- Excerpt from field diary, September 27th 2016

Before embarking on the discussion of this chapter, a quick review of the research question can be useful. Firstly, the research conducted tries to understand *how a digitized EMIS can be designed to support timely and decentralized decision making in the Zambia education sector*. To better understand and contextualize this research question, I also ask the following: *What are the enabling and constraining conditions for implementing a digital EMIS in Zambia?*

I will begin this section by assessing the enabling and constraining conditions for implementation, discussed according to the dimensions in the ITPOSM-framework. Rather than an assessment of status quo versus the envisioned future, the data analysis revealed a set of trade-offs between the dimensions in what is presented here as a set of digital EMIS design themes. Lastly I will highlight how all the dimensions affect each other, by looking at how the configuration of technology and processes in the two sub-pilots enable and constrain information and objectives in different ways.

Through the data analysis it became evident that an EMIS that supports timely and decentralized decision making has to;

- support multiple user objectives and needs
- overcome infrastructural challenges
- fit with work processes and tasks, and
- have a fit between technology and staff skills.

The successfulness of these digital EMIS design themes depends on the emphasis and approach to the ITPOSMO-dimensions, and have shown to produce trade-offs. I have chosen to highlight key findings that I find interesting for further discussions, which are presented in Table 7.1 below.

Digital EMIS design theme	ITPOSM Trade-off	Depends on
Support multiple user objectives and needs	Management, information, objectives and values	- Implementation process - Political will and motivation - Data quality and its perceived relevancy - Choice of technology
Overcome infrastructural challenges	Technology, information and objectives and values	- Choice of technology - Accessibility of technology
Fit with work processes and task	Management, process and information	- Flexible support structure - Teacher involvement
Have a fit between technology and staff skills	Technology, staff and skills	- Choice of technology - Computer literacy

Table 7.1 Enabling and constraining conditions for implementing an EMIS in Zambia

7.1 Support multiple user objectives and needs

An EMIS that supports multiple user objectives and needs is dependent on an approach to implementation that ensures ensure motivation, awareness of challenges at lower levels and promote a positive attitude. This is largely dependent on political will, and how the data collection and quality is perceived by those who use it. Lastly, the choice of technology needs to be capable of collecting the data at hand.

The pilot has been blessed with highly motivated staff, and has brought about new attitudes and routines on data collection, which has been positively received at school level. Both sub-pilots have however not been able to support the needs of stakeholders involved.

7.1.1 Implementation process

The process of approaching the EMIS pilot has been centralized both in terms of determining what software to use, which data elements to collect and the process of how to collect this data (reporting pathways). This process has greatly influenced most of the other factors discussed in this chapter. The NGOs involved have solely controlled which hardware and software to use, and has also been responsible for all

training and to increase the IT-capabilities of users. This could potentially be challenging for the MoGE in the future, if they are not capable of maintaining the system. The approach is however not uncommon as the importance of stable and reliable software often outweighs the benefit of developing systems from scratch (Baark & Heeks, 1999). As the NGOs provide the entire system they have a high degree of influence on what data to collect, thus positioning their objectives in the front seat. A more decentralized approach initiated by the government alone might have emphasized a revision of data elements and indicators to increase data relevancy, which will be discussed below. The notion of producing information this way neglects the informal information that teachers use every day to make decisions, and give little room for flexible and emerging routines on how to best approach data collection and its relevancy from school to school.

7.1.2 Political will and motivation

As illustrated in the excerpt introducing this chapter, one of the most important factors of whether or not the EMIS will succeed rests on leadership and their motivation. The Ministry have been very excited to see this project succeed

> *"As a ministry we're looking forward to change the way we're collecting*
> *data from paper-based to DHIS2 or DataWinners."*
> *- Ministry employee*

and the excitement has been transferred to lower levels:

> *"Namwala was picked. We see it as a blessing, and do not want to throw*
> *away this opportunity."*
> *- DEBS*

The DEBS in all piloted districts have been highly motivated, and have been excited to be chosen to participate. This effect trickles down to school level, as they can see

that this is a priority at District and Provincial level, which justifies the time spent reporting and collecting the data.

> *"This one is better. It makes data collection easier compared to the ASC."*
> *- Guidance teacher*

7.1.3   Data quality and its perceived relevancy

The pilot only collects low inference measurements. Not revising data elements has been a strategical decision that is rooted in HMIS strengthening literature, as it is considered more useful to mature the process of collecting data and increase report and completeness rates, before making any revisions (AbouZahr & Boerma, 2005; J. Braa & Sahay, 2012a; Heywood & Rohde, 2000; Voigts, 1999). This process is therefore a trade-off between objectives & values, information and management systems. The Ministry have future plans of revising the data elements collected based on the experiences from the pilot:

> *"Once we review, and get the results and experiences from colleagues that we are working with in the districts we'll be informed and able to see which [data elements] to include and not to include. So we'll use the opportunity and pilot to make informed decisions."*
> *- Ministry employee*

As pointed out by Scheerens (1990), the difference in need of high and low inference measures causes the aggregated data collected in the EMIS-pilot to be of varying relevance for schools as their objectives, needs and interventions differ from higher level organization units.

Using the ASC and statistics produced in the ESB as a baseline, National, Province and District are concerned with low inference data supporting policy development and operations. This includes enrolment ratios, dropouts and transition rates, gender equity, classroom-pupil ratios and quality measures like literacy and numeracy. These

figures allow for resource allocations and can support decisions to e.g. revise curricula or provide budgets to educate more teachers.

There are however no high inference measurements that allow schools to make hypotheses and see relationships between e.g. teacher expectations, school strategy and pupil performance. Thus there is in reality no ways of concluding *which* interventions that have improved achievements, and which didn't work.

Schools need information that allows them to plan each term, and follow up students who are performing poorly or risk dropping out by adjusting the way they teach and learn from schools performing well. Which efforts have provided good learning achievements, and where improvements are needed. A guidance teacher explained this quite explicitly:

> *"When did performance go down? How come there is so much drop-outs?*
> *What are we supposed to do? It is our job as guidance teachers to guide*
> *these kids so that we reduce these drop-outs and absenteeism."*
> *- Guidance teacher*

Teachers said they closely monitors each student's achievement, which currently is collected on a monthly basis in form of numeracy and literacy scores for each grade.

> *"I think assessments is at the core for all the schools. It is really important*
> *that it is updated monthly so that they know what interventions we can put in*
> *place."*
> *- Guidance teacher*

As information come back to schools, the current lack of granularity will make decision making challenging. The data should preferably be entered on class level, or even by subject, so schools and teachers can observe changes in a specific subset of students, or request supplies on specific courses.

The current format of data entry today is of varying relevance for teachers if they were to view the visualized data, and is not well suited to aggregate, as I will try to illustrate here. Following the instructions on the EMIS-form (see Appendix B and C), each school enters a data element called "Total attendance" for boys and girls respectively. The instructions are as follows:

> *"Total attendance for boys is calculated by ADDING DAILY ATTENDANCE for boys from all grades and streams for all the days your school was in session. Daily Attendance data is obtained from up-to-date class registers for each grade. For example, if you have total enrolment of 200 boys in the school, and 180 came on Monday, 100 on Tuesday, 190 on Wednesday, 170 on Thursday and 150 on Friday, the total number of boys attending school for these 5 days is 180+100+190+170+150=790 boys."*

The resulting data from boys and girls is used to calculate the indicator "Mean pupil attendance per day" (See Figure 7.1), using the number of school days in the current month as numerator. While these data points are interesting, the indicator results in an ambiguous number, e.g. 295, which provides little insight into what is happening. A more appropriate indicator that would aggregate well to both schools and District, would be a rate indicator giving the percentage of pupils attending compared to enrolment figures of the specific month.
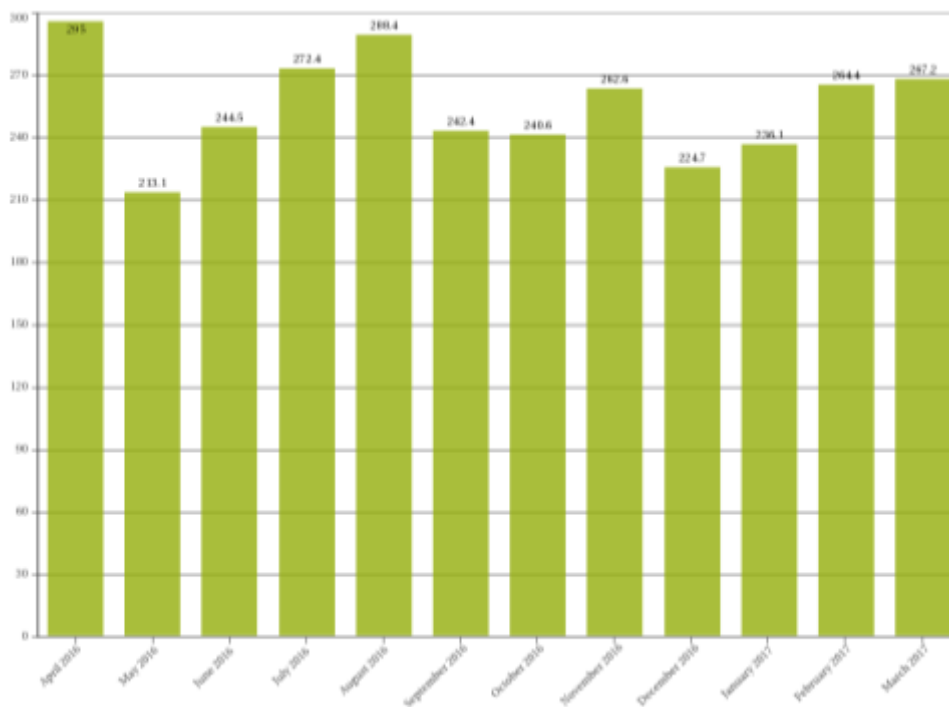
Figure 7.1 District Mean pupil attendance per day

Indicator makes little sense without total enrolment. Source: DHIS2

7.1.4   Choice of technology to support user needs

The EMIS-pilot has proved that choice of technology can affect to what degree users can reach their objectives. As illustrated through the DataWinners sub-pilot, reporting through feature phones restricted the amount of data elements that could be gathered. WFP therefore had to make a choice on what data elements were to be omitted. The choice fell on numeracy and literacy scores, which is arguably not in favor of school management.

Looking at the numeracy and literacy score matrix from the EMIS-form (Figure 7.2), it is apparent that an SMS will have difficulties capturing the desired information in addition to all the other data elements.

19	EXAMINATIONS TEST SCORES															
	19.1 LITERACY								19.2 NUMERACY							
	Below Minimum		Minimum		Desirable		Outstanding		Below Minimum		Minimum		Desirable		Outstanding	
	0 - 39%		40 - 59%		60 - 79%		80 - 100%		0 - 39%		40 - 59%		60 - 79%		80 - 100%	
Grade	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1																
2																
3																
4																

Figure 7.2 Examination test scores from EMIS-form are difficult to capture via SMS

An option would be to separate the examination test scores into a separate form, but it would still be challenging to enter 64 figures after each other without any errors, but it is very likely that this would be a highly frustrating task.

7.2 Overcome infrastructural challenges

Overcoming infrastructural challenges are largely affected by the context, and depend on the correct choice of technology. As is pointed out in *Chapter 3.2*, Zambia's lack of roads, stable power, water and sanitation affect school participation, but also makes it difficult to disseminate information efficiently. The use of M2W-solutions has to a large extent enabled the pilot's implementation, but two factors still stand out as particularly challenging; unstable power supply, and cellular coverage.

As many of the schools lacked stable electricity, many of the teachers had to bring the tablets home or find other places where they could be charged. It was not uncommon to charge the devices through solar power. While not seen as a problem for the teachers themselves, who were allowed to use the tablets for private purposes, issues of jealousy amongst other staff was reported, e.g. by the DEBS as well as stakeholders involved.

During the initial exploratory trip, we visited community champions in the Southern Province of Zambia. They had been using feature phones, similar to the DataWinners pilot, to report community health data, and have had the phones for approximately 4 years. While the feature phones worked well, several of the champion's phone batteries had stopped working, which generally is to be expected. However, as they

lived in rural areas, getting new batteries, particularly original ones from the phone manufacturer, was nearly impossible. This will likely be even more challenging with the Samsung Galaxy tablets which are not too common in rural areas.

7.2.1 Unstable power supply

Unstable power supply makes it difficult to rely on stationary computers if scaling the EMIS over time. As this pilot uses mobile to web technologies, a lot of these challenges are overcome as the phones and tablets can last for longer periods of time without being charged, and does not rely on Ethernet/WLAN access.

7.2.2 Cellular coverage

Cellular coverage was particularly an issue in the DHIS2-pilot as the tablets are provided with an Airtel SIM-cards. No sole telecom-provider has coverage in the entire country, and therefore it became difficult for some of the teachers to report on time. It also caused difficulties when having to download new applications or updates. This issue was not mentioned in the DataWinners pilot since they used their private phones and SMS with their existing subscription, and didn't rely on software.

The centralized approach is most likely the reason why Airtel was chosen to provide SIM-cards from the tablets, rather than letting the teachers choose telecom-provider. While often an advantage as prices and tracking of data can be negotiated with the telecom-operator for a closed user group, issues of coverage are often a problem (Sanner et al., 2012). In the DHIS2-case, Airtel was chosen as it integrated well with their system for automatic reimbursements based on the timeliness of report submission. As the DataWinners project functioned very well without these incentives, it should be reconsidered whether or not this form of vendor lock-in is necessary.

7.3 Fit with work processes and tasks

The EMIS-pilot has been designed to align with the three school terms, and differentiates between primary and secondary schools. The alignment provides an advantage to collect data at the correct times, e.g. after termly assessments, which

makes data easier to verify. As illustrated in *Chapter 6 - Empirical findings*, the monthly structure increased teacher involvement in data collection considerably, which is very positively received. Part from choosing who is responsible for reporting, there is however little flexibility for the different schools and wards to organize themselves around reporting, which could be necessary to make sure all schools submit their reports. This is a trade-off between dimensions of processes and management.

7.3.1   Flexible report structure

At the stakeholder's meeting it was decided that the DHIS2 sub-pilot will use the ZIC-led reporting pathway in future scaling, while the WFP sub-pilot likely will continue with the teacher-led reporting pathway. As there are variations to what extent there is capacity and motivation at the different schools, it should be considered whether or not the different wards should be allowed to choose for themselves which reporting structure fits best. Some teachers expressed concern that the school would feel distanced from the data in the ZIC-led pathway. Depending on the ZIC, a close collaboration between ZIC and school administration could not only eliminate this problem, but contribute to its improvement:

> *"[...] we agreed that at least before the data is submitted to the ZIC or*
> *planning officer, that the ZIC and administration and other stakeholders need*
> *to go through and analyze the data. [...] The last meeting we had, we said we*
> *need to analyze the data critically."*
> *- Guidance teacher*

As this will be largely dependent on who the ZIC is, and how motivated the staff at schools are, it should be considered a more flexible approach that allows for both pathways in the same District. This will be a trade-off between management structures, staffing & skills and processes.

7.3.2 Teacher involvement

As described in Chapter 6.6.3, the close involvement of other teachers has been reported as one of the major strengths of the EMIS-pilot. This was however not intentional by design, but rather emerged as the need to verify data more frequently became a necessity. Emphasizing this in future trainings is an advantage, as it can promote a culture of using information (J. Braa & Sahay, 2012a) in established meeting structures, as well as for the School Board and community stakeholders like PTA, and the Chief.

7.4 Fit between technology and staff skills

The fit between technology and staff skills are dependent on the choice of technology, and the computer literacy of the ones using it. As is already pointed to from HMIS-literature, frequent and regular training is essential to increase computer literacy, and is therefore a trade-off between the dimensions of technology, objectives, and staffing and skills. It is likely the costliest part of the entire EMIS-pilot.

As described in Chapter 6.6, the computer literacy and technical knowledge is currently quite limited among many of the teaching staff. This can pose challenges if changes are made in the user interfaces or device operating system, or upgrades has to be downloaded and installed manually. Further challenges will likely be present when data analysis become more important, as the built in tools require a lot of knowledge in use of computers, internet and the specific tools used to produce information.

Choosing tablets with touch interfaces for a group of people with limited computer literacy indicates that objectives that are important at higher organization levels may have been weighted as more important than usability. The trade-off is very visible in the two approaches, as the pilot use both feature phones and tablets. While the former required less training and used technology known to the users, it had limitations on how many data elements it was feasible to collect. The latter requires significantly more training, but allows for flexibility to change and modify content. (Heeks, 2006a).

As the pilot scales and focus turn to data analysis, trainings will have to be extensive and frequent (J. Braa & Sahay, 2012a).

Teachers revealed that reporting on the monthly data was a simple task to perform in the DHIS2 sub-pilot. The termly reports were challenging, mostly due to a differing user interface. In the DataWinners sub-pilot most issues were related to the users entering the wrong data, and a lot of time had to be spent cleaning the data that was sent to the database, as there are no possibilities for data validation.

7.5   Sub-pilot configuration

The configuration of reporting structure and technology in the two sub-pilots enables and constrains the extent to how user's objectives are achieved, and manifests itself as a trade-off of all the dimensions of the ITPOSM-framework. Information, technology, processes, objectives, staff skills and management can all enable or constrain each other depending on how they are configured. This section will illustrate that a choice of flexible technology that enables capture of relevant information to support objectives might can still be hampered by processes, management and skills – and vice versa.

The DHIS2 sub-pilot has powerful software for data analysis and visualization according to user groups, which can be accessed on the same tablets from which they are reporting. This enables easily accessible feedback, and can be rapidly be built out to support other functions like updated curricula and notices from the Ministry. Even though computer literacy is low. Forms and data elements can easily be modified, and changes appear immediately in the user's interface. Thus it can easily enable user's objectives, even if they were to change over time. These enabling factors are however hampered in the ZIC-led pathway opposed to the teacher-led pathway, as there is no guarantee that each school has a device to which they can receive information. They are thus reliant on other ways of providing feedback, e.g. through SMS or by paper, not taking full advantage of the enabling features of the technology chosen.

In the DataWinners sub-pilot, easy to use and low cost feature phones enable rapid scaling which aligns with staff skills. The teacher-led reporting pathway ensures that each school has a device, and it is thus possible to build feedback mechanisms where information is sent back to the schools so they can make informed decisions. However, the technology is highly constrained to support most any type of feedback to the schools and teachers, as SMSs has limitations to how information can be presented, and how much data can be included. This further constrains their possibility to achieve their objectives.

The dimensions of management structures and process (reporting pathway), information (what to collect and feedback) and technology (tablet vs. feature phones) must therefore all be configured correctly for objectives to be achieved at the schools.

7.6   Summary

Based on the above discussion, multiple trade-offs along the ITPOSMO-dimensions exist to reduce the gap between status quo and the envisioned future. These are most prominent between the centralized approach that is inherent in the current culture, management structures and work process, and the need to allow schools, wards and Districts to organize themselves, while balancing a choice of technology that overcomes infrastructural challenges and match staff skill levels and support their objectives.

Even though the two NGOs to a certain extent has had the opportunity to prioritize their objectives, it should not be overlooked that their contributions is what has enabled the pilot to come about in the first place. For future collaborations and handover to the government, it should be emphasized to increase government capacity in how to maintain and fund the pilot so it can be sustained.

The political will and desire to achieve timely reporting has however been a major factor which has enabled the pilot to succeed in its initial phases.

8 Concluding remarks

This chapter concludes the research conducted according to the research question. Lastly the chapter will present thoughts on future research.

8.1 Conclusion

Development of EMIS in low resource contexts has not been subject to a lot of digitization compared to HMIS. There are however huge gains towards what can be achieved by increasing data analysis at schools through designing an information system where close proximity to school staff and management is emphasized. The ITPOSMO-framework was applied as a lens to structure empirical observations and inform a discussion. As such, the thesis has applied ITPOSMO in a new dimension. While further research on digital EMIS is required, the study's findings suggest HMIS literature may be a good starting point for informing EMIS design and development.

This exploratory study has addressed the research question of how a digital EMIS can be designed to support timely and decentralized decision making in the Zambian education sector. The research found theoretically informed trade-offs that can be used to inform other digital EMIS-projects in similar contexts. This can help guide decisions for potential EMIS-managers or implementing partners who are faced with the issue of determining which technology to use, and how to organize human resources and structure reporting. The study concludes that a digital EMIS which supports timely, decentralized decision-making needs to support multiple user objectives and needs, and be flexible enough to fit various work processes and tasks, while the technology needs to overcome infrastructural challenges and fit with staff skills.

There are several enabling and constraining conditions to consider when implementing an EMIS in low resource contexts. Constraining factors include infrastructural challenges, few computers and devices at schools, and low computer literacy amongst staff. This renders the information system expensive to maintain as information is challenging to distribute, and extensive training is required to increase IT-capacity of staff so they can use it efficiently. Enabling factors include the use of M2W-

technology, highly motivated staff at all levels, prioritizing the EMIS-pilot within all government levels and aligning report structures with work processes and the school year. These factors have made the EMIS successful, despite its challenges.

Data collected must be perceived as useful at school level so they can properly assess and improve education, while also supporting school operations. The centralized approach to digital EMIS development increases the risk of donors and higher level organizational units addressing their own needs over school needs. In this context, however, government resources might not have been adequate to develop a digital EMIS in the first place, and therefore the centralized and donor-funded approach is likely the main enabler of a fast, controlled rollout with the resources required. Lack of perceived relevancy and proximity to the data collection process can contribute to lower data quality and untimely reporting. It is therefore important to assist the emergence of a culture for collaboration between all staff involved.

8.2   Further research

As mentioned above, more research on digital EMIS in low resource contexts is needed. Based on the empirical findings, feedback mechanisms between NGOs, national government, school level and communities have shown to be of high importance, and essential in low level decision making. As dynamics between these stakeholders are complex and context dependent, more research is required to understand how feedback mechanisms best can be implemented to increase quality of education with both communities and government. This will contribute to ensuring children in low resource contexts attend school and get the best possible education to live long, healthy and prosperous lives.

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Appendix

Appendix A - School profile
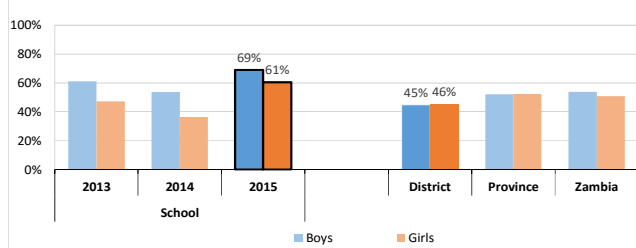
REPUBLIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION
2015 School Profile

Name of school	ITAPA PRIMARY	EMIS number	1549
Province	SOUTHERN	District	NAMWALA
Location	Rural Area	Phone Number	0978116148
Address	BOX 18 NAMWALA	Distance to DEBS	108
Name of Head Teacher	HAMPEYO OPPER	Running agency	GRZ

Learning outcomes: Grade 7 - Percentage of learners achieving Division 1, 2 or 3
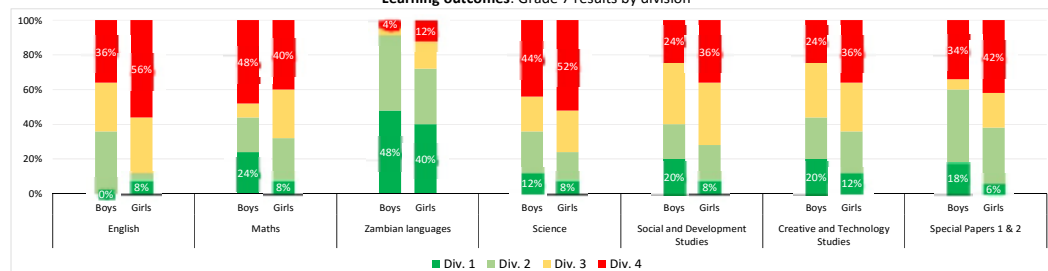
ECZ centre number: 3535 ECZ centre name: ITAPA

Congratulations! Overall results have improved from 2014 and 2013.

Caution! Girls' results are much lower than those of boys.

Congratulations! Your school's results are significantly above the district average.

Learning outcomes: Grade 7 results by division

ENGLISH: 0% of boys and 8% of girls achieved Division 1 and 36% of boys and 56% of girls failed.
MATHEMATICS: 24% of boys and 8% of girls achieved Division 1 and 48% of boys and 40% of girls failed.
ZAMBIAN LANGUAGES: 48% of boys and 40% of girls achieved Division 1 and 4% of boys and 12% of girls failed.
SCIENCE: 12% of boys and 8% of girls achieved Division 1 and 44% of boys and 52% of girls failed.
SDS: 20% of boys and 8% of girls achieved Division 1 and 24% of boys and 36% of girls failed.
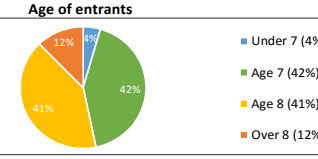
Enrolment

	Pre school	Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Total (2015)	2014
Enrolment	77	90	122	113	110	147	17	41	**640**	**710**
Boys	42	51	47	58	58	71	6	21	**312**	**376**
Girls	35	39	75	55	52	76	11	20	**328**	**382**
Readmitted after pregnancy									**0**	

Age of entrants

Age of new entrants in Grade 1

- Under 7 (4%)
- Age 7 (42%)
- Age 8 (41%)
- Over 8 (12%)

Vulnerable Children

Orphans		53
	(%)	8%
Non-Zambian children		0
	(%)	0%
Refugee children		0
	(%)	0%
Children with Special Education Needs		7
	(%)	1%

42% of new entrants were 7 years old. 41% were 8 years old.
12% were 9 years old or older.
Orphans are the largest group of vulnerable children and represent 8% of all pupils.

	Gr 1	Gr 2	Gr 3	Gr 4	Gr 5	Gr 6	Gr 7	Total (2015)	Last year (2014)	District
Percentage of Repeaters	0%	0%	1%	0%	0%	82%	0%	2%	13%	8%
Number of Drop Outs	2	2	12	0	148	14	0	112	0	-
Drop Out Rate	2%	0%	0%	0%	97%	15%	0%	95%	33%	16%
Boys	10%	3%	0%	0%	110%	16%	0%	117%	20%	20%
Girls	0%	0%	16%	0%	80%	13%	0%	65%	47%	13%

If there are new entrants during primary school, they may compensate for drop-outs, which may then not be visible in the displayed indicators.

Gr 6 has the highest percentage of repeaters (82%)
Gr 5 has the highest number of dropouts (148)
Gr 5 has the highest total dropout rate (97%)
Gr 5 has the highest dropout rate for boys (110%)
Gr 5 has the highest dropout rate for girls (80%)

Appendix B – Monthly EMIS Reporting Form – Primary Schools

Monthly EMIS Reporting Form • **Primary Schools**

REPUBLIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION

EMIS/P/2016-1

Note: READ INSTRUCTIONS prior to completing the questionnaire. All information should be provided as indicated in the instructions.

1. District	
2. School Name	
3. School EMIS No.	
4. ECZ Center No.	
5. Month	
6. Year	
7. No. School Session Days	

PUPIL ENROLMENT	
8. Total Enrolment: Boys	
9. Total Enrolment: Girls	
PUPIL ATTENDANCE	
10. Total Attendance: Boys	
11. Total Attendance: Girls	
TEACHING STAFF ATTENDANCE	
12. Total Attendance: Male Teaching Staff	
13. Total Attendance: Female Teaching Staff	
SCHOOL FEEDING	
14. No. of Feeding Days	
15. Total Food Consumed (in Kgs)	
GRANTS	
16. How much (in kwacha) did your school receive?	

WATSAN	
17. Number of teaching days in the months where grouped hand washing occurred?	
18. Number of teaching days in the month where water and soap/ ash in a private setting was available for Menstrual Hygiene Management (MHM)?	

19	EXAMINATIONS TEST SCORES															
	19.1 LITERACY								19.2 NUMERACY							
	Below Minimum		Minimum		Desirable		Outstanding		Below Minimum		Minimum		Desirable		Outstanding	
	0 - 39%		40 - 59%		60 - 79%		80 - 100%		0 - 39%		40 - 59%		60 - 79%		80 - 100%	
Grade	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1																
2																
3																
4																

Note: Only fil in r elevant information.

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Appendix C – Monthly EMIS Reporting Form – Secondary Schools

Monthly EMIS Reporting Form • **Secondary Schools**

REPUBLIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION

EMIS/S/2016-1

Note: READ INSTRUCTIONS prior to completing the questionnaire. All information should be provided as indicated in the instructions.

1. District	
2. School Name	
3. School EMIS No.	
4. ECZ Center No.	
5. Month	
6. Year	
7. No. School Session Days	

PUPIL ENROLMENT	
8. Total Enrolment: Boys	
9. Total Enrolment: Girls	
PUPIL ATTENDANCE	
10. Total Attendance: Boys	
11. Total Attendance: Girls	
TEACHING STAFF ATTENDANCE	
12. Total Attendance: Male Teaching Staff	
13. Total Attendance: Female Teaching Staff	
GRANTS	
16. How much (in kwacha) did your school receive?	

WATSAN	
17. Number of teaching days in the month where grouped hand washing occurred?	
18. Number of teaching days in the month where water and soap/ ash in a private setting was available for Menstrual Hygiene Management (MHM)?	

INSTRUCTIONS

1. District: Indicate the name of your district

2. School name: Indicate the official name of your school

3. School EMIS No: Indicate the official Education Management Information System (EMIS) number assigned to your school by DEBS. If not sure, consult the DEBS.

4. ECZ Center No: Indicate the ECZ Centre Number that is allocated by the Examinations Council of Zambia for examination purposes.

5. Month: Enter the month of reporting, e.g., July or 07. You can use the actual month names or the number of the month.

6. Year: Enter the year of reporting. The year should be written in full, e.g. 2015 or 2016.

7. No. School Session Days: Indicate the actual number of days your school was in session during the month. These are days when the school was open for learning.

8. Total Enrolment: Boys: This is the total number of boys enrolled at the school in all grades starting from the ECCD classes. Enrolment figures may remain the same from month to month but usually changes due to dropouts,

Appendix D – Termly EMIS Reporting Form – Primary Schools

Termly EMIS Reporting Form • **Primary Schools**

REPUBLIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION

EMIS/P/2016-2

Note: READ INSTRUCTIONS prior to completing the questionnaire. All information should be provided as indicated in the instructions.

1. District	
2. School Name	
3. School EMIS No.	
4. ECZ Center No.	
5. Month	
6. Year	

PUPIL DROP OUTS	
7. Total Drop Outs: Boys	
8. Total Drop Outs: Girls	
TEACHING STAFF	
9. Total Teaching Staff: Male	
10. Total Teaching Staff: Female	

11. COMMODITIES		
Commodity Name	**Tick**	**Comments (Give specific comments)**
Exercise Books		
Pencils / Pens		
Rubbers		
Rulers		
Text Books		
Computers		
Laboratory supplies / Reagents		
Flip charts		
Desks		

INSTRUCTIONS
1. District: Indicate the name of your district
2. School name: Indicate the official name of your school
3. School EMIS No: Indicate the official Education Management Information System (EMIS) number assigned to your schools by DEBS
4. ECZ Center No: Indicate the ECZ Centre Number that is allocated by the Examinations Council of Zambia for examination purposes.
5. Month: Enter the month of reporting, e.g., July or 07. You can use the actual month names or the number of the month.
6. Year: Enter the year of reporting. The year should be written in full, e.g. 2015 or 2016.
7. Total Drop Outs: Boys: Enter the total number of boys who dropped out of schools during the term. The figure is not cumulative over some months but just the total number of school boys from all grades who were recorded and confired in that term as having dropped out of school for whatever reasons.
8. Total Drop Outs: Girls: Enter the total number of girls who dropped out of schools during the term. The figure is not cumulative over some months but just the total number of school girls from all grades who were recorded and confired in that Term as having dropped out of schools for whatever reasons.
9. Total Teaching Staff: Male Total number of Male Teaching Staff: Enter the total number of male teachers deployed and present at your school for the term. This figure represents staffing for Male Teachers at your school.
10. Total Teaching Staff: Female Total number of Female Teaching Staff: Enter the total number of female teachers deployed and present at your school for the term. This figure represents staffing for Female Teachers at your school.
11. Commodities required: Tick only ONE item that your school needs most. Include further details in the comments column. For example if you tick Text Books, indicate the type of textbooks required, e.g., Grade 1 English Text Books in the comments column. **Please note that the comments section is filed only in the paper format.**

Appendix E – Termly EMIS Reporting Form – Secondary Schools

Termly EMIS Reporting Form • **Secondary Schools**

REPUBLIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION

EMIS/S/2016-2

Note: READ INSTRUCTIONS prior to completing the questionnaire. All information should be provided as indicated in the instructions.

1. District	
2. School Name	
3. School EMIS No.	
4. ECZ Center No.	
5. Month	
6. Year	

PUPIL DROP OUTS	
7. Total Drop Outs: Boys	
8. Total Drop Outs: Girls	
TEACHING STAFF	
9. Total Teaching Staff: Male	
10. Total Teaching Staff: Female	

11. COMMODITIES		
Commodity Name	**Tick**	**Comments (Give specific comments)**
Computers		
Desks		
Text Books		
Laboratory supplies / Reagents		
11.2 Vocational Pathway		
Workshop Tools		
Design and technology tools		
Home electronic tools		
Musical tools / equipment		

INSTRUCTIONS
1. District: Indicate the name of your district
2. School name: Indicate the official name of your school
3. School EMIS No: Indicate the official Education Management Information System (EMIS) number assigned to your schools by DEBS
4. ECZ Center No: Indicate the ECZ Centre Number that is allocated by the Examinations Council of Zambia for examination purposes.
5. Month: Enter the month of reporting, e.g., July or 07. You can use the actual month names or the number of the month.
6. Year: Enter the year of reporting. The year should be written in full, e.g. 2015 or 2016.
7. Total Drop Outs: Boys: Enter the total number of boys who dropped out of schools during the term. The figure is not cumulative over some months but just the total number of school boys from all grades who were recorded and confired in that term as having dropped out of school for whatever reasons.
8. Total Drop Outs: Girls: Enter the total number of girls who dropped out of schools during the term. The figure is not cumulative over some months but just the total number of school girls from all grades who were recorded and confired in that Term as having dropped out of schools for whatever reasons.
9. Total Teaching Staff: Male Total number of Male Teaching Staff: Enter the total number of male teachers deployed and present at your school for the term. This figure represents staffing for Male Teachers at your school.
10. Total Teaching Staff: Female Total number of Female Teaching Staff: Enter the total number of female teachers deployed and present at your school for the term. This figure represents staffing for Female Teachers at your school.
11. Commodities: Tick **ONE item ONLY** either under the academic pathway or vocational pathway that is MOST NEEDED BY THE SCHOOL during the month of reporting. Include further details in the comments column. For example, if you tick Text Books, indicate the type of textbooks required, e.g., Grade 1 English Text Books. If you tick Musical tools and equipment, indicate the type of musical tools/equipment required, e.g., Drums, Guitar, Piano etc.
Please note that the comments section is filed only in the paper format.

Appendix F – Daily Sanitation Reporting Form

Daily Sanitation Reporting Form

REPLUBIC OF ZAMBIA
MINISTRY OF GENERAL EDUCATION

District	
School Name	
School EMIS No.	
ECZ Center No.	
Month	
Year	
School Representative Name	

School Sessional Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total Checks
Did grouped handwashing take place?																										
Was there water and soap/ash in a private setting available for Menstrual Hygiene Management (MHM)?																										

INSTRUCTIONS

1. Please enter the district, school name, school representatives name and the month/year in the spaces provided.

2. Please tick one box for each activity that takes place on a school sessional day.

3. At the end of the month, count the number of teaching days recorded on the form during the month where the school organized at least one handwashing activity where students from all classes participated. This includes hand-washing activities from all streams on a given sessional day and at all handwashing stations. For example, before and after a meal time, before assembly and at home time but can also include other times where there is supervised handwashing on a school sessional day.

4. Count the number of checks recorded to get the total for the month where female students had access to water and soap or ash in a private setting for menstrual hygiene management.

Appendix G – Indicators in DHIS2 application

Name

Coverage: Male Teacher Attendance

Mean Food Consumed (Kgs, in a month)

Mean Food Consumed per student

Mean Pupil Attendance (Boys)

Mean Pupil Attendance (Girls)

Mean pupil attendance per day (Boys + Girls)

Mean Pupil Enrolment Per Day

Mean Teacher Attendance (Female)

Mean Teacher Attendance (Male)

Money received per student

Org Unit Count: Primary + Secondary

Overall Attendance (Pupils)

Percent enrolment attending (Boys + Girls)

Percent enrolment attending (Girls)

Percent of days where grouped hand washing occurred

Percent of days where MHM was available

Percent of enrolment attending (Boys)

Percentage of Grade 1 boys Failing Literacy

Percentage of all boys failing numeracy

Percentage of all boys outstanding numeracy

Percentage of all boys scoring at least desirable numeracy

Percentage of all boys scoring minimum numeracy

Percentage of all girls failing numeracy

Percentage of all girls outstanding numeracy

Percentage of all girls outstanding numeracy

Percentage of all Girls scoring at least Desirable Numeracy

Percentage of all girls scoring minimum numeracy

Percentage of Boy scoring at least Desirable in Literacy for all Grades	Percentage of Grade 1 Boys scoring at least Minimum grade in literacy
Percentage of Boys Failing Literacy in all Grades	Percentage of grade 1 boys scoring minimum numeracy
Percentage of Boys scoring at least Minimum in Literacy for all Grades	Percentage of Grade 1 boys scoring outstanding numeracy
Percentage of Boys scoring at least Minimum in Numeracy for all Grades	Percentage of Grade 1 Girls Failing Literacy
Percentage of Enrolled Attending (Boys & Girls) 2	Percentage of grade 1 girls failing numeracy
Percentage of Girl scoring at least Minimum in Literacy for all Grades	percentage of grade 1 girls outstanding numeracy
Percentage of Girls Failing Literacy in all Grades	Percentage of grade 1 girls scoring at least desirable numeracy
Percentage of Girls scoring at least Desirable in Literacy for all Grades	Percentage of grade 1 girls scoring at least desirable numeracy
Percentage of Girls scoring at least Minimum in Numeracy for all Grades	Percentage of Grade 1 Girls scoring at least Desirable scores in Literacy
Percentage of Grade 1 boys failing numeracy	Percentage of Grade 1 Girls scoring at least Minimum in Literacy
Percentage of Grade 1 boys scoring at least desirable numeracy	Percentage of grade 1 girls scoring minimum numeracy
Percentage of Grade 1 Boys scoring at least Desirable grade in literacy	Percentage of Outstanding Boys in Literacy for all Grades

Percentage of Outstanding Girls in Literacy for all Grades

Total Attendance (Teachers)

Total Attendance (Teachers)2

Percentage of Outstanding Grade 1 boys in Literacy

Total Number of Grade 1 who sat for exams in Literacy

Percentage of Outstanding Grade 1 Girls in Literacy

Total Number of Grade 1 who sat for exams in Numeracy

Percentage of Teacher Attendance

Total Pupil Enrolment