

External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia

Mobile phones, nutrition and health in Tanzania: Cost-effectiveness Baseline Report

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Executive summary

This is the baseline report for the cost-effectiveness analysis of the Healthy Pregnancy Healthy Baby text messaging service, Tanzania (also more widely known as Wazazi Nipendeni), a Value Added Service (VAS) supported by the GSM Association (GSMA) as a part of the mNutrition programme. mNutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) to use mobile technology to improve the health and nutritional status of children and adults in low-income countries around the world. This report forms part of the evaluation of mobile based services, which draws on a number of methods and interlinked components to gather evidence about the impact of the intervention in Tanzania supported by the mNutrition programme.

This is a baseline report for evaluation question 1 which asks: “What are the impacts **and cost-effectiveness** of mobile phone based nutrition and agriculture services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?” (ToR, Annex A).

The report is one of four baseline deliverables for the “External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia”. The scope of the evaluation is therefore the mobile based service as deployed under the mNutrition programme, rather than the incremental impact of support provided through the mNutrition programme. mNutrition in Tanzania was integrated into a wider mHealth service called Wazazi Nipendeni. The incremental costs and effects of the mNutrition component of the Wazazi Nipendeni service are impossible to separate, and therefore the programme will be evaluated as a whole. This report should be read in conjunction with the baseline Business Modelling Report (Scott, Batchelor and Sharp, 2017). The deliverables Quantitative Baseline Report (Gilligan et al., 2017) and Qualitative Baseline Report (Barnett et al., 2017) give insight into the consumer environment that the service is targeted at.

This baseline report presents the framework by which the cost-effectiveness of Wazazi Nipendeni will be determined. There will be two components in the analysis – calculation of cost-effectiveness metrics, and comparison with metrics from published studies of comparable interventions. This report has sought to identify the framework, the costs currently identified (as at March 2017) and relevant literature on interventions that have comparable components to the mNutrition project. While other mNutrition services include livelihoods advice, Wazazi Nipendeni does not directly address livelihoods and focuses on maternal and child healthcare.

This baseline starts with a literature review of cost-effectiveness in health. Two approaches were taken. In a more formal search, 38 studies met key criteria, with 170 relevant cost-effectiveness data-points. In a broader, less bounded approach, several different combinations of search terms were used.

Based on the literature, the report creates a framework for future analysis. The baseline presents the framework by which the cost-effectiveness of Wazazi Nipendeni will be determined. There will be two components in the analysis – calculation of cost-effectiveness metrics, and comparison with metrics from published studies of comparable interventions. Acknowledging that the analysis cannot be undertaken until the quantitative component of the evaluation delivers its endline in 2019, this baseline report has sought to define 3 analyses that will be conducted then. The analyses vary in the types of cost they include.

Analysis A includes setup and ongoing costs for the specific intervention. The Wazazi Nipendeni mNutrition service is a complex array of partnerships and is built on a prior history of public-private partnerships and significant funding from the CDC. It is therefore difficult to isolate the costs

directly associated with the mNutrition intervention. This is particularly challenging if one wants the costs to inform MNOs potentially replicating the service in other countries (Analysis A). These costs are documented as at end of March 2017 and will be updated during the period between baseline and endline. For instance, a new delivery platform has been introduced. This platform is a mixture of infrastructure, software and hardware, that facilitates the delivery of messages to registrants. This new platform may well provide opportunities to offset ongoing costs by charging third parties for hosting additional mHealth services. This analysis will be of primary use to stakeholders who may wish to replicate the service using the content developed through mNutrition, and have a willing MNO(s) in place with similar proportional coverage to the MNOs working with Wazazi Nipendeni.

Analysis B includes wider mNutrition programmatic costs. Analysis B will be of most use to DFID and other funders or policy actors to assess whether mNutrition represented Value for Money (VfM). It would be of particular use if a similar programme was being planned for the future.

Analysis C includes societal costs, such as the cost to households and governments of increased healthcare use. This analysis will be of most use to governments and donors considering a replication of the service in their country, and who wish to understand the full scope of impact of a nutrition based mobile messaging service.

Building on the framework, the report then attempts to document what costs were known as at March 2017, the end of the data collection phase. It should be noted that there is ongoing evolution of the service with consequent changes in ongoing costs and that these will be documented between now and 2019 as much as possible. The baseline costs in this report are therefore indicative of current costs, not representative of final costs.

Table 1 Summary of allocation of costs

	Year 1	Year 2
Analysis A: Direct Cost totals as at March 2017	£780,901	£848,720
Analysis B: A+ wider programme costs	£1,099,901	£1,167,720
Analysis C: A+B+ societal costs	Not yet known	Not yet known

The Wazazi Nipendeni service has been established as part of ongoing public-private partnerships over the last few years. The expanded nutritional aspect of the service is the additional value GSMA sought to bring. Unlike some mAgri interventions that were made on the basis of a grant from GSMA, the intervention of GSMA in Wazazi Nipendeni has been more fluid. mNutrition funding through GSMA has supported product development through content development, user research, and business intelligence services and has not been used to meet operational expenditures. Given the prior investment and the fluid programmatic contributions (often 'in-kind') it is a considerable challenge to identify the costs for the cost-effectiveness analysis. The report notes that GSMA commissioned a financial forecast before engaging more directly with Wazazi Nipendeni, and this forecast spreadsheet has been used to help identify some costs.

The cost-effectiveness analysis is dependent on a measure of what the project has achieved, and this is to be determined by the results of the quantitative study currently being undertaken as part of the independent study by IFPRI. The endline survey is expected to be conducted early in 2019, and the results published thereafter. Only once these results are available will it be possible to conduct the cost-effectiveness analysis. We have noted here that there will be a number of

different effects, which will be converted to DALYs (Disability Adjusted Life Years) averted. A DALY represents one year of healthy life lost, and therefore it is desirable for the programme to avert as many DALYs as possible. The report considers comparable health interventions from the literature that may also offer DALYs averted. It acknowledges that no single intervention is fully comparable but that elements of the Wazazi Nipendeni are comparable to elements in other services. For example, some interventions use mobile phones to distribute information, whilst others distribute maternal health information similar to Wazazi, but using other channels.

While costs of DALYs averted are extracted from the literature survey, their range is so large that they may be of little use in direct comparison. However, it has been established that the World Health Organisation (WHO) Commission for Macroeconomics and Health (WHO 2001) has provided the following guideline for thresholds of cost-effectiveness:

‘An intervention is considered very cost-effective, if the monetary amount spent on the intervention per disability-adjusted life year (DALY) saved is less than the per capita gross domestic product (GDP) for the nation in which the intervention is applied.’

‘An intervention is considered (moderately) cost-effective, if the monetary amount spent on the intervention per DALY saved is less than three times the per capita GDP.’

These guidelines will be used to comment on whether Wazazi Nipendeni is cost-effective according to WHO guidelines.

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List of abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AKHST- JHI	Aga Khan Health Services Tanzania - Joining Hands Initiative
ANC	Antenatal Care
ART	Antiretroviral Therapy
BCG	Bacillus Calmette-Guérin Vaccine
BMJ	British Medical Journal
CABI	Centre for Agriculture and Biosciences International
CARMMA	Campaign on Accelerated Reduction of Maternal Mortality in Africa
CCBRT	Comprehensive Community Based Rehabilitation in Tanzania
CDC	US Center for Disease Control and Prevention
CE	Cost-effectiveness
CEA	Cost-effectiveness Analysis
CER	Cost-effectiveness Ratio
CHW	Community Health Worker
COUNSENUTH	Centre for Counselling Nutrition and Health Care
CSR	Corporate Social Responsibility
DALY	Disability Adjusted Life Year
DCP2	Disease Control Priorities Project
DFID	Department for International Development
DHS	Demographic Health Survey
DPT3	Diphtheria, Pertussis (whooping cough), and Tetanus Vaccine
DSF	Demand Side Financing
E1M	Everyone Mobile
EGPAF	Elizabeth Glaser Pediatric AIDS Foundation
EMRI	Ethiopia Millennium Rural Initiative
FCS	Food Consumption Score
FDCP	Free Delivery and Caesarean Policy
FHI 360	Family Health International 360
FMCG	Fast Moving Consumer Goods
GAIN	Global Alliance for Improved Nutrition
GCP	Global Content Partnership
GDP	Gross Domestic Product
GSMA	GSM Association
HAZ	Height for Age Score
HDDS	Household Dietary Diversity Score
HIV	Human Immunodeficiency Virus
HNI	Human Network International
HPES	Health Promotion and Education Section (Tanzania)
HPHB	Healthy Pregnancy Healthy Baby
HSPR	Health Sector Priorities Review
ICER	Incremental Cost-effectiveness Ratio
ICPD	International Conference on Population and Development
IDS	Institute of Development Studies
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IVR	Interactive Voice Response
IYCF	Infant and Young Child Feeding
JHCCP	Johns Hopkins Center for Communication Programs
Jhpiego	Johns Hopkins Program for International Education in Gynecology and Obstetrics
LCP	Local Content Partners
LiST	Lives Saved Tool
LLIN	Long Lasting Insecticidal Net
LMICs	Low and Middle-Income Countries

LYG	Life Years Gained
M&E	Monitoring and Evaluation
M4RH	Mobile for Reproductive Health
MAMA	Mobile Alliance for Maternal Action
MDG	Millennium Development Goals
MMR	Measles Mumps Rubella
MNCH	Maternal Neonatal Child Health
MNO	Mobile Network Operator
MoHSW	Ministry of Health and Social Welfare (Tanzania)
NACP	National AIDS Control Programme
NBS	National Bureau of Statistics
NGO	Non- Governmental Organisation
NMCP	National Malaria Control Programme
O&P	Osterwalder and Pigneur (Business Model)
OBD	Outbound Dialling
OECD	Organisation for Economic Co-operation and Development
OFSP	Orange Fleshed Sweet Potato
OPM	Oxford Policy Management
PEPFAR	President's Emergency Plan for AIDS Relief
PHCU	Primary Health Care Unit
PMI	President's Malaria Initiative
PMTCT	Prevention of Mother to Child Transmission
PPP	Tanzania mHealth Public Private Partnership
PSI	Population Services International
QALY	Quality Adjusted Life Year
R&D	Research and Development
RCHS	Reproductive and Child Health Section
RCT	Randomised Controlled Trial SBCC TWG Social and Behaviour Change Communication Technical Working Group
SIM	Subscriber Identity Module
SMS	Short Messaging Service
SP	Sulfadoxine-pyrimethamine (malaria treatment)
T2C	Text to Change
TACAIDS	Tanzania Commission for AIDS
TB	Tuberculosis
TBA	Traditional Birth Attendant
TCCP	Tanzania Capacity and Communication Project
TDHS-MIS	Tanzania Demographic and Health Survey and Malaria Indicator Survey
TFNC	Tanzania Food and Nutrition Centre
TzSH	Tanzanian Shillings
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USSD	Unstructured Supplementary Service Data
UX	User Experience
VAS	Value Added Services
VfM	Value for Money
VP	Value Proposition
WAZ	Weight for Age Score
WDDS	Women's Dietary Diversity Score
WEI	World Education International
WHO	World Health Organisation
WHO-CHOICE	Choosing Interventions that are Cost-effective
WHZ	Weight for Height Score
WN	Wazazi Nipendeni
YLD	Years Lived with Disability
YLL	Years of Life Lost

1 Introduction

A mounting body of evidence links early childhood undernutrition to increased morbidity and mortality (Pelletier et al., 1995) as well as to poor adult outcomes including shorter stature, decreased educational attainment, reduced economic productivity (Alderman, 2006; Victoria et al., 2010; Hoddinott et al., 2013), and increased incidence of non-communicable disease (Barker et al., 1989; Gluckman and Hanson, 2004). Despite the potentially serious consequences, early childhood malnutrition remains common around the world: as of 2011, 165 million children under the age of five were stunted and 52 million children under the age of five were wasted (Black et al., 2013).

Though the causes are inarguably complex, poor maternal nutrition during pregnancy (Black et al., 2013; Christian et al., 2013) and inadequate Infant and Young Child Feeding (IYCF) practices (Bhutta et al., 2013) are thought to be two of the principal drivers of early childhood undernutrition. Improving these behaviours therefore seems likely to generate important returns for both childhood nutrition and adult well-being.

With the rapid increase in access to and ownership of mobile phones across sub-Saharan Africa and the broader developing world (Pew Research Center, 2015), Information Communication Technology (ICT) interventions using mobile phones are increasingly seen as a feasible way to disperse information to individuals and households. Largely, though not exclusively, these campaigns have focused on improving farmers' information for agriculture through the provision of crop and input prices, weather information, and agricultural extension services (Svensson and Yanagizawa, 2009; Fafchamps and Minten, 2012; Hildebrant et al., 2015; Courtois and Subervie, 2015; Aker et al., 2016; Cole and Fernando, 2016).

Though less common, ICTs and specifically SMS-based information interventions have also been used to provide health-related information (Labrique et al., 2013). Typically, these interventions target improved patient drug adherence (Nglazi et al., 2013) or behaviour change related to sexual and reproductive health (Rokicki et al., 2017). Few SMS-based message campaigns have targeted nutrition-related behaviour change. Jiang et al., (2013) and Flax et al., (2014) test whether two such interventions influence IYCF practices in Nigeria and China, respectively. To date, the existing research on ICTs for nutrition and health finds mixed results on their effectiveness and the nutrition-focused ICTs have not been designed to test for impacts on child nutrition outcomes.

mNutrition, a global initiative supported by DFID, organised by GSMA, and implemented by in-country service management organisations in cooperation with mobile network operators (MNOs), explores the potential to use mobile technology to change attitudes, knowledge, behaviours, and practices for improved nutritional status. In Tanzania, the programme focuses on the provision of nutrition and health information and services to vulnerable pregnant women and caregivers of children under the age of five on their mobile phones with the goal of improving nutrition outcomes and behaviours for mothers and young children.

1.1 Objectives

The mNutrition evaluation is intended to understand and measure the impact, cost-effectiveness and commercial viability of the mNutrition product using a mixed methods evaluation design. The evaluation includes a quantitative component, a qualitative component and a business model analysis. The evaluations are being conducted by a consortium of researchers from Gamos, the Institute of Development Studies (IDS) and the International Food Policy Research Institute (IFPRI). The team draws on a number of methods and interlinked work streams to gather evidence about the impact of the mNutrition intervention in Tanzania.

- A **quantitative impact evaluation** employing a randomised controlled trial (RCT) to determine the causal effect of the programme. This component will conduct large-scale, statistically representative household surveys at the start of the programme implementation and 2 years later.
- A **qualitative impact evaluation** which consists of three qualitative data collection rounds (i.e. an initial qualitative exploratory baseline, in-depth case studies at midline and rapid explanatory qualitative work after the quantitative endline survey data collection) and aims to provide understanding of the context, underlying mechanisms of change and the implementation process of mNutrition.
- A **business model and cost-effectiveness evaluation** employing stakeholder interviews, commercial and end user data, document analysis, and evidence from the quantitative and qualitative evaluation data to generate a business model framework and estimate the wider imputed benefits from the value-added service for the range of stakeholders involved.

The business model and cost-effectiveness component of the evaluation is designed to contribute evidence to help answer the first of the broad research questions specified in the Terms of Reference (Terms of Reference, Annex A), in addition to the last two:

1. What are the impacts and cost-effectiveness of mobile phone based nutrition services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?
5. How commercially viable are the different business models being employed at country level?
6. What lessons can be learned about best practices in the design and implementation of mobile phone based nutrition services to ensure (a) behaviour change and (b) continued private sector engagement in different countries?

The mNutrition intervention is being externally evaluated in two countries. In Tanzania, where the research consortium is evaluating mNutrition within a broader mHealth programme, the intervention aims to promote behaviour change around maternal and early childhood health and nutrition. The target group is therefore comprised of pregnant women and caregivers of children under the age of five years who reside in rural areas of the study region (Iringa). In Ghana, the intervention is implemented via an mAgriculture programme. The Terms of Reference refer to the impacts and effectiveness of mobile phone based services, so the scope of the evaluation is the mobile based service as deployed under the

mNutrition programme, rather than the incremental impact of support provided through the mNutrition programme. mNutrition in Tanzania was integrated into a wider mHealth service called Wazazi Nipendeni. The incremental costs and effects of the mNutrition component of the Wazazi Nipendeni service are impossible to separate, and therefore the programme will be evaluated as a whole.

The intended audience for the cost-effectiveness baseline report is DFID, along with other organisations involved in mNutrition and mHealth programmes globally (including local MNOs and NGOs implementing mNutrition services), national governments—in particular, the Tanzanian Ministry of Health, Community Development, Gender, Elderly and Children and the Tanzania Food and Nutrition Centre in Tanzania—international agencies and donors, and community-level health workers.

1.2 The mNutrition intervention in Tanzania

mNutrition is a global initiative supported by DFID, organised by GSMA, and implemented by in-country mobile network operators (MNOs) and third-party organisations to use mobile technology to improve the health and nutritional status of children and adults in low-income countries around the world. mNutrition is implemented through mAgri and mHealth programmes in several countries throughout sub-Saharan Africa and South Asia. The nutrition content aims to promote behaviour change around key farming practices and around dietary and child feeding practices that are likely to result in improved nutritional health within a household.

In Tanzania, mNutrition is implemented through the ‘Healthy Pregnancy, Healthy Baby’ (HPHB) SMS text messaging service. The mass media programme accompanying the service is called Wazazi Nipendeni. The Wazazi Nipendeni programme is a US Center for Disease Control and Prevention (CDC) funded project bringing together multiple partners contributing towards shared goals. Phase 1 of the programme, launched in 2012, was initially developed in coordination with the Tanzania Capacity Communication Project (TCCP), led by Johns Hopkins Center for Communication Programs (JHCCP). Wazazi Nipendeni was one of several behaviour change communication programmes using methods as diverse as TV drama series, radio distance learning for community health volunteers and several integrated mass media campaigns. The mass media campaign was developed by JHCCP, while the SMS component of the campaign was led by the mHealth Tanzania Public Private Partnership (PPP). The public-private partnership was initiated by the Ministry of Health and Social Welfare¹, with financial support from CDC². Wazazi Nipendeni is available nationally and on all phone networks.

The HPHB SMS Service sends free text messages with health care information to pregnant women, mothers with newborns, male supporters and general information seekers in Tanzania to drive health seeking-behaviour (Open Government Partnership, n.d.). The SMS

¹ MoHSW has since been renamed the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC).

² The Wazazi Nipendeni campaign and text messaging service is funded by the US President’s Malaria Initiative and US President’s Emergency Plan for AIDS Relief (PEPFAR) and implemented through US Government agencies USAID and CDC. It is run in coordination with the National Malaria Control Program, National AIDS Control Program and Health Promotion and Education Section. ‘On the ground’ health facility orientation support is also provided by the US Government, Aga Khan Health Services and Canadian International Development Agency. Other implementing partners include Jhpiego, EGPAF, the Mwanzo Bora Program, CCBRT, Tunajali Project, PLAN International, Aga Khan Foundation and others.

messages are sent in Swahili, originally to women up to 16 weeks post-partum on a range of pregnancy and early childhood issues timed to the stage of the pregnancy and age of child. Anyone interested in receiving healthy pregnancy information and appointment reminders can text the word 'MTOTO' (child) to the short code 15001. Registrants receive instructional messages, allowing them to indicate the woman's current week or month of pregnancy (or the age of the newborn baby) during the enrolment process. This process allows the recipients to receive specific text messages relevant to the time and stage of pregnancy.

The mNutrition programme has supported mHealth projects in 8 countries through the development of nutrition content, and GSMA has assisted projects with product development primarily through user experience research business intelligence support. Nutrition related content was a small component of the original HPHB SMS Service but was extended substantially with the addition of the mNutrition content, contributed through GSMA under the mNutrition programme. mNutrition adds roughly 120 nutrition messages delivered to caregivers of children up to five years old. The total received per week is 4-5 messages which cover a range of topics including malaria prevention, HIV, nutrition etc. however, the mix of messages received may vary over time depending on MoH campaigns, and that they should receive them until the child turns 5, unless they unsubscribe. The resulting product will simply be referred to as Wazazi Nipendeni in the following sections of this report.

The original Wazazi Nipendeni text messaging service did not have the capability to deal with voice messages, but voice messages were developed as part of the local content development process in Tanzania. Under a separate agreement, GSMA subsequently commissioned HNI to incorporate the mNutrition content into their 321 service, provided in partnership with Vodafone. In contrast to Wazazi Nipendeni, the 321 service is a 'pull' type of service, whereby users dial a short code and navigate through interactive menus to find the information they are seeking. The system mostly plays audio clips to users, rather than sending SMS text messages. 30 IVR scripts were selected to be integrated into the 321 Health service, and were being recorded at the time of the baseline field visits.

1.3 Purpose and scope of the cost-effectiveness baseline

This report is a milestone in the evaluation study; as a baseline report, it presents an outline of how the cost-effectiveness analysis will be conducted once the effect of the Wazazi Nipendeni intervention has been estimated by the quantitative component of the evaluation (in 2019). This report seeks to:

- Preposition the relevant comparative literature, enabling the cost-effectiveness to be compared with programmes that have some similar elements to the Wazazi Nipendeni Nutrition component treatment.
- Create a framework for the analysis in 2019 (from the literature and baseline data).
- Collect and collate known costs at this point in time, with the specific view to gathering and monitoring missing costs in the coming period.

The research questions in the Terms of Reference were designed to cover all the projects supported through the wider mNutrition programme. While some of these projects deliver information to support livelihoods (notably the mAgri projects), the information disseminated by Wazazi Nipendeni does not directly address livelihoods as it focuses solely on maternal

and child healthcare³. As the Wazazi Nipendeni service is freely available to all subscribers of the participating MNOs, it has no particular demographic focus. Even though the content is designed to address the needs of women and children, it may potentially be of benefit to broader groups of users. While the quantitative component of the evaluation will estimate the effects on women and children, it has also been designed to explore wider gender effects. The analysis will also disaggregate findings by demographic variables, such as socio-economic status, which will enable the impacts on poorer groups to be assessed.

The report is one of four baseline deliverables on those mNutrition evaluation activities focusing on the Wazazi Nipendeni project, each of which will be followed up by a final report at the end of the evaluation exercise in 2019. This report should be read in conjunction with the baseline Business Modelling Report (Batchelor, Scott and Sharp 2017). The Quantitative Baseline Report (Gilligan et al., 2017) and Qualitative Baseline Report (Barnett et al., 2017) give additional insights into the consumer environment that the service is targeted at. The findings from the cost-effectiveness baseline will be combined and triangulated with the quantitative, qualitative and business model baselines in a workshop planned for December 2017. The two-day workshop will examine the insights from the quantitative, qualitative cost-effectiveness and business modelling components of the evaluation and will be attended by the lead partners from IDS, IFPRI and Gamos responsible for each of these components. It will inform the development of the integrated mixed method baseline report of the mNutrition impact evaluation in Tanzania.

1.4 Organisation of the report

A literature study was undertaken that defined the general parameters of the cost-effective study; the key findings as they inform the analysis framework are presented in Section 2. Section 3 then seeks to create a framework by which to undertake the cost-effectiveness of the Wazazi Nipendeni service. In Section 4 the costs of Wazazi Nipendeni are documented and baseline costs established. Finally, the conclusions comment on how the cost-effectiveness will be handled once the endline is complete in 2019.

³ Types of content produced include public health, medical, diet, fortification, supplements, nutrition and processing (Global Content Partnership, 2017).

2 Methodology

2.1 Literature Review

2.1.1 Study selection

This paper includes a literature review of the cost-effectiveness of various health intervention services and technologies. The aim was to explore both methods of cost-effectiveness analysis and comparable cost-effectiveness of different health interventions. Two approaches were taken. In a more formal search, 38 studies met key criteria, with 170 relevant cost-effectiveness data-points, or measures of cost-effectiveness analysis. This is because several studies included the comparative cost-effectiveness of several interventions. Within this search, papers were included which focused on (1) any interventions aimed at improving nutrition; (2) any interventions aimed at improving mother and child healthcare outcomes; and (3) any interventions aimed at using information and communication to change behaviour. Only articles which presented cost-effectiveness data, in the form of cost per unit outcome, were considered.

In a broader, less bounded approach, several different combinations of search terms were used in several databases, including PubMed, Google Scholar, Mendeley, JSTOR and Scopus. Search terms included 'cost-effectiveness analysis, cost-effectiveness, cost-effectiveness ratio, health intervention, neonatal, antenatal, pregnancy, maternal, child, nutrition, mortality, morbidity, behaviour change communication.' These were also accompanied by searches according to outcomes including, 'impact, nutrition, mortality, DALYs, antenatal care, breastfeeding, vaccinations, dietary diversity and infant dietary diversity.' Each method of intervention was searched with the above terms, including 'mass media, mHealth, health promotion, health education.' Finally, the names of specific interventions were also searched, including 'health care systems improvement, training traditional birth attendants, peer counselling, community health workers.' The references of relevant papers were examined to produce a 'snowballing effect' of relevant papers. In addition, grey literature papers were searched, such as Opengrey, but little evidence from grey literature has been included as it does not often use measurements of cost. The studies are listed in a supporting document and there is an accompanying Excel database, along with a range of metadata and a list of all cost data identified in the sources for use in 2019.

The majority of interventions examined were based in sub-Saharan Africa, although some studies from other geographical regions were included if no appropriate African examples could be found.

Overall, the literature was found to be lacking; for example, a review of maternal and child nutrition interventions concluded that only a few have been assessed at scale (Bhutta et al. 2008), there are few rigorous evaluations of interventions using multimedia communications campaigns for child survival health (Naugle & Hornik 2014), and a study of SMS interventions for disease prevention in developing countries concluded that while many applications exist, few have been evaluated (Deglise, Suggs & Oddermatt 2012). Therefore, the literature review cannot provide a comprehensive assessment of the cost-effectiveness of different maternal and child health interventions. It does, however, provide several options for measuring the cost-effectiveness of the mNutrition project, dependent on the outcomes,

and some tentative guidelines as to the relative costs and impacts of other health interventions with a similar focus.

2.1.2 Using the literature to inform CEA methodology

This section seeks to briefly relate the literature to our chosen framework. Annex B summarises the literature insights, defining cost-effectiveness in general terms, discussing approaches to defining health benefits, and what costs should be included. The literature points to the use of DALYs (Disability Adjusted Life Years) to ensure comparative measures of effectiveness. The literature differentiates between direct costs, programme development costs and societal costs (sometimes using different names for each). Using DALYs as a measure of health benefits, our framework, which is given in Section 3 of the report, proposes three analyses. The three are differentiated by which costs are included; Analysis A direct costs only, Analysis B which is A plus programme costs and Analysis C adding in societal costs.

Outcomes and effectiveness

Few papers were found within the literature review that assessed the cost-effectiveness of multiple outcomes. Wazazi Nipendeni is a complex intervention, the messages are designed for a variety of outcomes (such as increased rates of vaccination and dietary diversity) and messages are intended to complement one another. The cost-effectiveness of an intervention that leads to multiple outcomes is sometimes distorted by including only one outcome in the analysis.

The quantitative evaluation will measure outcomes hoped to be achieved by Wazazi Nipendeni as a whole, which includes not only improved nutrition outcomes, but also outcomes associated with improved antenatal care and safe deliveries, malaria protection, and HIV treatment:

- Increased rates of vaccination (DPT3, BCG, MMR, Polio)
- Increased awareness of HIV/ AIDS and Anti-Retroviral Drugs
- Increased use of healthcare during pregnancy
- Increased use of antenatal care
- Increased awareness of signs of pregnancy complications
- Increased deliveries in healthcare facilities
- Increased use of bed nets or anti-malarials for pregnant women and infants
- Increased use of nutritional supplements during pregnancy
- Increased dietary diversity in women
- Increased dietary diversity in children <5
- Decreased stunting and wasting in children <1
- Increased rates of exclusive breastfeeding
- Increased knowledge of Infant and young child feeding practices (IYCF)
- Increased knowledge of nutrition (foods rich in iron/ vitamin A)

(IFPRI Questionnaire, 2016)

For instance; a DALY (Disability Adjusted Life Year) represents one year of healthy life lost, and therefore it is desirable for the programme to avert as many DALYs as possible. Chola et al. (2015) measure only the DALYs averted by reduction in the incidence of diarrhoea

following a breastfeeding peer counselling programme. This leads to a high cost per DALY averted of US\$11,353. However, the authors acknowledge that exclusive breastfeeding is likely to lead to additional outcomes, such as a reduction in incidence of stunting and wasting. Other papers attempt to apportion costs among multiple outcomes by dividing costs by the number of outcomes (Hutchinson, 2006).

For Wazazi Nipendeni, this methodology could mean creating several cost-effectiveness analyses based on the cost of research and messaging attributable to each health topic. In an intervention where so many possible health impacts are intended, a measure of cost-effectiveness focusing on only one possible outcome would not do justice to the full impact of the project, and would neglect the complementary nature of the messages. Learning from these and other similar papers (Larsen-Cooper et al. 2016, Waters et al. 2006, Fiedler et al. 2014, Horton et al. 1996), we will use the quantitative component of the impact evaluation to measure differences in multiple health outcomes between control and treatment groups⁴. The cost-effectiveness analysis will be based on data from the randomised controlled trial (conducted under the quantitative evaluation component), which will capture multiple health outcomes such as vaccination and breastfeeding rates, as well as dietary diversity scores.

For these reasons, we have chosen to convert all possible impacts into DALYs averted using the LiST model (see Annex B.6) and the PSI calculator (See Annex B.7). The LiST model (as used in Herrick et al., 2017, Nkonki, 2017 and Vosti et al., 2017) can estimate reductions in mortality based on behaviour changes, such as increased rates of breastfeeding. Nutritional outcomes, however, as intended as a key part of the Wazazi Nipendeni programme, often have a larger impact on disability and quality of life than they do on mortality. We have therefore chosen to use the calculator to convert rates of mortality derived from the LiST model to DALYs using the PSI impact calculator (see Annex B.7, Yang, 2013). These methods should enable all possible impacts to be aggregated, and a final figure of cost per DALY averted to be calculated for the treatment as a whole.

The World Health Organisation (WHO) Commission for Macroeconomics and Health (WHO 2001) has provided the following guideline for thresholds of cost-effectiveness:

'An intervention is considered very cost-effective, if the monetary amount spent on the intervention per disability-adjusted life year (DALY) saved is less than the per capita gross domestic product (GDP) for the nation in which the intervention is applied.'

'An intervention is considered (moderately) cost-effective, if the monetary amount spent on the intervention per DALY saved is less than three times the per capita GDP.'

These guidelines will be used to indicate if Wazazi Nipendeni is cost-effective. In regard to comparing more directly to other similar programmes Wazazi Nipendeni is, as said above, a project hoping to influence multiple outcomes. It is unlikely that any other project will be aiming to influence an identical combination of outcomes. However, in the literature there are a few projects hoping to influence similar combinations of outcomes, or single outcomes from within the group of possible outcomes. These cost-effectiveness commentaries of other projects found within the literature may provide some partial comparators for use with the endline analysis (Annex C).

⁴ In the treatment group, eligible women (and men) are signed up to receive messages from the Wazazi Nipendeni service.

Ensuring the inclusion of relevant costs

Our costing methodologies were also derived from the literature. Our literature review evidenced that a range of costing methodologies were used, and even terminologies used to describe costing methodologies were not consistent (Neumann, 2009, Adam, 2003). Neumann (2009), for example, found that studies claiming to be evaluating cost-effectiveness from a societal perspective often did not include all relevant societal costs. The wide variety of methodologies are sometimes presented as useful to the different audiences to which the cost-effectiveness analyses may be relevant. Several papers included only direct costs of implementation borne by the intervention provider, excluding beneficiary costs or the costs of research and development necessary for the project to even begin (e.g. Balthussen et al., 2008, Fiedler et al., 2014). This may be relevant to those intending to replicate the service. Hutchinson et al., (2006) go on to include research and development costs, such as those of creating the mass media content for their programme. Although an important part of programme development, the cost of research and development is often not included in cost-effectiveness analysis. Including research and development costs is proposed as being more relevant to donors and funders who might want to replicate the programme in another setting, and need to consider replicating some of the research that tailored the programme to its location. Finally, some papers also include wider costs incurred in order to achieve health impacts (Hounton and Newlands (2012) and Paintain et al., (2016)). This would include the costs to beneficiaries of behavioural change, such as increased attendance at antenatal care, for example. The inclusion or omission of certain costs varies according to the intended audience for the analysis. For example, an intervention provider may not wish to include the costs of beneficiary transport as, providing that beneficiaries are able to pay this fee, it does not impact the feasibility of the project from the provider's perspective. However, those wishing to understand the full scope of an intervention's impact would wish to include beneficiary costs. Seeing the potential relevance of several different costing methodologies, we have chosen to undertake three separate analyses, using different costing methodologies. These are described in Section 3 and are differentiated by the inclusion of direct costs, programme development costs and societal costs.

In terms of data collection, the literature also references several methodologies. Ideally, studies obtain the direct costs of a project using full financial data. Puett et al., (2014), for example, collected data from budgets and project documents as well as informant interviews. However, the literature also includes studies in which complete financial records were not always available (for example, Curry et al., 2013). In this case, authors have estimated costs by drawing on previous experience from elsewhere in the literature. Balthussen et al. (2008) for example, uses estimates from WHO publications to determine the price of iron supplementation.

We are aiming to evaluate the cost-effectiveness of the Wazazi Nipendeni programme using as accurate financial data as possible. This involves a data collection process which is still ongoing. However, where detailed financial records remain lacking, we will make estimates based on published literature (e.g. WHO cost data, as in Balthussen et al., 2008). Societal costs, such as the costs of healthcare, may need to be estimated from the wider literature, e.g. WHO-CHOICE unit cost estimates (WHO 2008), or stakeholder interviews.

Regarding societal costs, as discussed briefly above, the total cost of an intervention could include the take up of extra healthcare services not directly provided by the intervention itself (Neumann, 2009). For Analysis C, we will seek to cost the difference in healthcare use

between the control and intervention groups, a micro costing of the difference rather than the complete cost of healthcare use. For example, we will use the cost of the women attending extra antenatal care appointments, not the total cost of all the antenatal care appointments.

Regarding the use of DALYs averted, as stated above our cost-effectiveness analysis will be based on the results of the quantitative Randomised Controlled Trial. As of March 2019, we will know the extent of health impacts and behaviour change following exposure to the intervention. It is this difference that will be used to estimate DALYs averted. We should therefore be able to assess the difference between no intervention, or standard healthcare in Iringa (district of Tanzania), and the effect of the intervention.

At that date we will have refined our intervention cost data (including societal costs). Our results will present an average cost-effectiveness analysis, using the control group as a base case scenario (Baker et al., 2006, Gonzales et al., 2000, Nguyen et al., 2012).

Regarding comparison of the intervention with those with similar outcomes, some studies compare interventions to other possible interventions, as seen in Fiedler and Afidra (2014) for example. We have chosen to conduct an average cost-effectiveness analysis, as seen in Self et al., (2017), comparing Wazazi Nipendeni users in the treatment group to the control group of the RCT.

Regarding the time scale for assessing the effectiveness; Within the literature, timescales used in cost-effectiveness analysis vary widely. Waters et al., (2006), for example, collect only impacts within an 18-month time period, whereas Sabin et al., (2012) project DALYs averted over 10 years. As we will be working from the results of the RCT quantitative study, the time scale of our evaluation is defined by this period, i.e. the number of DALYs averted between October 2016 and October 2018 (Gilligan et al., 2017). However, appropriate timescales to be considered will be assessed at the endline. For example, if service is projected to continue, then R&D costs should be spread over more years, but if the service has stopped, reduced time scales may be considered. Cost data, as recommended by the WHO, will be collected from the time of programme inception up until the time of endline data collection (WHO, 2004).

Wazazi Nipendeni had a high research and development cost compared to ongoing costs. Therefore, measuring only the DALYs averted within the two years of the evaluation duration will likely give a relatively poor cost-effectiveness ratio, and perhaps not do justice to the lower ongoing costs of the service, nor the full impact of early research investment. However, the feasibility of projecting DALYs averted into future years to take a broader time horizon depends on both the continuation of the Wazazi Nipendeni programme (the intervention duration), its continued use of its current treatment, i.e. the content and delivery offering does not change significantly, and the duration of the existing behavioural changes. The ICT environment changes rapidly and the use of plain text SMS is likely to change significantly in the coming years. Certainly by 10 years (the horizon used in Sabin et al., 2012), SMS will likely be overtaken by media rich content – which effectively would be a different treatment. If the Wazazi Nipendeni intervention were to end, rather than to evolve, then it can be argued that the timescales to be considered should reflect any residual impact of the intervention, as knowledge-based interventions can have long term intervention effects on benefits beyond the duration of the intervention (Ory et al., 2010). We will wait until the endline data collection to determine whether using an extended time horizon in the analysis is appropriate. We will take into account the status of the Wazazi Nipendeni service

as evaluated in the endline business modelling component of the report, and the changes in service provision planned by the Wazazi Nipendeni team.

In the baseline below we have sought to document all provider and societal costs. While documenting the existing costs, we anticipate that new costs will arise, and the CE analysis, will need to include updated costs once the outcomes are defined from the quantitative component. The costs included so far were derived from available project budgets, and expenditure reports and from contact with key stakeholders and members of partner organisations. As is seen in Figure 2, Wazazi Nipendeni comprises a complex set of partnerships, and we therefore do not yet have a full understanding of investments and costs. Further cost data will be collected from key informants throughout the evaluation period.

Annex B includes other general insights from the literature that will need to be included in the final endline analysis such as a sensitivity analysis.

Annex C summarises comparator programmes that could be used at the time of the endline, although the process of literature scanning will continue for the duration of the evaluation.

In the Inception Report, we noted that we would include the use of the GSMA Theory of Change (ToC) for mHealth programmes as a component of this analysis. A detailed ToC was not available at the time of writing.

2.1.3 Limitations of the Literature Review

Due to limited time, although every effort has been made to pre-define search terms and use all relevant databases, the review is not intended to be a fully comprehensive study of all cost-effectiveness literature within health and nutrition. There is a risk of neglecting some relevant literature. Furthermore, the paucity of literature available creates a risk of bias towards the ideas presented within included papers. Nonetheless, the search for relevant literature was extensive, and the authors believe it accurately conveys the current landscape of cost-effectiveness literature in health and nutrition that relates to the Wazazi Nipendeni text messaging service.

2.2 Ethical considerations and approval

As an overall guiding principle, the research team sought to conduct themselves in a professional and ethical manner throughout the baseline phase of work, with strict respect for principles of integrity, honesty, confidentiality, voluntary participation, impartiality and the avoidance of personal risk. These principles were informed by the OECD (2010) DAC Quality Standards for Development Evaluation and DFID's 'Ethics Principles for Research and Evaluation' which will be followed for the duration of the evaluation.

Overall, the baseline phase of this component has mainly drawn on the qualitative and quantitative data collected in the other two components of the evaluation. Both components have been through rigorous ethical clearance procedures. Other data sources are stakeholder interviews conducted with MNOs as well as secondary data collection (commercial and monitoring data) from MNOs and other relevant organisations.

Most research participants involved in the stakeholder interviews were already familiar with the mNutrition programme, and the principle of an independent evaluation. However, informed consent was sought from all participants via emails and briefing documents sent in advance, describing the research. In particular, information described the relationship between the evaluation consortium, DFID and GSMA, in order to avoid any possibility of deception, given the sensitivity of the business relationships and issues discussed during the interviews.

Whilst this evaluation component does not involve any primary data collection from human subjects at community / household level, ethical considerations are still considered important for all work carried out under this component. In particular, GSMA remain highly aware of the commercial sensitivities of its partner MNOs, so the issue of commercial confidentiality is very important for this area of work given that it relies on sharing of sensitive commercial data. Therefore, the Gamos team will pay specific attention to this issue as part of their ongoing work.

The Gamos team is currently operating under the Non-Disclosure Agreement (NDA) signed by GSMA and OPM during the inception phase of the project. Where relevant, stakeholder respondents are informed that an NDA with their trade association has been signed, and that the interview is bound by it. All the data being gathered falls within the scope of this agreement (e.g. development, business plans, marketing, operations, and finances), although there is a provision that such information should be designated as proprietary or confidential⁵.

For the avoidance of doubt, all internal reports shared by Gamos are being marked as confidential and are not to be circulated outside of the evaluation team. Any outside reporting will not contain any detail that could be construed as proprietary or confidential information.

All external reports are being shared with key research participants in early draft form in order to establish principles of trust and reciprocity. This ensures that participants have an opportunity to confirm that their views have been reported accurately, and that publications do not breach their confidentiality requirements.

As this component draws on qualitative and quantitative data collected through the other two work streams, appropriate measures are being taken to ensure that the shared data is anonymised and there is no risk of confidentiality breach. For the quantitative data, a unique household ID has been assigned to each household which allows for following up with respondents as necessary without providing access to any personal information on datasets that are made available for analysis. Similarly, all qualitative transcripts are anonymised, pseudonyms given, and any information that can lead to personal identification has been removed.

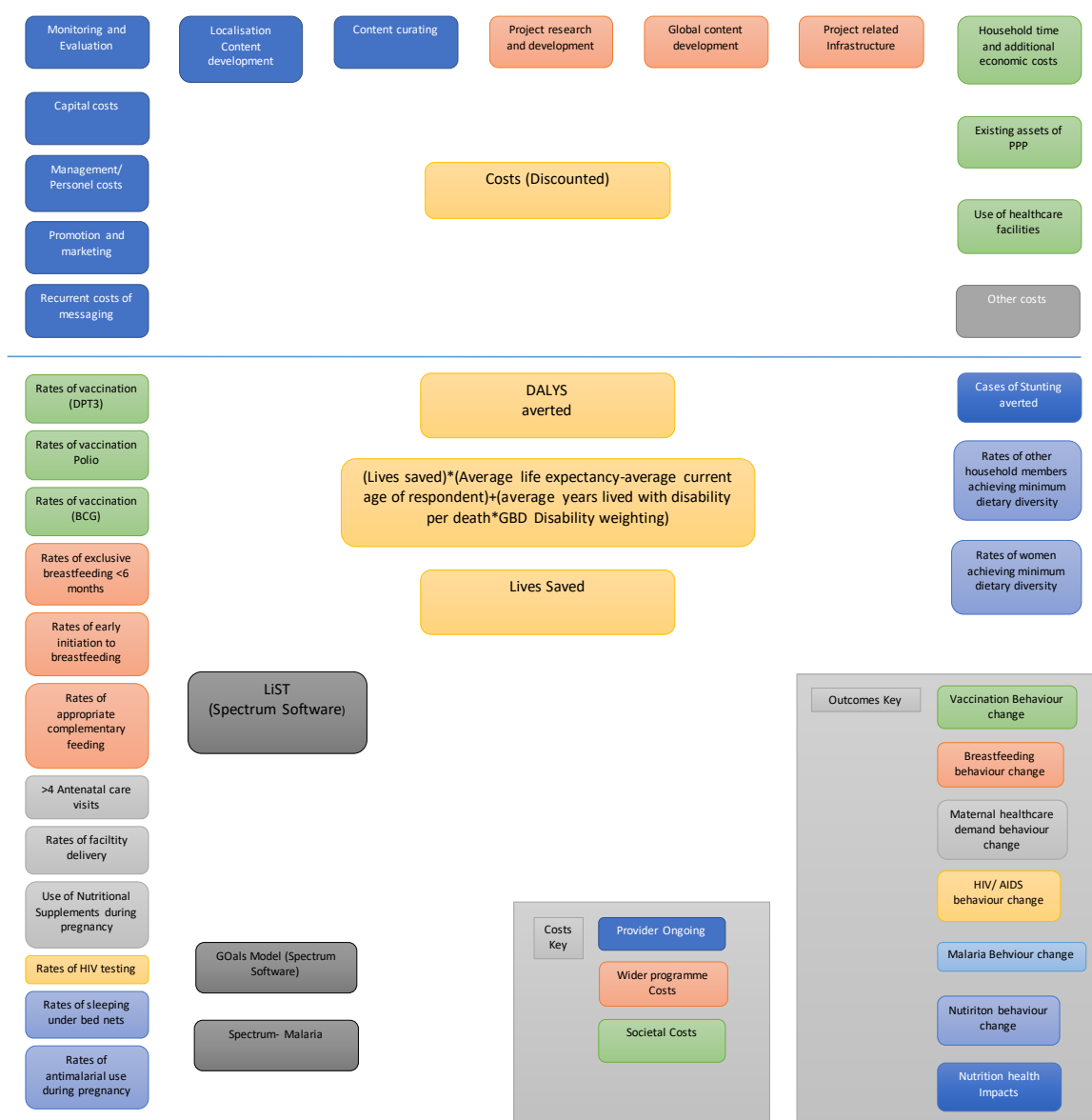
⁵ The agreement permits Gamos to share confidential information among the team if: 1. They need to know; 2. They have entered into a confidentiality agreement; 3. They are not a competitor.

3 Cost-effectiveness Framework for Wazazi Nipendeni

3.1 Analysis Framework

The elements involved in the proposed cost-effectiveness analyses are summarised in Figure 1. Costs of the programme are considered, and these are set against the DALYs averted. Costs are collected from project budgets, expenditure reports and key stakeholder contacts from multiple organisations as available at March 2017. DALYs averted will only be available after the completion and analysis of the quantitative endline survey data, and so this baseline seeks to define the outline of the analysis without seeking to undertake it as such. Other considerations necessary for the endline cost-effectiveness analysis, such as sensitivity analysis, are outlined in Annex B.2.

Figure 1 Components for cost-effectiveness analysis



Authors own

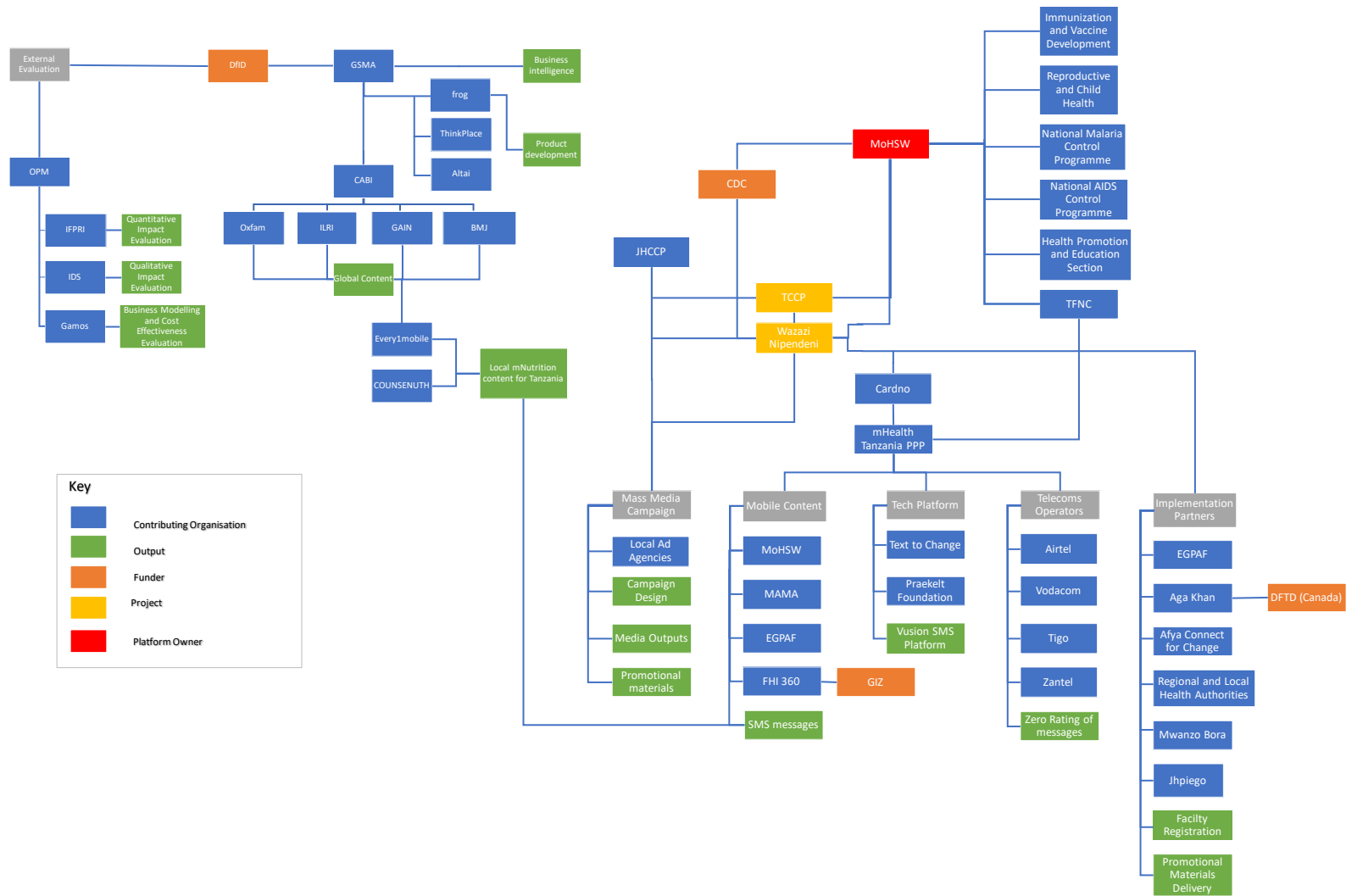
It is proposed to conduct three separate analyses, each of which considers different cost components, reflecting the factors of interest to different stakeholders.

- Analysis A: The first considers costs from the perspective of an organisation that would replicate a similar service, utilising the content created by CABI at no cost (Section 3.1.1).
- Analysis B: The second analysis considers cost-effectiveness from the perspective of a donor, including costs such as research and development. This analysis aims to show whether the impacts of the intervention represent Value for Money for the funders (Section 3.1.2).

- Analysis C: Includes all the relevant costs in achieving the impact of the mNutrition programme. This includes those borne by public services, and households using the service. Generating data on costs will be challenging, given the complexity of the partnerships involved in delivering the Wazazi Nipendeni service, which is illustrated in the draft stakeholder map presented below.

Data on impacts will be gathered from the quantitative baseline. The boxes along the right- and left-hand sides indicate data gathered by the quantitative teams. Where possible, this data will be converted into changes in mortality rates using the LiST model (see B.6) and converted to DALYs using the PSI impact calculator (see B.7). The dark blue box on the right-hand side represents changes in child anthropometric status, which can also be converted into DALYs if impacts are found. Finally, changes in dietary diversity will be converted into DALYs using estimates calculated from the literature. For example, Zerfu et al., (2016) states that women achieving minimum rates of dietary diversity have a 2-fold reduced risk of maternal anaemia, and a greatly lowered risk of pre-term birth and low birth weight. In this instance, the rates of increased WDDS would be used to calculate the reduced rates of anaemia. The weighting for anaemia within the WHO's Global Burden of Disease report (2004) would enable us to calculate the DALYs averted. We would aim to do this for all diseases influenced by WDDS and included in the WHO's Global Burden of Disease report. As the literature on dietary diversity is updated constantly, we will revise our method at the time of the quantitative endline.

Figure 2 Stakeholder map (Draft, known as at March 2017)



Authors own

3.1.1 Analysis A (Ongoing costs)

This analysis assesses the cost-effectiveness of the Wazazi Nipendeni service using the blue boxes above the line in Figure 1 – these are the provider ongoing costs, borne by all partners involved in the day to day operations of the intervention. This includes MNOs, managing organisations such as Cardno and partners assisting with registration on the ground. We have included localisation of content in these costs, since these are costs that would be incurred if another partnership were to replicate the service. This analysis does not attempt to allocate a proportion of the wider mNutrition programme costs, nor take into account the sunk and investment costs associated with building the asset value of the Wazazi Nipendeni text messaging platform that the mHealth Tanzania PPP brought to the partnership, or the network infrastructure resources made available by each of the participating MNOs. There may be ongoing costs of putting in place and managing the PPP, but the cost collection for this is still ongoing. However, it is represented in the management and personnel cost bubble in Figure 1. Cost data, including the partners from Figure 2 involved in expenditure, collected as of March 2017 can be seen in Table 3, Section 4, although the cost data collection process is still ongoing. Implementing partners, or those organisations that provide ‘in-kind’ support to the Wazazi Nipendeni programme by promoting the service or providing assisted registration services, are constantly changing. Therefore, there are several more unnamed implementing partners not shown in the diagram. Given the ongoing nature of identifying the cost data, the numbers stated in this report are sourced from expenditure, financial and other reports of expenditure to date, and estimates made on the basis of the wider reporting within the programme including from stakeholder interviews.

This analysis is based on the assumption that content, at least at the global level, will be available free of charge. This is indeed the case, given that all the factsheets and messages developed by the Global Content Partners to the mNutrition programme will be open access and made freely available through the CABI Knowledgebase. It also assumes that any future implementing agency will have access to a technical platform and the capability needed to implement such a system, either as part of their own resources, or by sub-contracting the services of a company that does have such capability, such as TTC Mobile (who developed the Vusion platform originally used for Wazazi Nipendeni). This analysis will be of primary use to stakeholders who may wish to replicate the service without further development costs, and have a willing MNO(s) in place with similar proportional coverage to the MNOs working with Wazazi Nipendeni.

3.1.2 Analysis B (Wider programme costs)

Analysis B includes a proportion of all costs invested in the mNutrition programme (orange boxes), in addition to the ongoing and service specific costs (blue cost boxes) (see Figure 1). The wider costs will be difficult to apportion. One could argue that a portion of the wider project research and development should be assigned to the Wazazi Nipendeni service costs, since if the donors were to invest in, for example, a next generation of mNutrition services, they would need an overarching programme of work similar to the mNutrition programme to stimulate MNOs to adopt new approaches, to coordinate learnings and effort, and to deliver wider programmatic benefits. The same argument applies to the global content developed as part of the overall mNutrition programme, and to the institutional

infrastructure set up by GSMA (and others) in order to deliver the programme. In-country costs are also included. Preliminary cost data can be seen in Section 3.1.2.

Analysis B will be of most use to DFID and other funders or policy actors to assess whether the programme of mNutrition represented Value for Money (VfM). It would be of particular use if a similar programme was being planned for the future.

3.1.3 Analysis C (Inclusion of Societal costs)

The final possible analysis (Analysis C) takes a comprehensive view of costs, considering not only operational costs (blue boxes) and wider programmatic costs (orange boxes), but also societal costs (green boxes) (see Figure 1).

There is an argument that the real cost of the text messaging service should include sunk investment in the platform, and the network of relationships that lie behind the successful development of the service. It is also clear that the text messaging service does not work in isolation, rather it complements campaigns and messages delivered by a range of partners with some kind of field presence, which incur related costs that should be accounted for. To a certain extent, these will be captured as part of ongoing operational expenditures e.g. management, promotion and marketing. However, if the service is successful in encouraging women to avail themselves of health services, be that through government, private, or NGO run health facilities, increased demand for services will result in increased costs. Given that it is the provision of these services that will be largely responsible for improved health outcomes, an argument can be made for including these costs in the cost-effectiveness analysis. The quantitative component will measure how many more women use healthcare services as a result of the intervention, and we aim to determine healthcare costs from this data to be presented in the endline report. Similarly, if women access care from health facilities, they will incur costs, which may be financial costs, such as the cost of vaccinations, or opportunity costs associated with the time taken to travel to clinics. This will also be derived from quantitative data. The costs associated with healthcare facilities are likely even more difficult to assign, although the endline quantitative data may give some insight into them. Household and healthcare costs will be collected over the next two years. Preliminary costs for Analysis C can be seen in Section 4.

This analysis will be of most use to governments and donors considering replication of the service in their country – to assess whether they have similar societal investments creating a similar landscape.

3.2 Effectiveness

Much of the discussion about effectiveness will be dependent on the endline quantitative survey due to be completed in 2019. The quantitative surveys have been designed to assess the primary outcomes of the study, namely child nutrition, infant and young child feeding practices, and women's dietary diversity. These will be measured using a range of indices:

- Child nutrition – dichotomous indicators for whether the child is stunted (a Height-for-age z-score below -2), the child is underweight (a WAZ below -2), and the child is wasted (a WHZ below -2); also dichotomous indicators for whether the child is moderately acutely

malnourished (WHZ between -2 and -3) or severely acutely malnourished (WHZ below -3).

- Infant and young child feeding practices (6 core indicators) - whether the child was put to the breast within one hour of birth, whether the child was exclusively breastfed during the first six months, whether the child was still fed breast milk between twelve and fifteen months of age, whether the child received foods from four or more food groups during the day preceding the survey (child dietary diversity), and whether the child met minimum meal frequency standards in the past 24 hours given their age and breastfeeding status.
- Women's dietary diversity - the Women's Dietary Diversity Score (WDDS) is the number of food groups, out of a maximum of nine, from which the woman consumed during the 24-hour period preceding the survey.

The quantitative study will also generate data on changes in a range of secondary outcomes associated with infant and young child feeding knowledge and beliefs. It will also measure impacts of other messages not directly produced by mNutrition, but incorporated into the wider Wazazi Nipendeni service, and received by the intervention group. These possible impacts can be seen in Figure 1.

For the cost-effectiveness analysis, it is proposed to use the metric most commonly found in the literature, which is cost per DALY averted, providing the quantitative analysis does indeed identify significant health impacts. The DALY metric captures both lives saved, and the impact of living with a disability. Since many of the outcomes measured, such as dietary diversity or stunting and wasting, are more likely to lead to disability than to death, it is appropriate to capture the lived burden of disease that many be averted by the mHealth intervention.

The Spectrum software (including LiST) provides a great tool to estimate the lives saved by improved rates of breastfeeding, attendance at antenatal care, and many other intermediate health outcomes. The PSI impact calculator has created a methodology for turning lives saved into DALYs averted (described in Annex B). The DALYs of mothers and children will likely be presented as an aggregate figure.

Table 2 provides a typology of impacts of the mHealth project that could be used in assessing cost-effectiveness. The table shows impacts on health outcomes, health behaviours, and health knowledge. Ideally, the cost-effectiveness model would be based on both measured health impacts (e.g. reduction in stunting) and imputed health impacts, calculated from measured changes in behaviours (e.g. improved dietary diversity), as these are the ultimate goal of the project. However, should significant health impacts not be found within the short timescale, other measures, such as knowledge, will have to be considered.

Table 2 Imputed and Measured impacts covered by the RCT quantitative study (primary and secondary outcomes)

Type of intervention	Health Impacts	Behaviour Impacts	Knowledge Impacts
Nutrition	DALYs/ deaths averted by reduction in malnutrition (calculated from anthropometry or DDS of mother and child <5)	Dietary diversity scores, consumption of 4+ food groups in past 24 hours	Awareness of nutritious foods (vitamin A, iron), Strategies to protect children from worms
IYCF	DALYs averted due to increase in exclusive breastfeeding (LiST)	Increase in months of exclusive or predominant breastfeeding, giving colostrum, time to start feeding after birth, received breastfeeding help after birth (WHO IYCF metric)	Increase in correct answers about IYCF practices
Malaria	DALYs averted due to use of nets/ anti malarials	Use of nets and anti-malarials (mother/ child)	
Diphtheria, Tetanus, Polio	DALYs averted by increased coverage of DPT vaccine	Increase in vaccinations	
Tuberculosis	DALYs averted by increased coverage of BCG vaccine	Increase in vaccinations	
Measles, Mumps, Rubella	DALYs averted by increased coverage of MMR vaccine	Increase in vaccinations	
Diarrhoea	DALYs averted by reduced rates of diarrhoea	Exclusive breastfeeding rates	
HIV/ AIDS	DALYs averted by increased testing	Testing for HIV/ AIDS, collecting of results, use of contraception	Knowledge of HIV/ AIDS and of ART and sources of ART
Birth Practices	DALYs averted by increase in facility delivery, skilled birth attendance, home visits, follow up visits	Increase in facility delivery, skilled birth attendance, follow up appointments	
Pregnancy Practices	DALYs averted by ANC appointments	Attendance of ANC	Knowledge of pregnancy 'warning signs'

These measures will contribute to nuancing the cost-effectiveness of Analysis C with the changes in (comprehensive) above-line costs. These measures do not primarily capture extra expenditure by households. Differentials in access to, and uptake of, health services will need to be extracted from the endline survey.

Very few studies have been conducted on the cost-effectiveness of a project with relation to its impacts on knowledge and attitudes. This is likely since knowledge and attitude change is rarely considered an end in itself, but rather a precursor for material or physical gains. Improved knowledge about infant and young child feeding practices, for example, will ideally lead to improved child health outcomes. Knowledge and attitude change therefore, despite its value, is unlikely to be a sufficiently robust measure to be included in any analysis of cost-effectiveness.

4 Baseline Wazazi Nipendeni Costs

4.1 Analysis A

4.1.1 Setup and Ongoing costs (Analysis A)

If another organisation in another country were to consider setting up a text messaging information service, they would need to consider the costs associated with establishing a localised information database, along with the capital expenditure and operational expenditure required to get such a system up and running.

Where possible, the team has collected and collated the costs for the Wazazi Nipendeni service. These costs, particularly ongoing ones, have and are likely to change as the service offering is adjusted. Some cost data is incomplete, and with the introduction of a new platform the ongoing costs are likely to change. The CDC and the Ministry of Health have invested in a new technological platform, to improve the performance of the Wazazi Nipendeni system, but which also offers possibilities for hosting additional mHealth services provided by third parties. As a baseline then, we have 'sketched' the costs in order to identify the gaps to be filled during the coming months. These are given in Table 3 section 4.1; they consist of costs sourced from financial and other reports, and estimates made, based on the wider reporting within the programme inclusive of stakeholder interviews.

So as not to be continually adjusting this report in the light of the dynamic changes of the service, all costs are taken as at March 30th 2017, the end of the data collection phase. For the rest of the programme of work, data will be collected from relevant stakeholders, provided in project budgets, expenditure reports and other relevant documents. At the endline report stage, when all cost data has been selected, we will perform sensitivity analysis, in order to account for any discrepancies in cost estimates or possible inaccuracies. At this stage we are not conducting any analysis, so sensitivity analyses cannot yet be addressed.

In the framework, the Setup and Ongoing costs (blue boxes) include:

- **Localisation Content development.** mNutrition as a whole has been funded to develop and collate a global repository of nutrition information. In order for this to be applied to Wazazi Nipendeni there had to be a localisation process - taking the global fact sheets and making them relevant to the clientele of Wazazi Nipendeni. This involved a number of partnerships which will be discussed below.
- **User experience (UX) testing, Baseline, Monitoring and Evaluation.** Resources and personnel needed for UX, baseline surveys, monitoring and evaluation. We include here the baseline surveys and user experience surveys required to design the specifics of the service, and the ongoing mechanisms of feedback to keep the service relevant to users and to keep stakeholders apprised of the services effects (public good impact). It could be argued that the UX surveys are a part of the product research and development which we have modelled as a wider programme cost. However, if a similar service utilising the experience of Wazazi Nipendeni Tanzania and the global content created by the mNutrition programme were to be set up in another country, there would need to be further UX surveys to inform the service shape and form, and to contribute to the localisation of the content. The same argument can be made for business intelligence

support provided by GSMA. Although primarily regarded as part of the wider programme costs, a proportion of the GSMA costs should be included under the setup costs, reflecting a need for any similar service to conduct business intelligence analysis; an estimate of 20% of GSMA costs have been allocated to this⁶.

- **Capital costs.** Cost of any infrastructure created to support Wazazi Nipendeni. For example, the service was initially based on the Vusion platform developed by TTC Mobile, which interfaced through a local aggregator to each of the partnering MNOs. The mHealth Tanzania PPP and the government subsequently invested in the development of a bespoke platform designed to improve performance and reduce costs, and the service migrated to the new platform late in 2016. These capital costs are not yet available. Introducing a service offering in a new country would likely require some capital equipment to strengthen infrastructure.
- **Management/ Personnel costs.** The ongoing service requires expenditure on staff and management, including training. MNO overheads could be incorporated here. Personnel costs need to include any engineers required to maintain the platform.
- **Promotion and marketing.** This includes two principal activities. Firstly, Wazazi Nipendeni mainly works through other NGOs (and government health facilities) by providing an information service that supports 'on the ground' campaigns, so the cost of these campaigns needs to be taken into account. Secondly, mHealth Tanzania PPP staff provide training of partners' in-country personnel, incurring costs for transport for trainers, hours of labour etc.
- **Recurrent costs of messaging.** On the face of it one of the simplest costs is the price assigned to the text messaging. Each message has a cost associated with it. Message scheduling and despatch platforms will also incur ongoing maintenance costs. Who pays this cost is a more complex question.
- **Content curating.** There is an ongoing need for updating the content of the messages. Information can get out of date and there is a need to ensure that the health and nutrition information remains relevant.

The Wazazi Nipendeni service is a product of collaboration between many partners, and the complexity of the relationships is illustrated in Figure 2. In terms of the ongoing costs, Table 3 shows which partners will have expended on which items in the framework.

Table 3 Allocation of costs - Analysis A

Costs	Partners involved in expenditure
Localisation Content development.	GSMA, COUNSENUITH, Every1Mobile, TFNC, Ministry of Health, mHealth Tanzania PPP
UX, Baseline, Monitoring and Evaluation.	ThinkPlace, frog, Altai, Cardno
Capital costs.	mHealth Tanzania PPP, Ministry of Health, HNI
Management/ Personnel costs.	Cardno, mHealth Tanzania PPP, TFNC, 15 active partners, HNI

⁶ This estimate is based on stakeholder interviews and opinion only.

Promotion and marketing.	mHealth Tanzania PPP, TFNC, 15 active partners, Ministry of Health
Recurrent costs of messaging.	Airtel, Vodacom Foundation, Tigo, Zantel
Content curating.	mHealth Tanzania PPP, HNI, TFNC

4.1.2 Analysis A, Baseline costs

Based on the analytical scenario described above, the following is the data available as at March 2017. It may be possible (and we hope) that other historical costs might be quantified as the programme interviews continue. Some estimates have been made by authors based on the best possible information at the time, and the source of the data can be seen in column 3 of Table 4.

Baseline costs for Wazazi Nipendeni Analysis A. Due to the complexity of the Wazazi Nipendeni partnerships, the additional nature of the nutritional component building on what has gone before, and the lack of a single budget for the intervention, it has been difficult to draw out the relevant costs. In Table 4 we outline the costs we continue to seek. At the completion of the data collection few actual costs were available. At the time of writing more detail about costs has been promised and cost information will be updated as it is received.

Table 4 Baseline costs for Wazazi Nipendeni Analysis A

	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
Localisation Content development.	GSMA, COUNSENU, Every1Mobile, TFNC, Ministry of Health, mHealth Tanzania PPP	Global content financial report (Tanzania costs only) CABI 2016.	Staff Costs	£13,399	£6,904
		Global content financial report (Tanzania costs only) CABI 2016.	Direct Costs	-	-
		Global content financial report (Tanzania costs only) CABI 2016, GSMA 2015e, DFID 2016.	LCP payments	£16,599	£45,869
Product development			Cancelled contract with		

	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
(UX, M&E, BI)	ThinkPlace, frog, Altai, Cardno, GSMA		Johns Hopkins		
		Estimates made from DFID 2016, GSMA 2017.	Monitoring & Evaluation (Altai)	£53,109	£53,109
		Estimates made from DFID 2016, GSMA 2017.	UX expert and design consultants	£66,962	£66,962
		Estimates made from CABI, 2016, GSMA 2015b, GSMA 2015c, GSMA 2015d, DFID 2016, GSMA 2017, stakeholder communication.	Business Intelligence (GSMA)	£47,704	£47,704
Capital costs.	GSMA, Wazazi Nipendeni Team, mHealth Tanzania PPP, Ministry of Health, HNI	Assumed costs from Financial model (Palladium, 2015).	Server platform for messaging, set up cost	£1,923	
Management/ Personnel costs.	GSMA, Wazazi Nipendeni team, Government, Cardno, mHealth Tanzania PPP, TFNC	Estimates based on Cardno 2017, United Nations 2015.	Assumed team of 4 paid for by CDC, Package costs, 30% of time.	£94,286	£94,286
		Estimates based on Cardno 2017, stakeholder interviews.	Assumed 20% time of key Government staff (3)	£28,286	£28,286
Promotion and marketing.	mHealth TZ PPP, partner NGOs	Estimates based on Cardno 2017, GSMA 2017, Palladium, 2015 & stakeholder interviews.	Training of NGO personnel	£5,143	£5,143
		Estimates based on Cardno 2017,	Implied extra cost for NGO	£25,714	£25,714

	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
		GSMA 2017, Palladium, 2015 & stakeholder interviews.			
		Estimates based on Cardno 2017 & stakeholder interviews.	Training expenses	£33,846	£33,846
		Estimates based on Cardno 2017.	Zero rated USSD sessions	£9,833	£9,833
Recurrent costs of messaging.	MNOs *4 Airtel, Vodacom Foundation, Tigo, Zantel	Calculated from Cardno 2017, Africa's Talking 2017, Aptus solutions 2017 plus estimates based on stakeholder interviews.	Zero rated SMS valued at	£334,296	£367,714
	Aggregator Platform	Estimate based on Palladium 2015.	Payment to aggregator	£18,462	£18,462
	Wazazi Nipendeni team	Estimate based on Palladium 2015.	Short code licence fee	£3,692	£615
		Estimate based on Palladium 2015.	Cloud server for SMS		£16,615
		Estimate based on Palladium 2015.	Annual Systems administration	£26,585	£26,585
Content curating.	Wazazi Nipendeni team	From Financial model (Palladium, 2017)	Translation (inc in content LCP above)		
			Updating	£1,071	£1,071
			Totals	£780,901	£848,720

Only the cost of message scheduling and the cost of sending the SMS messages themselves have been assumed to be variable costs. These costs have been based on estimated average numbers of users of 200,000 in Year 1, and 220,000 in Year 2. If we assume an attrition rate of 20 percent at the end of Year 1, then out of the 220,000 users in Year 2, 160,000 continued using the service from the previous year, and 60,000 would be newly registered in Year 2. The total number of people using the system over the two-year period would then be 260,000 (200,000 in year 1 plus 60,000 new registrants in Year 2). These figures are based on numbers of users on the system reported by mHealth PPP (Personal communication, 2017). This would give a figure of £6.3/user. If it can be assumed that there is no material cost to the MNOs of sending the SMS messages, then this ratio drops to £3.5/user.

4.2 Analysis B

4.2.1 Wider programmatic costs (Analysis B)

As discussed briefly above, if a cost-effectiveness study is to be used not just to inform thinking on replicating a mother and child information service, but for a wider, retrospective assessment of what can be achieved for a given level of investment, then actors might need to understand the full cost of incorporating the content into the Wazazi Nipendeni service, inclusive of the wider programmatic costs. This is typically the kind of approach that would appeal to donors and policy actors interested in assessing whether the programme represents value for money. To include this wider perspective, the following costs need to be explored:

- **R&D for mNutrition programme as a whole.** The expanded nutritional messages sent out by Wazazi Nipendeni is a particular output from the wider mNutrition programme. The mNutrition programme as a whole has spent time strategising, planning, co-creating global content etc., leading to 14 specific in-country services in 12 countries. While it is impossible to extract the specific costs of mNutrition related to the new nutritional content of Wazazi Nipendeni, it could be argued that 1/14 of the overall programme costs (minus specific costs identified) could be imputed to the mNutrition component of Wazazi Nipendeni (Hutchinson 2006). This assumption was supported by GSMA (2017). While this is open to question, for Analysis B we adopt this costing. It should capture the research and development behind the mNutrition project after the project's inception (hours of labour devoted to the project by larger organisations, the amount paid to external researchers, costs of rent, vehicles and other transport costs associated with the project, costs of office supplies, electricity and other expenses necessary for research and development tasks).
- **Global Content Development.** The mNutrition programme paid for a global content generation process that was carried out by a consortium, comprising CABI, the Global Alliance for Improved Nutrition (GAIN), Oxfam, the International Livestock Research Institute (ILRI), and the British Medical Journal (BMJ). The Global Content Partnership was responsible for identifying relevant content, creating content structures, and specifying content validation and quality control processes. The content developed by the consortium was then made available to local content partners in each country to adapt for local consumption, and these costs are included as the localisation content development in Analysis A. A proportion of costs associated with the work of the global content consortium should be imputed to Wazazi Nipendeni in Analysis B.

- **Project related infrastructure.** In order to implement a complex programme across 13 countries and two continents, GSMA had to set up substantial infrastructure, at substantial cost. This includes institutional management structures, personnel, offices, IT networks etc. It is a proportion of these costs, paid for through the wider mNutrition programme, that are included in Analysis B.

4.2.2 Analysis B, Baseline costs

Additional costs that could be considered in Analysis B have been estimated from high-level budgets so they clearly lack any degree of accuracy. These figures will be updated if new cost data becomes available, and sensitivity analysis will be performed in the endline report, when all cost and impact data is available.

Table 5 Baseline Costs for mNutrition

Cost	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
mNutrition programme as a whole (R&D, infrastructure).	GSMA (plus programme partners)	DFID 2013, DFID 2016, GSMA 2017 and CABI 2016	Proportion of programme overheads and global work.	£191,000	£191,000
Global content development.	CABI, GAIN	CABI 2016		£128,000	£128,000
Total including Analysis A Direct costs				£1,099,901	£1,167,720

4.2.3 Global content development

The CABI budget outlines costs associated with the local content generation process, which includes both payments to local content partners and consortium staff costs (these are included in Analysis A). However, additional costs are allocated to the consortium partners for direct costs and staff costs, which amount to over £3.5m. A crude assumption can be made that these are spread evenly across all 14 projects, giving a total of £256,000 per country, or £128,000 per year if split over two years. The cost of content development for mNutrition was particularly high, as it was premised on building capacity within local institutions. It has been argued that it would be possible to develop content cheaper had the capacity building mandate not been in place.

4.2.4 mNutrition programme as a whole

GSMA have provided an estimate of the average total budget per project of £1,056,000 for those countries running mHealth projects as part of mNutrition. We have identified direct

expenditure items which are included in Analysis A (Localisation Content Development, Product developments (Monitoring and evaluation, UX expert and design consultants, and Business Intelligence)), and the proportion of Global content development (section 4.2.1). When these items are deducted from the average budget spend, the balance is £382,000. This has been split evenly over two years. This does not take into account whether GSMA has costed its overheads commercially. It is more than likely that some other parts of GSMA are subsidising the mDevelopment stream.

4.3 Analysis C

4.3.1 Including Household costs (Analysis C)

For a more complete picture of the costs involved in the Wazazi Nipendeni text messaging service, one needs also to consider a number of additional costs, which can fall into two categories:

- Indirect, variable costs incurred as a consequence of users taking the actions advised through the Wazazi Nipendeni service.
- Sunk costs involved in building the assets that each partner brings to the partnership that delivers the Wazazi Nipendeni service.

To undertake these elements of the analysis we need to add to the above a view on:

- **Existing Assets.** Each of the organisations involved in delivering the Wazazi Nipendeni service are building on their existing networks and infrastructure, and additionally, some bring intellectual assets.
 - It can be argued that it would not have been possible to implement the nutritional component so easily if the **mHealth Tanzania PPP** and team (including **TFNC**) had not had prior experience of running a mother and child intervention.
 - Each of the participating **MNOs** are building on their existing network infrastructure. The MNOs provide coverage of the majority of the country with their mobile networks and this makes the possibility of messaging large numbers of consumers a reality.
 - The mNutrition programme builds on the learning and experience **GSMA** has gained through running previous mHealth programmes. The GSMA was able to implement the programme because it had previously invested in the infrastructure through which it operates. However, it must be recognised that the GSMA infrastructure includes much more than the physical items described in Analysis B e.g. branding, relationships, reputation, and so on. This draws attention to the idea that another country wishing to implement a similar programme needs to consider if it has such project infrastructure in place – the GSMA has a unique role in the context of mobile telephony.
 - Development of the **global content repository** would have incurred considerable additional expenditure if GAIN and CABI had not had a collated ‘head start’ in terms of global content. This repository of content had to be collated. The money paid to external content developers and hours of labour spent by other employees, necessary resources etc. could be taken into account. (N.B. it is important not to double count any payments made by mNutrition to content providers within the first item - the wider R&D of the programme.)

- **Use of health facilities – fixed costs.** There are two ideas to capture here. Firstly, the qualitative component of the study, and most of the literature on how households learn, emphasises that people learn from multiple sources. In addition to advice received through Wazazi Nipendeni, women may be learning improved health management from other sources, such as private or public clinics, antenatal care visits, and broadcast media; indeed, this is precisely how the Wazazi Nipendeni approach was designed – as a multimedia campaign. While the experimental, quantitative component will disaggregate the added benefit arising from use of the Wazazi Nipendeni service, the impact of the Wazazi Nipendeni advice may still have been supported by other health services and campaigns. So, for instance, for a woman who has no other sources of advice (not even her neighbour), the outcomes of the service might be considerably reduced. The experimental component then shows the additional value of the service, which may be less than if she had had a higher base loading of advice. Therefore, in terms of cost-effectiveness we need some insight into the base loading of advice, and costs associated with providing this base load of health services. The second idea captured here is that certain advice can only be followed if some investment has been made in other facilities. For instance, women may be advised to attend a clinic for antenatal care. Is there a clinic nearby? What is the quality of the services provided? One can imagine considerable gains made by the women resulting from increased use of government healthcare facilities. Therefore, the base loading of healthcare facilities also needs to be taken into account (if possible).
- **Use of health facilities - variable costs.** In order to take action on advice given to them via the Wazazi Nipendeni service, and in order to achieve the intended outcome of DALYS averted, women will be expected to access more publicly available healthcare e.g. attending antenatal clinics, receiving vaccinations, all of which will result in increased costs for health facilities, be they run by government, private sector, or NGO.
- **Household costs.** Similarly, in order to take action on advice given to them via the Wazazi Nipendeni service, women will have to increase their out of pocket expenditure on health services (e.g. vaccinations), and they may need to spend more on a variety of foodstuffs needed to diversify the household diet. The quantitative and qualitative components should give insight into this possible extra expenditure. Account can also be taken of the opportunity costs associated with the additional time needed to follow advice, such as the time taken to travel to clinics, or additional time needed to prepare nutrition meals, for example.

An attempt at micro costing the differential use of the health service as a result of the treatment and any extra household costs, will be made based on data from the RCT quantitative endline study. This is briefly discussed further in Section 4.3.2.

4.3.2 Analysis C, Baseline costs

Table 6 Baseline Costs, Analysis C

Cost	Partners involved in expenditure	Source of data	Detail	Year 1	Year 2
Global content repository	CABI, GAIN	To be determined at endline	Proportion of embedded value of global research and content	Not yet available	Not yet available
Use of public facilities	Beneficiaries	To be determined by changed behaviour at endline	Micro costing re consumer	Not yet available	Not yet available

Costs to be included in Analysis C mostly represent embedded value (or asset value) that each partner brings to the partnership. Quantifying this is a tricky and subjective exercise. Although some rough estimates can be made using crude assumptions, efforts will be made over the next two years to collate costs invested in the mHealth Tanzania PPP, for example, to make more informed estimates of the asset value of the partnership.

The other components relate to additional variable costs incurred as a result of increased uptake and use of health services. This can only be added after the endline quantitative survey in 2019, which will generate some data on uptake of services.

4.3.3 Global content repository

CABI has been operating for more than 100 years. Focusing on generating and accumulation agricultural knowledge, the project obviously benefits from years of research. With a turnover of about £36m per year, the residual generated knowledge was available for the project. CABI is of course only one source of generated knowledge. The CGIAR network alone has a five-year budget of £8 billion - generating knowledge that Wazazi Nipendeni would draw on. How then do we assign a cost proportion of this valuable content? One option would be to take the GAIN project budget for developing content in Tanzania, and apportion an IP overhead of 50 percent, which would give a total of £41,000. The full set of options will be assessed at endline, once the frequency of updating messages is known, and whether this is on the basis of recent research.

4.3.4 Use of public facilities

The outcomes of Wazazi Nipendeni depend not only on behaviour change, but on use of existing public health services. The quantitative study will reveal the extent of increased healthcare use at the endline. The cost of this increased healthcare use will be included in this analysis. Data on the cost of certain healthcare units, such as antenatal care, vaccinations and facility delivery will be calculated from available literature at the time of the endline. For example, WHO CHOICE published data on the unit costs of inpatient and outpatient care in Tanzania, in 2008, although this is now somewhat outdated. We will seek to micro cost those healthcare services impacted in the treatment group according to literature available at the time of the endline. Where available literature cannot accurately provide cost information for healthcare use, we will seek information from relevant stakeholders.

4.4 Limitations

Many of the stated costs are integral to a number of other programmes. The mNutrition programme as a whole has transaction costs that may or may not be imputed in part to the Wazazi Nipendeni project. Airtel Tanzania, for example, has infrastructure which is being used for the delivery of the service, and one could argue that a proportion of 'overhead' costs needs to be assigned to the service. The counter argument is that this overhead is included in the SMS cost structure. In the endline analysis we will construct a number of scenarios which cover both provider and societal costs, ensuring that double counting is avoided. If the objective of the cost-effectiveness assessment is to add such a service to an existing Mobile Network Operator, then provider costs may be enough. However, were DFID to consider the value for money of its intervention, and seek to repeat it in a new country with new partnerships, then societal scenarios may be more applicable.

4.5 Financial forecast model

GSMA prepared for its involvement with mHealth by commissioning a financial forecast model from Palladium⁷. They anticipated some of the costs and anticipated a cost per user. This was seen as potentially a policy tool on which to hang discussions with potential partners and government. In this section, we examine the model and comment on the assumptions made, in the context of operational experience to date.

In the Tanzania model, they created two scenarios; in one they assumed that messages are delivered through SMS only, and in the other they assumed messages are sent through both SMS and IVR. They work with 4 SMS and 4 IVR messages a month for the time span between signing up as a pregnant mother and then for 2 years after the child's birth. The user in their second scenario receives 132 SMS messages and 132 IVR messages in just under 3 years. However, at the time of the baseline visits, the HNI voice messaging IVR service was not yet operational, but the frequency of SMS messaging was indeed 4 per month.

⁷ The work was originally carried out by Futures Group, which was subsequently taken over by the Palladium Group.

The sheet was predicated on TzSh1936 to the US Dollar, while the exchange rate at time of writing the report is TzSh2239. Since most expenditure will occur in local currency, the model projections have been reinterpreted for the change in exchange rate.

Since the model was built for assessing mHealth interventions in a number of countries, they assign space in the model for programme planning costs, including the following:

- Engage government and validate priorities
- Identify opportunity for mNutrition
- Conduct research
- Identify partner model
- Validate product concept
- Secure commitments
- Develop M&E framework
- Develop sustainable business framework
- Support launch

However, in the Tanzania model no costs were attributed to any of these items. The assumption seems to be that Wazazi Nipendeni, as an existing entity known to the government with all the right permissions for running the basic Wazazi Nipendeni service, would not incur significant extra costs.

They provide for localisation of content, including content validation and translation of messages into Swahili. They assume that GSMA provides the content for free, and there are no broader content development costs. All of the costs included in the model will be covered by the costs paid to Every1Mobile as the local content partner. They also include a small allowance for ongoing content curation.

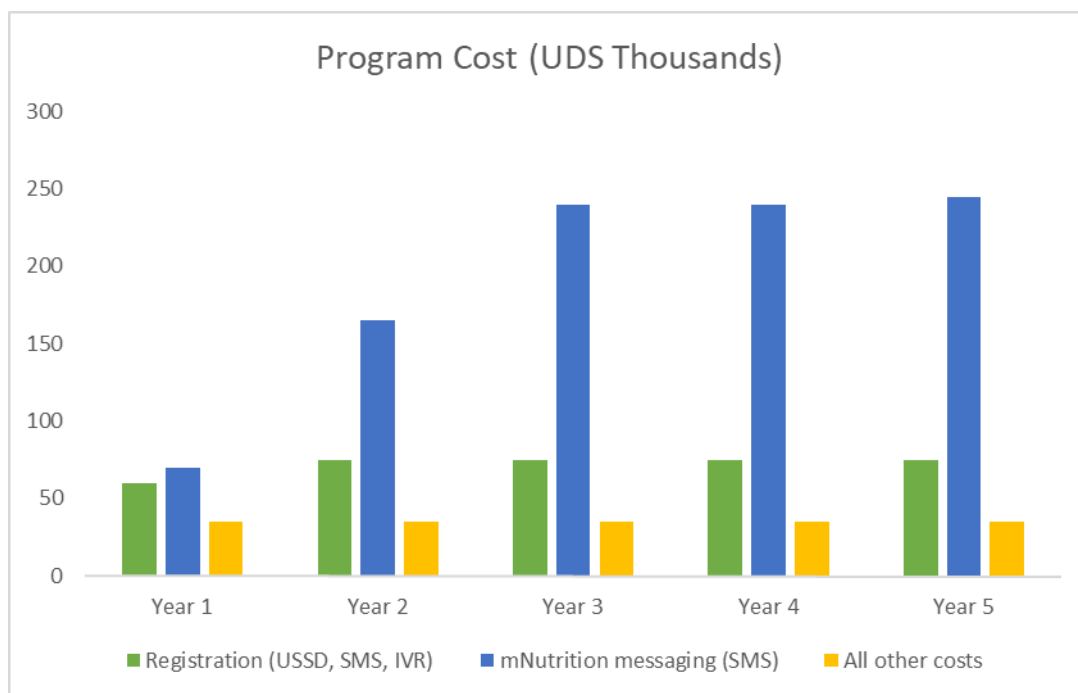
The financial model assumes costs to set up a short code, as well as an annual rental fee for it. At the time of the baseline visit, Wazazi Nipendeni already had in place the short code, along with agreements with the participating MNOs to zero rate this along with all the SMS text messages sent to users.

The model assumes the cost of an SMS server in Year 1 to be around US\$2,500, and the ongoing cost for renting a cloud server to be US\$1800 per month. These cost estimates are used in all 3 analyses (see Table 4). Additional costs are provided for software development, but this function will be provided by staff of the mHealth Tanzania PPP.

Palladium used an estimate of the number of subscribers in addition to these costs to calculate possible programme costs for 5 years, as can be seen in Figure 3.

As described in the business model report, Wazazi Nipendeni have migrated to a new platform so there will be additional software development costs, but the model also assigned a value to the messaging costs which at the moment are being absorbed by the MNOs through their CSR budgets.

Figure 3 5 Year programme costs (derived from Palladium Model, GRM Futures Group (2015))



Authors own

The model concludes that the cost per user reached is under US\$3. However, practice to date has departed from the assumptions made, including a greater than expected number of subscribers (Blomberg, 2016). Nevertheless, it adds value to the cost-effectiveness study by confirming the range of costs being considered by the CE study below.

5 Conclusion

The baseline report presents the framework by which the cost-effectiveness of Wazazi Nipendeni will be determined. There will be two components in the analysis – calculation of cost-effectiveness metrics, and comparison with metrics from published studies of comparable interventions. This report has sought to identify the framework, the costs currently identified (as at March 2017) and relevant literature on interventions that have comparable components to the mNutrition project.

The cost-effectiveness analysis is dependent on a measure of what the project has achieved, and this is to be determined by the results of the quantitative study currently being undertaken as part of the independent study by IFPRI. The endline survey is expected to be conducted early in 2019, and the results published thereafter. Only once these results are available will it be possible to conduct the cost-effectiveness analysis.

Regarding costs, the Wazazi Nipendeni mNutrition service is a complex array of partnerships and is built on a prior history of public-private partnerships and significant funding from CDC. It is therefore difficult to isolate the costs directly associated with the mNutrition intervention. This is particularly challenging if one wants the costs to inform MNOs potentially replicating the service in other countries (Analysis A).

While the baseline has identified and parked some historical costs, at the time of writing various stakeholders have said they will send further details of project budgets. Since the service will evolve, the costs will have to be modified over time to reflect the status of the service over its lifetime and at the time of the endline. For instance, the service migrated to a new platform late in 2016. The cost structure of the new platform is such that it eliminates the cost of the aggregator and should result in lower operating costs. Costs of the new platform were not available by the end of the baseline phase of data gathering activities.

The cost-effectiveness analysis relies on the ‘effectiveness’ which will be generated from the quantitative endline survey and analysis. We have noted here that there will be a number of different effects, which will be converted to DALYs saved. A scan of literature has shown that some components of the mNutrition service will be comparable to other nutritional interventions, and that may enable some limited comparison to be made with alternative interventions. The limitations of this comparison will be exacerbated by the lack of coherence in the literature, particularly with incomplete costing being reported in some other studies.

We propose conducting three distinct analyses, taking account of different costs, to generate metrics that will be relevant to different stakeholders. The simplest analysis will include project related costs only, and is designed to reflect the interests of parties that might be interested in replicating the Wazazi Nipendeni service in some way. This approach assumes that capital expenditure would be limited to modest costs associated with localising content, and to infrastructure items required to run the service, and that it would not be necessary to invest in the content generation and capacity building activities included in the mNutrition programme. A more comprehensive analysis will include all the mNutrition project costs, providing an assessment of value for money for the project as a whole. The third approach will take a much more comprehensive view of the costs associated with a wider range of factors required to achieve the improved outcomes, such as out of pocket expenditure by households, the increased cost burden on public health facilities, and the asset value of

resources that partners bring to the project. This comprehensive approach is intended to inform policy makers of the wider implications of such a project.

There will be ongoing data gathering, and the cost-effectiveness framework will be updated as and when details become available.

References / Bibliography

Africa's Talking (2017) SMS bulk purchasing webpage. [Accessed 31/04/2017].

<https://africastalking.com/services/bulksms/pricing/tanzania>

Aker, J., Burrell, J., Ghosh, I. (2016) 'The promise (and pitfalls) of ICT for agriculture initiatives' in *Agricultural Economics* 47(S1).

Alderman, H. (2006) 'Long-term consequences of early childhood malnutrition' in *Oxford Economic Papers* 58(3), 450–474.

Aptus Solutions (2017) SMS bulk purchasing webpage. [Accessed 31/04/2017].

<https://www.sms.co.tz/login.php>

Baker, E. J., Sanei, L. C., Franklin, N., Elizabeth, M., & Baker, J. (2006). 'Early Initiation of and Exclusive Breastfeeding in Large-scale Community-based Programmes in Bolivia and Madagascar' in *Journal of Health, Population and Nutrition* 24(4), 530–539. Retrieved from <http://imsear.li.mahidol.ac.th/bitstream/123456789/873/2/jhpn2006v24n4p530.pdf>

Baltussen, R., Cile Knai, C., & Sharan, M. (2004a). 'Nutritional Epidemiology Iron Fortification and Iron Supplementation are Cost-Effective Interventions to Reduce Iron Deficiency in Four Subregions of the World 1' in *J. Nutr*, 134, 2678–2684. Retrieved from <http://jn.nutrition.org/content/134/10/2678.full.pdf>

Barker, DJ., Winter, PD., Osmond, C., Margetts, B., Simmonds, SJ. (1989) 'Weight in infancy and death from ischaemic heart disease' in *Lancet* 2(8663), 577–580.

Barnett, I., Scott, N., Batchelor, S. and Haddad, L. (2016) Dial 'N' for Nutrition? A Landscape Analysis of What We Know About m-Nutrition, m-Agriculture and m-Development.

Barnett, I, Srivastava, S, and Gordon, J. (2017). 'Mobile phones, nutrition and health in Tanzania: Qualitative Baseline Report.' External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia. IDS, e-Pact Consortium.

Batchelor, S, Scott, N, and Sharp, J. (2017). 'Mobile phones, nutrition and health in Tanzania: Business Modelling Baseline Report.' External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia. GAMOS, e-Pact Consortium.

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., Webb, P., Lartey, A. and Black, R. E. (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *The Lancet*, 382(9890), 452–477. [https://doi.org/10.1016/S0140-6736\(13\)60996-4](https://doi.org/10.1016/S0140-6736(13)60996-4)

Black, RE., Victoria, CG., Walker, SP., Bhutta, ZA., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R. (2013) 'Maternal and child undernutrition and overweight in low-income and middle-income countries' in *The Lancet* 382(9890), 427–451.

Blomberg (2013) GSMA M4D mNutrition Initiative, mNutrition Overview.

Blomberg, J. (2014) Tanzania nutrition landscape analysis. Part 1 and 2. GAIN.

CABI (2016) 'GCP spend to date and projected', Charlotte Jordan, Unpublished. Last edited 14/11/2016.

Cardno (2017) 'mHealth Tanzania PPP and Cardno (2017) Wazazi Nipendeni_PPP Contributions_Q1FY17.' Received 31/04/2017. Unpublished.

Chee G, Smith K. (2006) Cost and effectiveness analysis of the Ndola Demonstration Project in Zambia: Bethesda, Maryland, Abt Associates, 2006 Feb. [47].

Chee G, Smith K, Makinen M, Rambelosen Z. (2004) Cost and effectiveness analysis of LINKAGES Infant and Young Child Feeding Program in Madagascar: Executive summary. Bethesda, MD: Abt Associates, Inc; 2004. p. 1.

Chola, L., Fadnes, L. T., Engebretsen, I. M. S., Nkonki, L., Nankabirwa, V., Sommerfelt, HTylleskar, T. (2015). Cost-Effectiveness of Peer Counselling for the Promotion of Exclusive Breastfeeding in Uganda. *PLoS ONE*, 10(11). Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4664391/pdf/pone.0142718.pdf>

Christian, P., Lee, SE., Donahue, AM., Adair, LS., Arifeen, SE., Ashorn, P., Barros, FC., Fall, CH., Fawzi, WW., Hao, W., Hu, G., Humphrey, JH., Huybregts, L., Joglekar, CV., Kariuki, SK., Kolsteren, P., Krishnaveni, GV., Liu, E., Martorell, R., Osrin, D., Persson, LA., Ramakrishnan, U., Richter, L., Roberfroid, D., Sania, A., Ter Kuile, FO., Tielsch, J., Victoria, CG., Yajnik, CS., Yan, H., Zeng, L., Black, RE. (2013) 'Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low- and middle-income countries' in *International Journal of Epidemiology* 42(5),1340–1355.

Cole, S., Fernando, A. (2016) 'Mobile'izing agricultural advice: Technology adoption, diffusion and sustainability' *HBS Working Paper*.

Copenhagen Consensus (2008) Results. Retrieved from http://www.copenhagenconsensus.com/sites/default/files/cc08_results_final_0.pdf

Courtois, P., and Subervie, J. (2015) 'Farmer bargaining power and market information services' in *American Journal of Agricultural Economics* 97(3), 953-977.

Curry, L. A., Byam, P., Linnander, E., Andersson, K. M., Abebe, Y., Zerihun, A. Bradley, E. H. (2013a). 'Evaluation of the Ethiopian Millennium Rural Initiative: Impact on Mortality and Cost-Effectiveness' in *PLoS ONE*, 8(11). <https://doi.org/10.1371/journal.pone.0079847>

De Steur, H., Gellynck, X., Blancquaert, D., Lambert, W., Van Der Straeten, D., & Qaim, M. (2012). 'Potential impact and cost-effectiveness of multi-biofortified rice in China' in *New Biotechnology* 29(3): 432–442.

Déglise, C., Suggs, L. S., & Odermatt, P. (2012). 'Short Message Service (SMS) Applications for Disease Prevention in Developing Countries' in *Journal of Medical Internet Research*, 14(1). <https://doi.org/10.2196/jmir.1823>.

Desmond, C., Bland, R. M., Boyce, G., Coovadia, H. M., Coutsoydis, A., Rollins, N., & Newell, M. L. (2008). 'Scaling-up exclusive breastfeeding support programmes: the example of KwaZulu-Natal' in *PLoS One* 6: e2454.

Development Media International. (2015a). BURKINA FASO RCT: MIDLINE RESULTS. Retrieved from http://www.developmentmedia.net/uploads/9/0/0/3/90035669/dmi_midline_results_final_2015.pdf

Development Media International. (2015b). PRINCIPLES | The Saturation+ approach to maximise behavioural impacts. Retrieved from http://www.developmentmedia.net/uploads/9/0/0/3/90035669/dmi_saturation_plus_approach.pdf

DfID (2016) Annual Review (3) Project Title: mNutrition–business models for mobile phone based delivery of nutrition services in Africa and South Asia. Document 5619141. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-203638/documents>

DfID (2015) Annual Review (2) Project Title: mNutrition–business models for mobile phone based delivery of nutrition services in Africa and South Asia. Document 5061454. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-203638/documents>

DfID (2014a) Annual Review (1) Project Title: mNutrition–business models for mobile phone based delivery of nutrition services in Africa and South Asia. Document 4577065. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-203638/documents>

DfID (2014b) Contract: DFID 6420 External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-PO6420/documents>

DfID (2013) Accountable Grant. Accountable Grant Arrangement for mNutrition- Business models for mobile phone based delivery of nutrition services in Africa and South Asia. Document 5703173. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-203638/documents>

DfID (2013) Business Case and Intervention Summary. Intervention Summary Title: mNutrition–business models for mobile phone based delivery of nutrition services in Africa and South Asia. Document 4139050. [Accessed 03/4/2017]. <https://devtracker.dfid.gov.uk/projects/GB-1-203638/documents>

Drummond, M.F., Sculpher, M. J., Claxton, K., Stoddart, G. L., & Torrance, G. W. (2005). *Methods for the economic evaluation of health care programmes*. 3rd ed. Oxford: Oxford University Press.

Evans, D. K., & Popova, A. (2016). 'Cost-Effectiveness Analysis in Development: Accounting for Local Costs and Noisy Impacts' in *World Development*, 77, 262–276. <https://doi.org/10.1016/j.worlddev.2015.08.020>

Fabrizio, C. S., Liere, M., & Pelto, G. (2014). 'Identifying determinants of effective complementary feeding behaviour change interventions in developing countries' in *Maternal & child nutrition*, 10(4), 575-592.

Farchamps, M., Minten, B. (2012) 'Impact of SMS-based agricultural information on Indian Farmers' in *World Bank Economic Review* 26(3), 383-414.

Fiedler, J and Semakula, R. (2014). 'An analysis of the costs of Uganda's Child Days Plus: Do low costs reveal an efficient program or an underfinanced one?' in *Food and Nutrition Bulletin*, 35(1). Retrieved from <http://journals.sagepub.com/doi/pdf/10.1177/156482651403500111>

Fiedler, J. L., and Afidra, R. (2010). 'Vitamin A Fortification in Uganda: Comparing the Feasibility, Coverage, Costs, and Cost-Effectiveness of Fortifying Vegetable Oil and Sugar' in *Food and Nutrition Bulletin* 31(2), 193–205. <https://doi.org/10.1177/156482651003100202>

Fiedler, J. L., Mubanga, F., Siamusantu, W., Musonda, M., Kabwe, K. F., & Zulu, C. (2014). Child Health Week in Zambia: costs, efficiency, coverage and a reassessment of need. *Health Policy Plan*, 29(1), 12–29. <https://doi.org/10.1093/heapol/czs129>

Flax, V., Negerie, M., Ibrahim, AU, Leatherman, S., Daza, E., Bentley, M. (2014) 'Integrating group counseling, cell phone messaging, and participant-generated songs and dramas into a microcredit program increases Nigerian women's adherence to international breastfeeding recommendations' in *Journal of Nutrition* 144, 1120-1124.

Galhena, D.H., Freed, R. and Maredia, K.M., (2013). 'Home gardens: a promising approach to enhance household food security and wellbeing' in *Agriculture & Food Security*, 2(1), p.8.

Gilligan, D, Hidrobo, M, Ledlie, N, and Palloni, G. (2017). 'Mobile phones, nutrition, and health in Tanzania: Quantitative Baseline Report' External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and South Asia. IFPRI, e-Pact Consortium.

Global Content Partnership (GCP), (2017). Lessons Learned from the Content Development Stream of the mNutrition Initiative.

Gluckman, PD., Hanson, MA. (2004) 'Living with the past: Evolution, development, and patterns of disease' in *Science* 305(5691), 1733–1736.

Gold, M.R., et al., eds, (1996). Cost-effectiveness in health and medicine. New York: Oxford University Press.

Gonzalez, M. A., Mene Â Ndez, C., Font, F., Kahigwa, E., Kimario, J., Mshinda, H. Alonso, P. L. (2000). 'Cost-effectiveness of iron supplementation and malaria chemoprophylaxis in the prevention of anaemia and malaria among Tanzanian infants' in *Bulletin World Health Organisation*, 78(1), 97–107. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2560593/pdf/10686744.pdf>

GRM Futures Group (2015) Financial Forecast Model, mNutrition Product Concept. GSMA.

GSMA (2017) 'Average breakdown of costs per country; Cost estimates for GAMOS.' Personal Communication. Email received 24/08/2017. Unpublished.

GSMA (2015a) '130820 mHealth services Tracker data for PAMI countries' Last edited 10/03/2014. Unpublished.

GSMA (2015b) GSMA mHealth Ppt Report Tanzania, Pan- African mHealth Initiative. Consumer Survey Tanzania.

GSMA (2015c) 'GSMA mHealth Market Report Tanzania', <https://www.gsma.com/mobilefordevelopment/programme/mhealth/gsma-country-feasibility-report-tanzania-2015> [Accessed 03/04/2017].

GSMA (2015d) 'Market Access Document - Tanzania (unformatted)', Last edited 27/10/2015. Unpublished.

GSMA (2015e) 'GSMA mHealth PPT report Tanzania 18th February', Last edited 20/02/2015. Unpublished.

GSMA (2014) Life Story Videos, MNO Testimonies.

GSMA (2014) '140325 mHealth Deployment Plan (Detail)', Last edited 20/09/2014. Unpublished.

GSMA (2014b) '140905 Tanzania Word Doc Final V3 (version for inputs)' Last edited 09/09/2014. Unpublished.

GSMA (2014) Tanzania Country Feasibility Report Version 3.

GSMA and Palladium (2015) Tanzania mNutrition Market Access Document. The Costs and Health impacts of mobile messaging for nutrition. GSMA.

Harris, L., Norton, G., Karim, A., Alwang, J. and Taylor, D. (2013). 'Bridging the Information Gap with Cost-Effective Dissemination Strategies: The Case of Integrated Pest Management in Bangladesh' in *Journal of Agricultural and Applied Economics* 45(04), pp.639-654.

Hatt, L., Nguyen, H., Sloan, N., Miner, S., Magvanjav, O., Sharma, A.Hossain, A. (2010). Economic Evaluation of DSF Voucher Program in Bangladesh. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/Bangladesh_DSf_evaluation_FINAL_Feb_2010.pdf

Hazel, E., Gilroy, K., Friberg, I., Black, R. E., Bryce, J., & Jones, G. (2010). 'Comparing modelled to measured mortality reductions: applying the Lives Saved Tool to evaluation data from the Accelerated Child Survival Programme in West Africa' in *International Journal of Epidemiology* 39 Suppl 1(Suppl 1), i32-9. <https://doi.org/10.1093/ije/dyq019>

Helitzer-Allen, D. L., Mcfarland, D. A., Wirima, J. J., & Maches (1993). 'Malaria Chemoprophylaxis Compliance in Pregnant Women: A Cost Effectiveness Analysis in *Social Science & Medicine* 36(4). Retrieved from https://vpn.lboro.ac.uk/+CSCO+0h756767633A2F2F6E702E7279662D7071612E70627A++/027795369390402P/1-s2.0-027795369390402P-main.pdf?_tid=ab6da9f6-395b-11e7-b02e-00000aab0f26&acdnat=1494845333_053ca8a037dbac7cabae7acaf9686eb1

Herrick, T., Harner-Jay, C., Shaffer, C., Zwisler, G., Digre, P., & Batson, A. (2017). 'Modeling the potential impact of emerging innovations on achievement of Sustainable Development Goals related to maternal, newborn, and child health' in *Cost Effectiveness and Resource Allocation* 15(1), 12.

- Hidrobo, M., Hoddinott, J., Peterman, A., Margolies, A., Moreira, V., (2014). 'Cash, food, or vouchers? Evidence from a randomized experiment in northern Ecuador' in *J. Dev. Econ.* 107, 144–156.
- Hildebrandt, N., Nyarko, Y., Romagnoli, G., Soldani, E. (2015) 'Price information, inter-village networks, and `bargaining spillovers': Experimental evidence from Ghana' *Working Paper*.
- Hoddinott, J., Behrman, JR., Maluccio, JA., Melgar, P., Quisumbing, AR., Ramirez-Zea, M., Martorell, R. (2013) 'Adult consequences of growth failure in early childhood' in *The American Journal of Clinical Nutrition* 98(5), 1170–1178.
- Hoddinott P, Craig L, Maclennan G, Boyers D, Vale L. (2012). The FEeding Support Team (FEST) randomised, controlled feasibility trial of proactive and reactive telephone support for breastfeeding women living in disadvantaged areas. *BMJ Open* 2: e001039. doi:10.1136/bmjopen-2012-001039.
- Hounton, S., & Newlands, D. (2012a). Applying the Net-Benefit Framework for Analyzing and Presenting Cost-Effectiveness Analysis of a Maternal and Newborn Health Intervention. *PLoS ONE*, 7(7). <https://doi.org/10.1371/journal.pone.0040995>
- Hutchinson, P., & Wheeler, J. (2006). 'The Cost-Effectiveness of Health Communication Programs: What Do We Know?' in *Journal of Health Communication*, 23(7), 823–841. <https://doi.org/10.1080/10810730600973862>
- Hutchinson, P., Lance, P., Guilkey, D. K., Shahjahan, M., & Haque, S. (2006). 'Measuring the Cost-Effectiveness of a National Health Communication Program in Rural Bangladesh' in *J Health Commun.* 11(suppl 2), 91–121. <https://doi.org/10.1080/10810730600974647>
- Iribarren, S. J., Cato, K., Falzon, L., & Stone, P. W. (2017). What is the economic evidence for mHealth? A systematic review of economic evaluations of mHealth solutions. *PloS one*, 12(2), e0170581.
- Jiang, H., Li, M., Wen, LM, Hu, Q., Yang, D., He, G., Baur, L., Qian, X. (2013) 'Effect of a short message service intervention on infant feeding practices in Shanghai, China: a prospective, community-based, controlled study' in *The Lancet* 382(P4).
- Labrique, A. Vasudevan, L., Kochi M. (2013) '12 common applications and a visual framework' in *Global Health Science* 1(2), 160-171.
- Larsen-Cooper, E., Bancroft, E., Rajagopal, S., & Levin, A. (2016). Scale Matters: A Cost-Outcome Analysis of an m-Health Intervention in Malawi. *Telemedicine Journal and E-Health*, 22(4), 317–324. <https://doi.org/10.1089/tmj.2015.0060>
- Low, J. W., Arimond, M., Osman, N., Cunguara, B., Zano, F., & Tschirley, D. (2007). 'A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique' in *The Journal of Nutrition*, 137(5), 1320-1327.
- Mangham-Jefferies, L., Pitt, C., Cousens, S., Mills, A., & Schellenberg, J. (2014a). 'Cost-effectiveness of strategies to improve the utilization and provision of maternal and newborn

- health care in low-income and lower-middle-income countries: a systematic review' in *BMC Pregnancy and Childbirth*, 14. <https://doi.org/10.1186/1471-2393-14-243>
- Masset, E., Haddad, L., Cornelius, A. and Isaza-Castro, J., (2012). 'Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review' in *BMJ*, 344, p.d8222.
- Mauceri, M., Alwang, J., Norton, G. and Barrera, V. (2007). 'Effectiveness of Integrated Pest Management Dissemination Techniques: A Case Study of Potato Farmers in Carchi, Ecuador' in *Journal of Agricultural and Applied Economics* 39(03), pp.765-780.
- McEwan, Patrick J. "Cost-Effectiveness Analysis Of Education And Health Interventions In Developing Countries". *Journal of Development Effectiveness* 4.2 (2012): 189-213.
- Mcpake, B., Edoaka, I., Witter, S., Kielmann, K., Taegtmeier, M., Dieleman, M., Cometto, G. (2015). 'Cost-effectiveness of community-based practitioner programmes in Ethiopia, Indonesia and Kenya' in *Bulletin of the World Health Organization*, 93, 631–639. <https://doi.org/10.2471/BLT.14.144899>
- Mgbakor, M., Iyobor, O., & Okezie, U. (2013). 'Contributions of Mass Media to the Development of Agricultural Extension in Ika North East LGA of Delta State, Nigeria' in *Academic Journal of Plant Sciences*, 6(3), 127-133.
- Musgrove, P. and Fox-Rushby, J., (2006). Cost-effectiveness analysis for priority setting. In: D.T. Jamison et al., eds. *Disease control priorities in developing countries*. 2nd ed. New York: The World Bank and Oxford University Press, 271–286.
- Naugle, D. A., & Hornik, R. C. (2014). 'Systematic Review of the Effectiveness of Mass Media Interventions for Child Survival in Low-and Middle-Income Countries' in *J HEALTH Commun.*, 19(1), 190–215. <https://doi.org/10.1080/10810730.2014.918217>
- Neumann, P., Thorat, T., Zhong, Y., Anderson, J., Farquhar, M., Salem, M., Sandberg, E., Saret, C., Wilkinson, C. and Cohen, J. (2016). 'A Systematic Review of Cost-Effectiveness Studies Reporting Cost-per-DALY Averted' in *PLOS ONE*, 11(12), p.e0168512.
- Nglazi, M., Bekker, L., Wood, R., Hussey, G., Wiysonge, C. (2013) 'Mobile phone text messaging for promoting adherence to anti-tuberculosis treatment: a systematic review' in *BMC Infectious Diseases* 13(566).
- Nkonki, L.L., Lumbwe, L. C., Aviva, A. T., & Karen, K. H. (2017) 'Modelling the cost of community interventions to reduce child mortality in South Africa using the Lives Saved Tool (LiST)' in *BMJ Open*, 2017. 7(8): p. e011425.
- OECD (2010) DAC Guidelines and Reference Series Quality Standards for Development Evaluation.
- Ory, M., Smith, M.L., Mier, N., and Wernicke, M.W. (2010). 'The Science of Sustaining Health Behavior Change: The Health Maintenance Consortium' in *American Journal of Health Behavior* 34(6): 647-659.
- Paintain, L. S., Awini, E., Addei, S., Kukula, V., Nikoi, C., Sarpong, D., Manyei, A.K., Yayemain, D., Rusamira, E., Agborson, J. & Baffoe-Wilmot, A. (2014). 'Evaluation of a

- universal long-lasting insecticidal net (LLIN) distribution campaign in Ghana: cost effectiveness of distribution and hang-up activities in *Malaria journal*, 13(1), 71.
- Palladium (2015) 'Financial Forecast Model v1.6 - Tanzania 2015_05_27 SMS+IVR.' Last edited 27/10/2015. Unpublished.
- Palmer, T and Darabian, N (2017) Creating scalable, engaging mobile solutions for agriculture. A study of six content services in the mNutrition Initiative portfolio. GSMA.
- Pelletier, DL., Frongillo Jr, EA., Schroeder, DG., Habicht, JP. (1995) 'The effects of malnutrition on child mortality in developing countries' in *Bulletin of the World Health Organization* 73(4), 443–448.
- Pew Research Center. (2015) 'Cell phones in Africa: Communication lifeline' Technical Report.
- Population Services International (2015) PSI IMPACT CALCULATOR. Retrieved from <http://impactcalculator.psi.org/>
- Puett, C., Salpéteur, C., Lacroix, E., Zimunya, S. D., Israël, A. D., & Aït-Aïssa, M. (2014). "Cost-Effectiveness Of Community Vegetable Gardens For People Living With HIV In Zimbabwe in *Cost Effectiveness and Resource Allocation* 12(1), p.11.
- Rice SJC, Craig D, McCormick F, Renfrew MJ, Williams AF. (2010). 'Economic evaluation of enhanced staff contact for the promotion of breastfeeding for low birth weight infants' in *International Journal of Technology Assessment in Health Care* 26: 133–40.
- Rokicki, S., Cohen, J., Salomon, J., Fink, G. (2017) 'Impact of a text-messaging program on adolescent reproductive health: A cluster randomized trial in Ghana' in *American Journal of Public Health* 107(2), 298-305.
- Sabin, L. L., Knapp, A. B., Macleod, W. B., Phiri-Mazala, G., Kasimba, J., Hamer, D. H., & Gill, C. J. (2012). Costs and Cost-Effectiveness of Training Traditional Birth Attendants to Reduce Neonatal Mortality in the Lufwanyama Neonatal Survival Study (LUNESP). *Of America PLoS ONE*, 3(74). <https://doi.org/10.1371/journal.pone.0035560>
- Schreinemachers, P., Patalagsa, M.A., Islam, M.R., Uddin, M.N., Ahmad, S., Biswas, S.C., Ahmed, M.T., Yang, R.Y., Hanson, P., Begum, S. and Takagi, C., (2015). 'The effect of women's home gardens on vegetable production and consumption in Bangladesh' in *Food Security*, 7(1), pp.97-107.
- Schreinemachers, P., Patalagsa, M.A., Uddin, M.N. (2016) Impact and cost-effectiveness of women's training in home gardening and nutrition in Bangladesh, *Journal of Development Effectiveness*, 8:4, 473-488, DOI: [10.1080/19439342.2016.1231704](https://doi.org/10.1080/19439342.2016.1231704)
- Scott, R (2012) mAgri Infographic. GSMA.
- Self, J., Kederah, E., Grant, F., Wamalwa, M., Hu, J., Low, J., Cole, D. and Levin, C. (2014). 'Financial costs of Mama-SASHA; a project to improve health and nutrition through an integrated orange flesh sweet potato production and health service delivery model' in *The FASEB Journal*, 28(1).

Shillcutt, S. D., Walker, D. G., Goodman, C. A., & Mills, A. J. (2009). 'Cost-Effectiveness in Low-and Middle-Income Countries: A Review of the Debates Surrounding Decision Rules' in *Pharmacoeconomics*, 27(11), 903–917. <https://doi.org/10.2165/10899580-000000000-00000>

Sondaal, F. V., Browne, J. L., Amoakoh-Coleman, M., Borgstein, A., Miltenburg, A. S., Verwijs, M. and Klipstein-Grobusch, K. (2016). Assessing the Effect of mHealth Interventions in Improving Maternal and Neonatal Care in Low-and Middle-Income Countries: A Systematic Review. *PLoS ONE*, 11(5). <https://doi.org/10.1371/journal.pone.0154664>

Sood S. and Nambiar D. (2006) 'Comparative cost effectiveness of the components of a behavior change communication campaign on HIV/AIDS in North India' in *J Health Commun* 11(Suppl 2):143-62. DOI: 10.1080/10810730600974837

Stewart, R, Langer, L, Da Silva, RN, and Muchiri, E (2016). 'Effects of training, innovation and new technology on African smallholder farmers' economic outcomes and food security', *3ie Systematic Review Summary 6*. London: International Initiative for Impact Evaluation (3ie).

Svensson, J., Yanagizawa, D. (2009) 'Getting prices right: the impact of the market information service in Uganda' in *Journal of the European Economic Association* 7(2-3), 435-445.

The Lives Saved Tool. (2017). HOW LiST WORKS - The Lives Saved Tool. Retrieved May 16, 2017, from <http://livessavedtool.org/how-list-works>

The World Health Organisation (2013). Micronutrient deficiencies. Retrieved from <http://www.who.int/nutrition/topics/idd/en/>

The World Health Organisation (2008). Indicators for assessing infant and young child feeding practices. Retrieved from http://apps.who.int/iris/bitstream/10665/43895/1/9789241596664_eng.pdf

The World Health Organisation (2004) *Global Burden of Disease 2004 update: disability weights for diseases and conditions*. Geneva.

The World Health Organisation (2003). *WHO GUIDE TO COST-EFFECTIVENESS ANALYSIS*. Geneva: WHO, Web. 5 Apr. 2017. Making Choices In Health.

The World Health Organisation (2001) Report of the WHO Commission on Macroeconomics and Health.

Tsiboe, F. (2015) *Cost-Benefit Analysis Of The Cocoa Livelihoods Program In Sub-Saharan Africa*, University of Arkansas.

United Nations (2015) United Nations Dar Es Salaam (Tanzania) General Service Category - Annual Salaries and Allowances (in thousands of Shillings) Effective 1 October 2015. United Nations: Salaries, Allowances, Benefits and Job Classifications. Salary Scales for Staff in the General Service and Related Categories. [Accessed 03/04/2017]. http://www.un.org/Depts/OHRM/salaries_allowances/salaries/tanzania.htm

Victoria, CG., de Onis, M., Hallal, PC., Blossner, M., Shrimpton, R. (2010) 'Worldwide timing of growth faltering: Revisiting implications for interventions' in *Pediatrics* 125(3), e473–e480.

Vosti, S.A., Engle-Stone, R., Luo, H., Kagin, J., Clermont, A., & Walker, N. (2017) 'From Dietary Adequacy for Vitamin A in Children and Folate in Women to Children's Lives Saved in Cameroon: A Bioeconomic Model to Inform Cost-Effective Policy Choices' in *The FASEB Journal*, 31(1 Supplement): p. 312.3-312.3.

Waddington, H. and White, H. (2014). *Farmer field schools for improving farming practices and farmer outcomes in low- and middle-income countries*. [online] Available at: <http://dx.doi.org/10.4073/csr.2014.6> [Accessed 20 Apr. 2017].

Witter, S., Adjei, S., Armar-Klemesu, M., & Graham, W. (2009). 'Providing free maternal health care: ten lessons from an evaluation of the national delivery exemption policy in Ghana' in *Global Health Action*, 2(1). <http://doi.org/10.3402/gha.v2i0.1881>

World Bank (2013) Country Data, Tanzania. <http://data.worldbank.org/country/tanzania>

World Bank (2017) The World Bank in Tanzania, Overview. <http://www.worldbank.org/en/country/tanzania/overview>

Yang, H., Duvall, S., Ratcliffe, A., Jeffries, D., & Stevens, W. (2013). 'Modeling health impact of global health programs implemented by Population Services International' in *BMC Public Health* 13(2). <https://doi.org/10.1186/1471-2458-13-S2-S3>

Zerfu, T., Umata, M. and Baye, K. (2016). 'Dietary diversity during pregnancy is associated with reduced risk of maternal anemia, preterm delivery, and low birth weight in a prospective cohort study in rural Ethiopia' in *American Journal of Clinical Nutrition* 103(6), pp.1482-1488.

Zurovac D, Larson BA, Sudoi RK, Snow RW (2012) 'Costs and Cost-Effectiveness of a Mobile Phone Text-Message Reminder Programmes to Improve Health Workers' Adherence to Malaria Guidelines in Kenya' in *PLoS ONE* 7(12): e52045. doi:10.1371/journal.pone.0052045

Annex A Terms of reference

PO 6420: External evaluation of mobile phone technology based nutrition and agriculture advisory services in Africa and South Asia

Introduction

DFID (Research and Evidence Division) wishes to commission an external impact evaluation of mNutrition, a mobile phone technology based nutrition and agricultural advisory service for Africa and South Asia. mNutrition is a programme supported by DFID that, through business and science partnerships, aims to build sustainable business models for the delivery of mobile phone technology based advisory services that are effective in improving nutrition and agricultural outcomes.

mNutrition is primarily designed to use mobile phone based technologies to increase the access of rural communities to nutrition and agriculture related information. The initiative aims to improve knowledge among rural farming communities especially women and support beneficial behaviour change as well as increasing demand for nutrition and agriculture extension services. The mNutrition initiative launched in September 2013 will work in 10 countries in Africa (Cote d'Ivoire, Ghana, Malawi, Mozambique, Nigeria, Tanzania, Kenya, Rwanda, Uganda, Zambia) and four countries in South Asia (Bangladesh, India, Pakistan and Sri Lanka). The desired impact of mNutrition will be improved nutrition, food security and livelihoods of the poor.

Mobile phone based services have been endorsed by WHO as an effective strategy for behaviour change and for driving adherence to anti-retroviral treatment protocols (Horvath, Azman, Kennedy and Rutherford 2012). There is currently scant evidence on the impact and cost-effectiveness of mobile phone technology based services for nutrition and agriculture and on the sustainability of different business models for their provision. A rigorous evaluation of mobile phone technology based nutrition services would add significantly to the current evidence base. An external evaluation team managed by the Evaluator, independent of the programme delivery mechanism, will conduct an assessment of the impact, cost-effectiveness and sustainability of mobile phone technology based information and behaviour change messages for nutrition and agriculture.

Background to mNutrition

Introduction

Undernutrition is a major challenge to human and economic development globally. It is estimated that almost one billion people face hunger and are unable to get enough food to meet their dietary needs. Agriculture is a major source of livelihood in many poor countries and the sector has a potentially critical role in enhancing health, specifically maternal and child health and nutritional status. A well-developed agriculture sector will deliver increased and diversified farm outputs (crops, livestock, non-food products) and this may enhance food and nutrition security directly through increased access to and consumption of diverse food, or indirectly through greater profits to farmers and national wealth. Better nutrition and health of farmers fosters their agricultural and economic productivity. Current agricultural and health systems and policies are not meeting current and projected future global food, nutrition and health needs.

Despite major investment in agricultural and nutrition research and its uptake and application, there is significant social and geographic inequality in who benefits from these investments.

Furthermore, in many developing countries, public extension systems for agriculture, health and nutrition are inefficient, have limited capacity and have a poor track record of delivery, especially in terms of supporting women and girls and the most marginalised populations (Alston, Wyatt, Pardey, Marra and Chan-Kang 2000; Anderson 2007; IFPRI 2010; Van den Berg and Jiggins 2007).

Several research and mobile network operators (MNOs) are testing a range of information and communication technology (ICT) solutions for improving access to a wide range of information and advisory services. Mobile phone based technologies are among the most promising ICT strategies, although current initiatives in nutrition are relatively small and fragmented.

What is mNutrition?

Enhancing access to the results of nutrition and agricultural research and development is potentially critical for improving the nutrition, health and livelihoods of smallholders and rural communities. mNutrition will harness the power of mobile phone based technologies and the private sector to improve access to information on nutrition, health and agricultural practices especially for women and farmers (both male and female). Specifically, mNutrition will initiate new partnerships with business and science to deliver a range of services including:

- An open-access database of nutrition and agriculture messages for use in mobile phone based communication (for example, information and behaviour change messages on practices and interventions that are known to have a direct impact on nutrition or an indirect impact via for example agriculture);
- A suite of mobile phone based nutrition and agriculture information, extension and registration services designed to: improve knowledge and generate beneficial behaviour change in nutrition and agriculture; increase demand for nutrition, health and agriculture goods and services; register and identify target populations for support; and, using real-time monitoring, support the conduct of nutrition risk assessments by community health workers.

The impacts of mNutrition are expected to include improved nutrition, food security and livelihoods of the poor, especially women in 10 countries in Africa (Cote d'Ivoire, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Tanzania, Uganda and Zambia) and 4 countries in South Asia (Bangladesh, India, Pakistan and Sri Lanka). This impact will result from the increased scale and sustainability of mobile phone based nutrition and agricultural-based information services, delivered through robust public private partnerships in each country.

mNutrition has two major outcomes. One outcome will be cost-effective, sustainable business models for mobile phone enabled nutrition and agriculture services to 3 million households in 10 countries in Africa and 4 countries in South Asia that can be replicated in other countries. Linked to this outcome, the second outcome will expect these services to result in new knowledge, behaviour change and adoption of new practices in the area of agriculture and nutrition practices among the users of these mobile phone based services.

These outcomes will be achieved through four outputs:

- Improved access to relevant mobile based health, nutrition and agricultural advisory services for 3 million poor people and community health workers across 10 SSA and 4 Asian countries;
- Launch and scaling of mobile phone based health, nutrition and agricultural advisory services targeted to poor people and community health workers;
- Generation and dissemination of high quality research and evidence on the impact, cost-effectiveness and sustainability of mobile phone based advisory services in nutrition and agriculture in South Asia and SSA; and
- Development of locally relevant content for mobile phone technology based agriculture and nutrition services meeting demands from users and community health workers.

In terms of promoting behaviour change and/or adoption of new practices, mNutrition will seek to achieve changes in one or more of the following areas:

- Adoption of new agricultural practices that are nutrition sensitive, improve agricultural productivity and utilise post-harvest technologies
- Changes in nutrition practices in either one or several knowledge domains including improved maternal nutrition practices during pregnancies; infant and young child feeding practice; and micro-nutrient supplementation to children at risk (i.e. Vitamin A, Zinc and Oral Rehydration Solution (ORS)).

mNutrition has started implementation from September 2013. For the 2 countries selected for the impact evaluation (Tanzania and Ghana), mobile network operators and content providers have been identified through a competitive process during the first half of 2014. The MNOs and content providers started developing and launching their services during the 4th quarter of 2014 and early 2015. The mobile phone based advisory services are expected to run at least till 3rd quarter of 2018.

mNutrition Project Coordination

DFID support to mNutrition will be channelled to GSMA, as well as directly to this associated independent external impact evaluation. GSMA is a global body that represents the interests of over 800 mobile operators. GSMA already works with the major mobile operators across Africa, (including Airtel, MTN, SafariCom/VodaCom) with a collective mobile footprint of more than 67% of total African connections. GSMA has a number of existing development initiatives, including mHealth and mFarmer, that are part of GSMA's Mobile for Development which brings together mobile operator members, the wider mobile industry and the development community to drive commercial mobile services for underserved people in emerging markets. GSMA will provide technical assistance to mobile phone operators, and support new partnerships with content providers to develop and scale up new nutrition and agriculture message services. GSMA will ensure sharing of best practices and promote wider replication and uptake of effective business models.

Objective and Main Questions

The objective of this work is to conduct an external evaluation of the impacts and cost-effectiveness of the nutrition and agriculture advisory services provided by mNutrition compared to alternative advisory services available in the two selected countries (Ghana and Tanzania), with particular attention paid to gender and poverty issues. The impact assessment is required to answer the following questions that relate to impact, cost-effectiveness and commercial viability:

- What are the impacts and cost-effectiveness of mobile phone based nutrition and agriculture services on nutrition, health and livelihood outcomes, especially among women, children and the extreme poor?
- How effective are mobile phone based services in reaching, increasing the knowledge, and changing the behaviour, of the specific target groups?
- Has the process of adapting globally agreed messages to local contexts led to content which is relevant to the needs of children, women and poor farmers in their specific context?
- What factors make mobile phone based services effective in promoting and achieving behaviour change (if observed) leading to improved nutrition and livelihood outcomes?
- How commercially viable are the different business models being employed at country level?
- What lessons can be learned about best practices in the design and implementation of mobile phone based nutrition services to ensure a) behaviour change and b) continued private sector engagement in different countries?

Further evaluation questions related to other aims of mNutrition will be addressed in at least 1 country (either Ghana and/or Tanzania):

- Are mobile phone based services a cost-effective way to register and identify at risk populations to target with nutrition support?
- Are mobile phone based services a cost-effective way for community health workers to improve the quality and timeliness of data surveillance (a core set of nutrition-related indicators)?

The content for the mobile phone based advisory services will be based on international best practices and widely endorsed protocols (i.e. by the World Health Organisation) and evidence-based nutrition-sensitive agricultural practices identified by international experts. Through an iterative multi-stakeholder process, international and country experts will localise and adapt the content to make it relevant to the specific target audience in the 14 countries. The adapted content and nature of messages is expected to vary across specific target audiences within and across countries. The main purpose of assessing the relevance of the content is not to evaluate the overall health and nutrition content but on how this content has been localised and adapted and to what extent the needs of the specific target groups within their particular context have been met.

In assessing the commercial viability, it is recognised that evaluating the sustainability/long-term financial viability of the mobile phone based advisory services will be difficult as mobile network operators may not be willing to provide this potentially commercially sensitive information. Therefore, GSMA will provide support through its access to aggregated confidential financial results of the mobile network operators providing the service. GSMA will provide a financial summary report on the commercial viability of the business models without compromising the commercial sensitivity of the data for the mobile network operators. The evaluator will assess and validate commercial sustainability through an analysis of the aggregated information provided by GSMA and additional qualitative business analysis approaches.

The Evaluator has the option of proposing refinements of the existing evaluation questions during the inception phase as part of developing the research protocol. These suggestions will be considered by the Steering Committee and an independent peer review during the review of the research protocol as part of the inception phase.

Output

The output of this work will be new and robust evidence on the impact, cost-effectiveness and commercial viability of mobile phone based advisory services focusing on nutrition and agriculture delivered by public and private partners, and including the development of robust methodological approaches to impact assessment of phone based advisory services.

Recipient

The primary recipient of this work will be DFID, with the beneficiaries being GSMA, governments, international agencies, foundations, MNOs and other private companies and civil society involved in policies and programmes in nutrition and agriculture that are aimed at improving nutritional, health and agricultural outcomes. The findings of this impact evaluation are intended as global public goods.

Scope and timeline

The scope of this work is to:

- Develop a research protocol for the external evaluation of mNutrition;
- Design and undertake an external evaluation of mNutrition in two countries: Ghana and Tanzania;

- Contribute to the communication of the learning agenda, evaluation strategy and evaluation results.

The evaluation will be in two of the 14 mNutrition target countries; Ghana and Tanzania. These countries have been selected based on the phased start-up of mNutrition programme activities. The focus and approach in the two respective countries will be different allowing for a comparison of the effectiveness of approaches applied. In Tanzania, mNutrition will focus on mobile phone technology based nutrition and health services and registration and identification of target population. In Ghana, the mobile phone technology will focus on nutrition and agriculture sensitive services.

In terms of coverage in number of people being targeted for these services, in total 3 million people will be reached through mNutrition; including 2 million for nutrition sensitive agriculture advisory messages in 4 Asian and at least 2 African countries and about 1 million beneficiaries for mobile phone based nutrition services in 10 countries in SSA.

The evaluation contract period will be September 2014 to 31st December 2019. The development of the research protocol must be completed by month 4 for review and approval by DFID. Full details on tasks and deliverables are provided in sections below.

Statement on the design of the mNutrition evaluation

The evaluation design is expected to measure the impact, cost-effectiveness and commercial viability of mNutrition, using a mixed methods evaluation design and drawing on evidence from two case study countries and the M&E system of the programme. Overall, the proposed design should ensure that the evidence from the two case study countries has high internal validity and addresses the priority evidence gaps identified in the Business Case. Being able to judge the generalisability/replicability of lessons learned from the programme is of equal importance and so a credible approach to generalisation and external validity will be an important component of the overall evaluation design. The final evaluation design and methodology to generate robust evidence will be discussed in detail with DFID and GSMA before implementation.

For assessing cost-effectiveness, the Evaluator will further fine-tune their proposed evaluation approach and outline their expectations in terms of data they will require from implementers. A theory based evaluation design, using mixed methods for evaluating the impact has been proposed. During the inception phase, the Evaluator will put forward a robust evaluation design for the quantitative work, either an experimental or a quasi-experimental method, with a clear outline of the strengths and limitations of the proposed method relative to alternatives. During the inception phase, the Evaluator is also expected to identify clearly what will be the implications of the design for implementers in terms of how the overall programme would be designed and implemented and for evidence to be collected in the programme's monitoring system. The Evaluator will also assess the degree to which it is realistic to assess impacts by early 2019 for a programme where implementation started mid 2015 and, if there are challenges, how these would be managed.

The Evaluator, in its 6 monthly reports, will be required to provide information to feed into the DFID Annual Review and Project Completion Report of mNutrition.

Gender and inclusiveness

The impact evaluation will pay particular attention to gender and other forms of social differentiation and poverty issues. From current experiences, it is clear that access to and use of mobile services is differentiated along a range of factors, including gender, poverty, geographic marginalisation, education and illiteracy levels. Therefore, the impact evaluation

will look at and analyse differentiated access to and potential utilisation of mobile phone based services for improved nutrition and agricultural production. Based on the findings, it will identify opportunities and challenges in having an impact on women in general and more specifically the poor and the marginalised.

Tasks

The Evaluator will perform the following tasks:

A. Finalise a coherent and robust evaluation approach and methodology based on their proposal (inception phase)

- Conduct landscape analysis of existing experiences in mobile phone based services for nutrition and agriculture based on available publications and grey project documents to identify additional critical lessons and priorities for evidence gathering and programme design and implementation;
- Ensure that gender issues and poverty issues are well integrated into the impact evaluation design;
- Develop robust sampling frameworks, core set of indicators and research protocols that allow the consistent measurement and comparison of impacts across study countries, taking into account differences in business models and programmes as needed;
- Work closely with mNutrition programme team in GSMA to familiarise them with impact assessment methodology, discuss evaluation approaches, identify and agree on data provided by programme monitoring system and possible modifications to design;
- Identify risks to the evaluation meeting its objectives and how these risks will be effectively managed;
- Review existing evaluation questions and if deemed relevant propose refinement of existing questions and/or add other questions;
- Prepare a research protocol, including an updated workplan, project milestones and budget. The research protocol will be subject to an independent peer review organised by DFID; and
- Develop a communication plan.

B. Implement and analyse evaluations of impact, cost-effectiveness and commercial viability in accordance with established best practices

- Based upon the agreed evaluation framework, develop and test appropriate evaluation instruments which are likely to include data collection forms for households, community health workers, service providers including health and agricultural services, content providers and private sector stakeholders including mobile network operators. Instruments will involve both quantitative and qualitative methods;
- Register studies on appropriate open access study registries and publish protocols of studies where appropriate;
- Conduct baselines and end-lines, qualitative assessments and business model assessments in both of the two impact evaluation countries;
- Conduct and analyse the evaluations and present findings in two well-structured reports addressing the evaluation questions. The reports should follow standard reporting guidelines as defined by, for example, the Equator Network. Primary findings should be clearly presented along with a detailed analysis of the underlying reasons why the desired outcomes were/were not achieved;
- The Evaluating Organisation or Consortium may subcontract the administration of surveys and data entry, but not the supervision of those tasks, study design, or data analysis; and
- The country-specific mixed methods evaluation reports, cost effectiveness and business models studies and final evaluation report will be subject to an independent peer review organised by DFID.

C. Contribute to the communication of the learning agenda, impact evaluation strategy, and evaluation results.

- Develop a communication plan outlining the main outputs and key audiences;
- Conduct lessons learnt workshops in each of the 2 impact evaluation countries and key dissemination events; and
- Assist in communicating the results of the evaluation and contribute to the development and communication of lessons learnt about mobile phone based extension approaches in nutrition and agriculture.

Deliverables

The Evaluator will deliver the following outputs⁸:

During the design and study inception phase of maximum 4 months:

- A publishable landscape analysis report highlighting lessons learnt from existing initiatives on mobile phone based advisory services related to nutrition and agriculture by month 4;
- An updated work plan with project milestones and budget by end of month 1 (possibly adjusted based on the approved research protocol by month 4);
- A communication plan outlining the key outputs, audience and timeline for review and approval by month 4; and
- A full research protocol by month 4 for review and approval. The research protocol should be registered with appropriate open access study registries;

Interim reports:

- 4 biannual progress reports for the External Evaluation as a whole, and for each country evaluation, against milestones set out in the workplan;
 - Two desk reviews submitted by June 2016
 - Two Baseline quantitative reports submitted by April 2017
 - Two Baseline qualitative reports submitted by February 2017
 - Two Cost-effectiveness reports 1 submitted by March 2017
 - Two Business Model reports 1 submitted by March 2017
 - Two Mixed Methods Baseline reports completed by September 2017
 - Two Midline qualitative reports submitted by March 2018
- All survey data collected during the evaluation provided in a suitable format to DFID for public release.

At project's end:

- Two Endline quantitative reports submitted by June 2019
- Two Endline qualitative reports submitted by August 2019
- Two Cost-effectiveness report 2 submitted by July 2019
- Two Business Model report 2 submitted by July 2019
- Two Evaluation reports submitted by October 2019
- At least 1 article, based on the findings from the country evaluation reports, published in a research journal;
- A shared lesson learnt paper published and at least one presentation highlighting key lessons for similar initiatives of promoting mobile based technologies for providing extension services and the promotion of uptake of technologies by December 2019.

Research protocol and all final reports will be independently peer reviewed. This will be organised by DFID. Outputs are expected to be of sufficiently quality so that a synthesis of findings can be published in a leading peer-reviewed journal.

⁸ Exact timeframe of deliverables will be agreed on during the design phase as appropriate.

Coordination and reporting requirements

A mNutrition Advisory Group (AG) will be established for the programme which will a) provide technical oversight and b) maximise the effectiveness of the programme. The Advisory Group will meet on a bi-annual basis and comprises of representatives of DFID, NORAD and GSMA representatives and independent technical experts. The Evaluator will be managed by DFID on behalf of the mNutrition Advisory Group. The Evaluator will work closely with the mNutrition programme team in GSMA and its specific country implementing partners. The Evaluator will:

- Ensure coherence and lesson learning across all pilot impact assessments on the key evaluation questions and indicators identified.
- Incorporate a clear code of ethics; incorporate plans for open access publications and public access to data sets.

The Evaluator will work closely with the mNutrition project management team, in particular in the design of the overall evaluation framework and the evaluation plan for the specific project components and the countries selected for the evaluation. Collaboration and regular communication between Evaluator and mNutrition project management team and implementing partners in selected case study countries is crucial as the evaluation design may have implications for project implementation and vice versa. The mNutrition project management team will lend support in communication as requested by the Evaluator or the Advisory Group. The Evaluator will report directly to DFID who will manage the evaluation on behalf of the mNutrition Advisory Group. The main point of contact for technical matters is Louise Horner, Livelihoods Adviser and Hugh McGhie, Deputy Programme Manager for all other project related issues. The mNutrition Advisory Group will be the arbiter of any disputes between the evaluation function and the overall programme implementation.

At the end of each 6 months, the Evaluator will submit a brief report outlining key achievements against the agreed deliverables. Pre-agreed funding will then be released provided that deliverables have been achieved.

In addition to the 6 monthly reports outlined above, the Evaluator will provide information to feed into the DFID Annual Review of mNutrition. The 6 monthly reports will be a key source of information used to undertake the Annual Review and Project Completion Report for the programme. These reviews will be led by the Livelihoods Adviser and Deputy Programme Manager, in consultation with the mNutrition AG. All reviews will be made available publicly in line with HMG Transparency and Accountability Requirements.

Mandatory financial reports include an annual forecast of expenditure (the budget) disaggregated monthly in accordance with DFID's financial year April to March. This should be updated at least every quarter and any significant deviations from the forecast notified to DFID immediately. In addition the Evaluator will be required to provide annual audited statements for the duration of the contract.

Contractual Arrangements

The contract starts in September 2014 and will run till end of December 2019 subject to satisfactory performance as determined through DFID's Annual Review process. Progression is subject to the outcome of this review, strong performance and agreement to any revised work plans or budgets (if revisions are deemed appropriate).

A formal break clause in the contract is included at the end of the inception period. Progression to the implementation phase will be dependent on strong performance by the Evaluator during the inception period and delivery of all inception outputs, including a revised proposal for implementation period. Costs for implementation are expected to remain in line with what has been agreed upon for this contract, with costs such as fee rates fixed for contract duration. DFID reserves the right to terminate the contract after the inception phase if it cannot reach agreement on the activities, staffing, budget and timelines for the implementation phase.

DFID reserves the right to scale back or discontinue this assignment at any point (in line with our Terms and Conditions) if it is not achieving the results anticipated. The Evaluator will be remunerated on a milestone payment basis. DFID has agreed an output based payment plan for this contract, where payment will be explicitly linked to the Evaluator's performance and effective delivery of programme outputs as set out in the ToR and approved workplan. The payment plan for the implementation phase will be finalised during the inception period.

Open Access

The Evaluator will comply with DFID's Enhanced and [Open Access Policy](#). Where appropriate the costs of complying with our open access policy should be clearly identified within your commercial proposal.

Branding

The public has an expectation and right to know what is funded with public money. It is expected that all research outputs will acknowledge DFID support in a way that is clear, explicit and which fully complies with DFID Branding Guidance. This will include ensuring that all publications acknowledge DFID's support. If press releases on work which arises wholly or mainly from the project are planned this should be in collaboration with DFID's Communications Department.

Duty of Care

The Evaluator is responsible for the safety and well-being of their Personnel (as defined in Section 2 of the Contract) and Third Parties affected by their activities under this contract, including appropriate security arrangements. The Evaluator is responsible for the provision of suitable security arrangements for their domestic and business property. DFID will share available information with the Evaluator on security status and developments in-country where appropriate.

The Evaluator is responsible for ensuring appropriate safety and security briefings for all of their Personnel working under this contract and ensuring that their Personnel register and receive briefing as outlined above. Travel advice is also available on the FCO website and the Evaluator must ensure they (and their Personnel) are up to date with the latest position.

The Evaluator has confirmed that:

- The Evaluator fully accepts responsibility for Security and Duty of Care.
- The Evaluator understands the potential risks and have the knowledge and experience to develop an effective risk plan.
- The Evaluator has the capability to manage their Duty of Care responsibilities throughout the life of the contract.

Annex B Insights into the analysis from the literature

B.1 Definitions and process of analysis

Cost-effectiveness

Cost-effectiveness has been taken as a measure of an intervention's value for money. The aim is to analyse which interventions can provide the best possible outcomes at the least cost. The aim is to save valuable and finite resources. It is differentiated from Cost-Benefit Analysis, as the gains of the project are non-monetary and therefore the measurement will be given as the number of dollars that yield a certain health benefit, a certain decrease in malnutrition, or any other measures of non-monetary impacts of the intervention.

Measuring health benefits

'Cost-effectiveness analysis (CEA) is increasingly considered in public health decision making in low- and middle-income countries (LMICs), as reflected in the growing number of published studies. It has been used in several prioritization exercises, such as the World Bank Health Sector Priorities Review (HSPR), the WHO Choosing Interventions that are Cost-Effective (WHO-CHOICE) initiative, the second edition of the Disease Control Priorities Project (DCP2) and the Copenhagen Consensus. The ceiling ratio (λ), or decision rule, is an important component of CEA, representing a decision maker's valuation of a unit of health gain, or the relative value against which the acceptability of incremental cost-effectiveness ratios (ICERs) is judged. The value of λ that is appropriate may be heavily contingent upon epidemiological, medical, political, ethical, cultural, budgetary and other factors, and therefore is likely to vary across time and space, but is usually chosen arbitrarily in practice' (Shillcut et al., 2009).

The WHO (2003) created guidelines for a generalised cost-effectiveness analysis that allows health interventions to be compared against one another, based on their ability to diminish the global burden of disease at the least cost. The benefits of health interventions are measured in Disability Adjusted Life Years (DALYs) averted, which allows for the Years of Life Lost (YLL) to a specific disease to be combined with the Years Lived with Disability (YLD), weighted for the severity of the disability caused. Wasting and Stunting, for example, are calculated as 0.053 and 0.002 of YLL respectively (WHO, 2004). DALYs caused by an inadequate diet would therefore be the YLL plus the YLD caused by wasting and stunting, as well as other disabilities caused by malnutrition including iodine deficiency, vitamin A deficiency and iron deficiency anaemia, each multiplied by their respective weighting.

To calculate the cost-effectiveness of a health intervention, the total costs are divided by the number of DALYs averted. The World Health Organization (WHO) Commission for Macroeconomics and Health (WHO 2001) has provided the following guideline for thresholds of cost-effectiveness:

- *'An intervention is considered very cost-effective, if the monetary amount spent on the intervention per disability-adjusted life year (DALY) saved is less than the per capita gross domestic product (GDP) for the nation in which the intervention is applied.'*

- *An intervention is considered (moderately) cost-effective, if the monetary amount spent on the intervention per DALY saved is less than three times the per capita GDP.*
- *An intervention is not cost-effective if, per DALY saved, its cost is greater than three times the per capita GDP.'*

A health intervention in Tanzania, for example, would be considered very cost-effective if one DALY is saved for US\$860 (World Bank, 2013) and cost-effective if one DALY could be saved for US\$2,590. This allows different outcomes of a myriad of health projects to be compared to one another.

The WHO guidelines, although very useful, do not directly enable decision makers to choose the most cost-effective option, as several interventions may be considered within the cost-effective threshold. It is therefore desirable to directly compare interventions with other similar options. An average cost-effectiveness ratio compares the intervention to the 'base-case scenario, or 'doing nothing' (World Bank, n.d.). However, due to the wide variation in costing methodologies (See Annex C.2) and measured impacts found in the literature, an incremental cost-effectiveness analysis would be inaccurate, and we will therefore conduct an average cost-effectiveness analysis, seeking to enumerate our results in cost per DALY averted. This can then be compared to other interventions as seen in (Neumann, 2016) with an acknowledgement of variation in methods.

The Lives Saved Tool (LiST) was developed by the Johns Hopkins Bloomberg School of Public Health, and can estimate changes in mortality rates and other health outcomes linked to changes in prevalence of health risk factors that may arise from interventions. The tool contains up to date national contextual data, which allows intermediate outcomes to be converted into final ones using detailed population, demographic and burden of disease data. The model can predict the outcome of, for example, an increase in rates of exclusive breastfeeding, vaccinations, skilled birth attendance at delivery and other factors. It can therefore predict the mortality outcomes from certain behaviour changes. The LiST model is described in more detail in Annex B.6. It has been used in the cost-effectiveness analysis of several interventions reviewed in the literature, including Herrick et al., 2017, Nkonki, 2017 and Vosti et al., 2017, among others.

Given the aim of the cost-effectiveness component is to compare the intervention with other alternatives, we will seek to define the outcomes in terms of DALYs and would therefore aim to use the PSI calculator (Annex B.7) to convert the LiST results into DALYs averted.

Measuring Costs

Equally as important as the measurements of effectiveness, are the costs of the intervention considered. Including the costs to beneficiaries, for example, can have massive impacts on any cost-effectiveness analysis.

Cost-effectiveness results may depend on the choice of comparator, the costs included, and assumptions made in estimating total health benefits. For example, home-based care is often more expensive than care at an outreach clinic or at the health facility when the costs included are estimated from a health services perspective, and any direct or indirect costs incurred by families are ignored. Similarly, the cost-effectiveness of life-saving interventions may substantially under-estimate the resources required to reduce maternal and neonatal

mortality if the cost of demand- and supply-side strategies are not considered. As one study demonstrated, there was an eightfold increase in the cost per facility-birth when the full costs of the health promotion activities were included in the cost-effectiveness calculations' (Mangham-Jeffries, 2014).

Costing techniques within the literature generally fall into two categories; the societal or the provider perspective. The societal perspective accounts for costs, regardless of whom the costs fall upon, whether inside or outside the official budget of the intervention. A provider perspective includes only the costs borne by the intervention provider. Within the literature, there was also variation within these two categories of costing technique (see Annex C.2). This means, for example, that the labour cost of volunteer health workers would be included in costs from a societal perspective, but not from a provider perspective. In interventions that rely heavily on volunteer support, a provider perspective type of cost-effectiveness analysis would discount the considerable labour of unpaid workers. Although this perspective may still be useful for healthcare providers, a societal perspective would provide a broader consideration of the costs of the intervention.

The WHO (2003) recommends the ingredients approach to costing; in this method (1) all programme resources (or 'ingredients') are identified, (2) each ingredient is assigned a value (including its opportunity cost), (3) the values are then adjusted for inflation, time-value (since costs incurred in the future are worth less to society than those incurred in the present), and currency, and (4) the values are aggregated (McEwan, 2012 in Evans and Popova, 2015). The ingredients method can be approached from either the societal or the provider perspective, certain ingredients are simply not included if only calculating from the provider perspective.

The WHO recommends counting the costs for an intervention from the moment of its inception. This includes research and development costs and start-up costs, defined as; 'the period between deciding to implement an intervention and starting to deliver it to the first beneficiary'. Capital investments, such as building and vehicles, must be added together with the start-up costs and annualised over the period of the intervention. Other start-up costs may include staff training and content development. The extent to which these resources are utilised must also be considered, for example a van, or personnel, may operate outside of the intervention as well as inside. Therefore, incorporating an entire salary, or the cost of the whole van would be an overestimation of cost.

Once start-up costs are considered, the recurrent costs of establishing, evaluating and running an intervention should be considered. These include costs to the implementer of the intervention, and costs to the beneficiaries. Costs to beneficiaries may include the cost of transport to reach an intervention, the costs of time and labour spent on an intervention, or the cost of new inputs or practices necessary to take part fully in the intervention. Finally, further costs that may need to be included are the potential costs of scaling up an intervention, rolling it out to more remote areas, or costs of adding or removing individual services from bundled interventions.

Evans and Popova (2015) also assert that researchers should be aware of 'pilot bias' when conducting a cost-effectiveness analysis. The cost of a pilot is usually considerably higher than a scaled-up programme, and impacts can vary considerably when the programme is implemented on a wider scale. Possible variations in cost according to the scale of the project must be considered.

Another potential challenge is 'recall bias'. Costs estimated using qualitative methods following the event are often estimated as lower than in actuality.

B.2 Factors to be considered in analysis

Discount Rates

It is important to remember that in the majority of interventions, benefits will not be seen for some time. The costs incurred in each year cannot simply be summed without any adjustment. 'Individuals and society prefer to pay costs in the future rather than now, so from today's perspective, a cost of \$100 payable after 10 years is not seen to be as high as a cost of \$100 payable today. The present value of \$100 payable in 10 years is, therefore, less than \$100. Discounting is the process of converting future costs to their present value, to reflect the fact that, in general, individuals and society have a positive rate of time preference for consumption now over consumption in the future. For comparability across studies, it is important that analysis is performed using a common discount rate. For that purpose, WHO-CHOICE uses a discount rate of 3% for the base case, as suggested in a number of guidelines. A discount rate of 6% is also explored using sensitivity analysis. If country analysts wish to use country-specific rates of return of long-term government bonds as the social discount rate for costs, they may do this using sensitivity analysis' (WHO, 2003).

The discount rate for health projects is usually 3%, (WHO, 2017). While some studies did not use a discount rate (e.g. Fiedler & Semakula 2014), most of the key references used a rate of 3% (e.g. Sabin et al., 2012, Baltussen et al., 2008); only one reference was found to use a different rate of 4% (Chola et al., 2015). The argument for a constant or zero rate of discounting is that interventions are not aimed at making a profit, but improving standards of living, and the concept of longitudinal equity states that society should make allocation decisions in such a way that present and future cohorts are treated equally, regardless of when they come into existence (Datz and Welch, 1993). Therefore, curing an illness in the future has the same value as curing one now.

Adjusting for contextual changes

Again, if the benefits of an intervention are only seen after several years, the value of a currency may be less at the time of measuring benefits than at the time of the initial costs. This is particularly true of developing countries, where inflation rates are often high. Similarly, costs accrued in different currencies must be converted to one currency, in one year.

Complex interventions

Most of the interventions studied in the literature will have multiple outcomes, even if the study only measures a single outcome of interest. For example, in a study of malaria prophylaxis, Gonzalez et al., (2000) measured changes in deaths and disability from malaria, but they did not measure associated improvements in livelihoods that would be expected to result from improved health outcomes.

Some of the projects studied in the literature also have multiple impacts. For example, Hutchinson (2006) studied a national health communication programme using multimedia

campaigns including a nationally broadcast television serial drama supported by radio, television, newspaper, and billboard advertisements as well as local promotion activities. Hidrobo et al., (2014) studied different mechanisms for providing support to refugees (cash, vouchers, or food), but each was implemented in combination with nutrition sensitisation trainings and recipes. Different approaches were taken to calculate the costs of producing those outcomes:

- *Apportion total intervention costs to outcomes by activity.* For example, Hutchinson (2006) measured the effect of billboards, posters and pamphlets to encourage the use of a package of family health services. They measured the use of three health services: antenatal care and child vaccines for DPT3 and measles. They used the distribution of visits by activity to clinics as a rough approximation of the appropriate share of the national costs for each of these activities – from survey data. Costs are apportioned to four primary activities: family planning, maternal health, child health and other health. Antenatal services are costed by the maternal health activity, and the two vaccines are both costed by the child health activity. Chee et al., (2004 and 2006) also apportion costs by outcome indicator, but there is no discussion of this in the paper – costs are imported from another source.
- *Use the same intervention cost for each outcome.* For example, Sood et al., (2006) measured the effect of a mass media (TV) campaign on three different behaviour changes among the population: increased condom use, increased knowledge of HIV, increased interpersonal communication. The cost-effectiveness calculations assumed the same cost for producing each outcome – the total intervention cost. Since they were comparing different kinds of interventions as opposed to different kinds of outcomes, there is no discussion of this assumption. Hidrobo (2014) also uses the same intervention cost for different outcomes. The study measured the cost-effectiveness of three different interventions (cash transfer, food vouchers and food) on three outcomes (15% increase of HDDS, FCS and Dietary Diversity Index (DDI)). There is no discussion of this approach, but it is likely that because the three outcomes are all measures of nutrition that they cannot be disaggregated. This is also the case for Puett (2014) who also measures two nutrition outcomes and uses the same intervention cost for each.

In none of these studies has any attempt been made to disaggregate the effects of the individual components of these interventions – all activities included in the project design have been treated as a discrete intervention. There are two reasons why this could be the case:

- There is no sound methodology for disaggregating the effect of linked, composite activities;
- There is synergy (or reinforcing effect) between components designed to work together whereby the impact of the bundle exceeds the sum of the impacts that each component might yield in isolation.

Sensitivity Analysis

Sensitivity analysis is necessary as, evidently, there are many plausible combinations of the numbers used to conduct the analysis. As stated earlier, the discount rate is a subject of debate, and therefore must be varied to understand the full scope of possibility of the CER.

Definitions of cost may also vary widely. There may be several plausible ways to value the cost of beneficiary time, for example, or arguments for different costs to be included or excluded from analysis. Therefore, sensitivity analysis must be conducted using different measurements of cost. Finally, different methods of calculating benefits must be considered in sensitivity analysis. This may include using 95% confidence intervals of the effect size, for example, or it may include considering different benefits, such as knowledge gained. Evans and Popova (2016) suggest that there are confidence intervals within almost every ingredient used in cost analysis, and every measure of impact. This can lead to wide variation in methods of cost-effectiveness. In this case, all potential figures should be recorded (at a 90% confidence interval), multiple simulations of cost-effectiveness should be created and the proportion of models that suggest cost-effectiveness should be counted to allow for an intuitive measure of an intervention's cost-effectiveness. This creates a probability figure of an intervention being cost-effective when placed against a specific benchmark, for example the most cost-effective alternative option, or the WHO criteria of cost-effectiveness. This is known as the Monte Carlo method (Evans and Popova, 2015). Alternatively, sensitivity analysis can simply allow for an optimistic and pessimistic measure of cost-effectiveness for any intervention.

B.3 Assessing Costs

Budgets

Several projects (Waddington and White, 2014, Mauceri et al., 2007, Harris et al., 2013, Tsiboe et al., 2015) used the project budget to account for costs and divided per household. Budgets and expense reports can account for several more concrete measures of costs, such as equipment and staff salaries.

These published budgets, however, rarely account for the full cost of a project. Projects often use resources outside of their budget, such as public services and beneficiary labour, which must be accounted for in order to understand the full cost of a project. Furthermore, at the times when budgets are created, there are usually considerable expenses sunk into the project; into the design, budgeting and research stages. Nonetheless, budgetary information can inform one 'ingredient' of the total costs of the project.

Research and Development Costs

Of all the studies, only one made an attempt to include research costs, even if these were based on estimates only (De Steur et al., 2012). Several other studies explicitly stated that they had not included research and development costs (e.g. Hoddinot et al., 2012, Zurovac, 2012). The problem with research costs is that every project utilises past research and knowledge, as does every individual involved in the project. Research is often not carried out with any specific project in mind, for example systematic reviews may inform a project, and have considerable costs, but these costs cannot be directly linked to the project. To attempt to account for all of these costs would be impossible, but the research behind any intervention is not free and therefore some decision as to what aspects of research costs may be considered must be made. Usually, this extends only as far as research carried out with the explicit aim of informing the intervention in question.

Estimations using Qualitative Data

The problem of research costs brings up another key issue; that of shared costs between institutions and interventions. In the case where professionals may be working on multiple projects, for example, it may not be clear how much of a professional's time is taken up by a particular project. In this case, qualitative interviews are required to clarify the cost of labour used by a project. Puett et al., 2014, Schreinemachers et al., 2015, and Self et al., 2014 all used key informant interviews to estimate the percentage of working time staff spent on a particular project in order to ascertain staff labour costs. This was also used to estimate the proportion of rent or vehicle costs used on a particular intervention by a particular organisation. Qualitative interviews may also be necessary to determine public services used during the project.

Beneficiary Costs

Costs to beneficiaries will rarely be found in project budgets and reports, but are integral to any measure of cost-effectiveness. Women's labour is usually necessary for projects to achieve outcomes, and has an associated opportunity cost. For example, women need to make time to attend antenatal care, or to cook nutritious food using more complicated recipes. Labour costs were quantified in a number of ways in the literature. Schreinemachers et al., (2015), for example, considered the opportunity cost of women's time spent on training and home gardening, valuing it at half the average minimum daily wage in rural Bangladesh. Some studies made allowances for labour involved in caring for sick children e.g. Gonzalez (2000).

Health Service Provider Costs

Many health interventions involve some form of community volunteers such as community health workers, and traditional birth attendants. In these cases, the time that they contribute voluntarily towards project activities has an opportunity cost. Several studies counted only the time of workers to attend the trainings but did not account for the time taken to apply the new practice and gain the improved yields (Self et al., 2014). In their study of the Ethiopian Millennium Rural Initiative, Curry et al., (2013) speculate that opportunity costs of volunteer health workers' time were not included in the costs used, and emphasise that labour costs are likely to be significant as they account for a high proportion of the care provided at primary health care facilities. Similarly, Sabin et al., (2012) highlight that the time provided voluntarily by traditional birth attendants was not quantified.

B.4 Cost-effectiveness Metrics used in the Literature

The studies identified by the formal, 'bounded' literature review identified 170 relevant cost-effectiveness data points, from studies on varying intervention types and with differing study purposes. Although these studies used a range of cost-effectiveness metrics, it is DALYs averted that are clearly most commonly users – see Table 7.

Table 7 Cost-effectiveness data points by outcome measure

Outcome measure (only those with ≥ 4 counts included)	Count
DALYs averted	60
QALYs gained	12
Deaths averted	12
People increasing condom use	6
Cases of stunting averted	6
Mothers adopting exclusive breastfeeding	5
Mothers adopting breastfeeding within first hour of birth	5
HDDS	4
Cases of child malnutrition averted	4
Lives saved	4

DALYs averted framework

As we can see, DALYs averted is the most common metric. This is not surprising given its emphasis by WHO.

DALYs are a combination of years of life lost (YLL) to a certain disease, combined with years lived with disability (YLD) caused by a certain disease which are multiplied by their weighting in the global burden of disease study. This weighting is chosen based on the severity of the disability caused by any given condition, with a weighting of 1 being equivalent to death, and 0 being perfectly healthy. Wasting and Stunting, for example, are calculated as 0.053 and 0.002 of YLL respectively (WHO, 2004).

The difference in incidence of a particular disease following an intervention (or the difference in difference) between an intervention and control group, would be used to calculate the DALYs averted. This is sometimes based on a single disease, or several, depending on the outcomes measured by the study.

Chola et al., (2015), for example, measures only the DALYs averted by reduction in incidence of diarrhoea following a breastfeeding peer counselling programme. This leads to the very high cost per DALY averted of \$11,353. However, the authors acknowledge that other outcomes from exclusive breastfeeding are likely, including a reduction in incidence of stunting, wasting and many other diseases. Similarly, Sabin et al., (2012) measures DALYs averted directly from reductions in neonatal mortality, and does not include disabilities that could be caused by poor delivery practices, and averted by the training of traditional birth attendants. In both cases, the ability of the study to capture the full cost-effectiveness is limited by the measured outcomes.

Other studies take advantage of the ability of the DALYs metric to quantify the combined averted burden of several diseases. Self et al., (2015) assess the combined DALYs averted by stunting, wasting, vitamin A deficiency, anaemia, diarrhoea, and mortality for children <2 years and their mother. Fiedler et al., (2014) examines the cost-effectiveness of child health week in Uganda by assessing DALYs averted from vitamin A supplements, deworming and

measles vaccinations. The metric accounts for the differences in severity between diseases, and therefore show overall burden on health, rather than on a specific disease. It also enables the cost-effectiveness of the programme to be directly comparable to a range of health interventions, as league tables of various cost-effectiveness interventions, based on the cost per DALY averted, have already been created.

Cost-effectiveness According to Intermediate Health Outcomes

Several studies estimated the cost-effectiveness of an intervention based on intermediate health outcomes. Although further impacts were often not measured, it is assumed that changes in such intermediate practices will lead to wider health impacts, as supported by other literature. Measures included:

Cost per behaviour change: This metric incorporated both changes in rates of exclusive breastfeeding, and complementary feeding practices to give a cost per change in infant and young child feeding practices (Baker et al., 2006).

Cost per month of exclusive or predominant breastfeeding: The cost per additional mother breastfeeding following the intervention, times by the average increase in months of breastfeeding (Chola et al., 2015).

Cost per compliant woman: This metric was taken from a study aiming to increase compliance in Malaria chemoprophylaxis during pregnancy. The metric measures the cost per woman to remain on the drugs during her pregnancy, and the incremental cost of education and coating tablets to make them more palatable (Helitzer- Allen et al., 1993).

Cost per additional skilled delivery/ facility delivery/ caesarean: The cost per additional facility delivery used by Hatt et al., (2010) and Witter et al., (2009) measures the cost of successfully encouraging a mother to deliver in a health facility. This, again infers health impacts from evidence linking facility delivery to maternal and neonatal health. Hounton and Newlands (2012) estimate the cost of a skilled delivery, which may be at home or in a health facility and again, infers wider health impacts.

Other possibilities include Cost per new ANC user; Cost per person/ child sleeping under a net; Cost per additional facility delivery; Cost per household with improved dietary diversity; Cost per household with improved food security; Cost per additional caesarean; Cost per additional facility delivery.

Outside of health, it is more difficult to compare the cost-effectiveness of different outcomes of interventions. 'Most social interventions pursue multiple objectives. It is possible that an intervention is the most cost-effective option for increasing one outcome, but not another' (McEwan, 2012). It is only possible to compare projects when the outcomes are measured in the same units. Education projects, for example, can be compared by their impact on test scores within one country. For example, McEwan (2012) conducted an 'experimental impact evaluation of a programme that provided merit scholarships for adolescent girls who scored well on examinations. The average treatment effect was 0.12 standard deviations (a common metric for expressing test score gains). The incremental cost per pupil was \$1.69, implying a Cost-effectiveness Ratio (CER) of \$1.41 per 0.1 standard deviations. The author calculated CERs for other interventions, using other Kenyan experimental evaluations, including a teacher incentive programme, textbooks and flipchart provision, and school-based deworming. The effect of some interventions could not be statistically distinguished

from zero in the impact evaluation, implying an infinite CER, and removing them from consideration. The CERs suggest that scholarships and teacher incentives are similarly cost-effective (\$1.41 and \$1.36 per 0.1 standard deviations, respectively), and much more so than textbook provision (\$5.61 per 0.1 standard deviations).’ Here, however, a cost-effectiveness ratio cannot be considered a complete measure of an interventions value, as projects may have other effects outside of the measured outcome. School based deworming, for example, may have health benefits even if it does not impact test scores.

However, it is possible, to extrapolate data from achievement of one outcome and convert it into another. Poverty Action Lab (2012), for example, ‘compares the cost-effectiveness of multiple interventions in reducing the incidence of child diarrhoea, a final outcome. Two experiments only report effects on an intermediate outcome: change in water chlorination rates. The CEA used descriptive data to inform its assumptions about the relationship between chlorination rates and eventual incidence of diarrhoea (in McEwan, 2012). Drummond et al., (2005), Gold (1996) and Musgrove and Fox-Rushby (2006) all provide examples of the use of regression modelling to convert short term impact evaluations into measurements of an interventions long term impact on health.

B.5 Types of costing approach

The following typology of costing approaches has been drafted from key references identified in the literature review (Drummond 1987, Levin, n.d., Mogyorosy 2005, Conteh 2004, McEwan 2012).

Type of Costing	Description
Absorption costing	Both fixed and variable costs are taken into account in cost calculations. Used for valuing total cost of goods or services – as in most CEAs.
Marginal costing	Only marginal costs are taken into account, fixed costs are ignored. Used to calculate cost of one additional unit of service.
Differential costing	Assesses the differences in revenues and costs between relevant alternatives. Used to decide between two or more different products or services.
Direct costing	Overhead costs are allocated to a final cost centre (department, programme, budget line etc.) based on calculated proportions. Interaction between costs centres are ignored.
Step down cost accounting (SDCA)	Costs of each overhead department are allocated, one by one, to all other overhead departments, then to the final cost centres, thus partially adjusting for interactions of overhead departments.
Activity based costing (ABC)	Indirect costs (primarily personnel time) allocated to products and services by first defining the main activities on which personnel in an organisation spend their time. Recommended for healthcare costing as it better estimates actual costs of processes and services.

Ingredients based costing	A standardised approach to report cost data which clearly distinguishes quantities of specific inputs and their unit costs – rather than reporting total costs from budget sheets. Promoted by the WHO. There is a software called CostItt which provides a template for ingredients costing.
Programme experience costing	Generated unit cost data that captures all aspects of service delivery from actual programmes in operation. Tends to yield higher costs than ingredients based, but usually based on more realistic assumptions, including wastage and other inefficiencies.
Mark up approach	Uses real accounting data from one year of operation of the intervention and extrapolates to find the full cost of the intervention.

B.6 The Lives Saved Tool (LiST)

The lives saved tool (LiST) can help to model the impact of a project on overall health indicators, where only intermediate outcomes are available (Mangham- Jeffries et al., 2014). 'The Lives Saved Tool (LiST), developed by the Institute for International Programs at Johns Hopkins Bloomberg School of Public Health and funded by the Bill & Melinda Gates Foundation, is a model that estimates the impact of scaling up health and nutrition interventions on maternal, newborn, and child health. LiST is a part of Spectrum, a software package maintained by Avenir Health. The model been used for over 10 years and is regularly updated to incorporate the latest evidence from the scientific literature and household survey data.

The accompanying database for LiST includes national levels of coverage for health, nutrition, water, sanitation, and hygiene interventions; mortality rates and cause of death distributions; and data on key risk factors such as stunting, wasting, adverse birth outcomes, disease prevalence, and micronutrient deficiencies. This information is updated frequently and is available for over 120 countries. It can also be supplemented with user-entered data to reflect more recent local information, or to model the impact of coverage change for subnational regions. Effectiveness estimates for every LiST intervention are maintained to reflect the latest research. The LiST model estimates cause specific mortality and other health outcomes based on changes in intervention coverage and prevalence of risk factors. Mortality reductions or 'lives saved' can be attributed proportionally to specific interventions as they are scaled up.

LiST, housed within the broader Spectrum software package, facilitates the incorporation of detailed demographic data and in-depth analysis of HIV/AIDS and family planning through the DemProj (Demographic Projection), AIM (AIDS Impact Model), and FamPlan (Family Planning) modules. A number of other tools have been added and provide LiST users with options for additional analysis. Examples include the Missed Opportunities Tool, which helps to prioritise interventions by displaying the impact of each intervention individually scaled up to 90% coverage, and the Equity Tool, which shows the impact of interventions scaled up to the coverage level of the wealthiest quintile of population within that country. The LiST Costing Tool allows users to quickly produce a general estimate of some costs associated with the coverage scale-up plan in their projection. The LiST Subnational Wizard helps users create models at the regional, district, or county level. Finally, the dynamic LiST Visualizer

(list.cherg.org) presents the conceptual framework behind LiST, as well as the data sources for coverage and effectiveness values in a web-based format that does not require downloading the software' (LiST, 2017). Several studies have compared the LiST projections with actual reductions in mortality of specific projects, and concluded that LiST is a useful tool for estimating mortality reduction (Hazel et al., 2010, Larsen et al., 2011).

B.7 The PSI Impact Calculator

Population Services International (PSI) uses the LiST tool to calculate the impact of their projects. However, the LiST model does not calculate DALYs averted by a given intervention, but rather calculates lives saved or years of stunting averted. This makes it more difficult to compare the cost-effectiveness of the intervention compared with those using the WHO's Cost per DALY averted framework.

PSI only calculates the impact for certain intervention, but the framework can be used for all outcomes calculated by LiST. One example is the calculation of deaths and DALYs averted per facility delivery:

The following description of steps in running the model are drawn from the impact calculator website⁹:

- Step 1: Running a projection in the Lives Saved Tool (LiST)
 - LiST is a multi-cause mortality model developed by Johns Hopkins Bloomberg School of Public Health that estimates the number of deaths averted (or lives saved) through the scale up of maternal and child health interventions.
 - PSI begins by running a projection in LiST for select countries. We model multiple interventions simultaneously in order to capture the impact of the full range of interventions available at a facility delivery with a skilled attendant. In LiST, this includes: clean birth practices, immediate assessment and stimulation, labour and delivery management, magnesium sulphate for management of eclampsia, and active management of the third stage of labour. In this projection, access to all of these interventions is increased from the current, country-specific baseline to 100% at the "Essential Care" level of delivery in LiST. LiST then projects the number of deaths averted among neonates and mothers by this increased level of coverage.
 - Step 1 Output: Number of additional deaths averted (or lives saved) among mothers and neonates if coverage of SBA is increased from baseline to 100%.
- Step 2: Estimating deaths averted per facility delivery
 - PSI uses the step 1 output (deaths averted at 100% coverage of skilled birth attendance) to estimate the number of deaths averted by a single attended birth in a facility. To do this, we divide the number of deaths averted by increasing to 100% coverage by the number of additional facility deliveries needed to reach 100% coverage of births. PSI estimates the number of facility deliveries needed to reach 100% coverage using a number of parameters, including baseline coverage of the interventions and the number of births in a year.
 - Step 2 Output: Maternal and neonatal deaths averted coefficient for SBA.

⁹ <http://impactcalculator.psi.org/intervention/390>

- Step 3: Estimating DALYs averted per facility delivery among mothers and neonates
 - A DALY (or disability adjusted life year) includes two components: years of life lost due to premature death (YLL) and years lived with disability (YLD). DALYs averted are in turn comprised of YLLs averted and YLDs averted or, put simply: death and disability that is prevented by PSI interventions.
 - To estimate YLLs averted per facility delivery among mothers and neonates, PSI first estimates the number of years of life lost per death among mothers and neonates due to the causes impacted by the interventions. This includes: maternal sepsis, maternal haemorrhage, hypertensive disorders of pregnancy, preterm birth complications, neonatal encephalopathy, and sepsis and other infectious disorders of the newborn baby. This is equal to the life expectancy at the average age of death from each of these causes. Age-specific life expectancies are taken from the 2010 Global Burden of Disease study (GBD 2010). The number of years of life lost per maternal and neonatal death is then multiplied by the number of deaths averted per facility delivery among mothers and neonates (maternal and neonatal deaths averted coefficients), calculated in step 2 above for a selected country. This gives us the YLLs averted per facility delivery.
 - To estimate YLDs averted per facility delivery among mothers and neonates, we use a YLD/YLL ratio, based on the 2010 GBD. This ratio represents the relative number of years lived with disability for every year lost due to death from the maternal or neonatal causes. We apply this ratio to the number of YLLs averted per facility to estimate the number of YLDs averted per facility delivery among mothers and neonates.
 - Finally, YLLs averted and YLDs averted are added together to estimate the number of DALYs averted per facility delivery among neonates.
 - Step 3 Output: Maternal and neonatal DALYs averted coefficient for Skilled Birth Attendance.’ (Population Services International, 2015).

The number of DALYs averted, divided by the total cost of the project provides a measure of cost-effectiveness that fits the WHO criteria, and can therefore be deemed very cost-effective, cost-effective or not cost-effective according to WHO criteria. It can also be compared to other nutrition, maternal and neonatal health, and other interventions.

The challenge of evaluating the cost-effectiveness of mHealth this way is that to include the impact of, for example, increased facility delivery, the model must also include the cost of the facilities used. Therefore, the cost per person of facility delivery, doctors time and other factors must also be included to gain a full picture of the costs associated with the possible averted DALYs (PSI, 2015, Yang et al., 2013).

Annex C Comparable Interventions

C.1 Overview of literature

As stated in the main report, Wazazi Nipendeni is a project hoping to influence multiple outcomes. It is unlikely that any other project will be aiming to influence an identical combination of outcomes, but there are many projects hoping to influence similar combinations of outcomes, or single outcomes from within the group. This section will examine the existing information on the cost-effectiveness of interventions designed to improve maternal and newborn health.

The aim of the literature review was to explore both methods of cost-effectiveness analysis and comparable cost-effectiveness of different health interventions. Two approaches were taken. In a more formal search, 38 studies meet key criteria, with 170 relevant cost-effectiveness data-points. The studies are listed in a supporting document and there is an accompanying Excel database, along with a range of metadata and a list of all cost data identified in the sources for use in 2019. In a broader, less bounded approach, several different combinations of search terms were used.

In this section, we outline the studies identified, and undertake a short review of the possibilities for use in the final endline comparison. In the more formal search, most of the articles found (26) relate to nutrition interventions, predominantly biofortification (development of plant varieties with enhanced nutrient content, e.g. golden rice), home or industrial fortification, and supplementation (see Table 8). The only studies found from the behaviour change communication search, were related to health communication (6), on a range of topics including HIV/AIDS prevention, infant health and blood pressure reduction. Six studies were found on breastfeeding promotion which relate to both nutrition and behaviour change communication.

Table 8 Studies by intervention type (formal bounded study only)

Intervention type	Count
Nutrition – General / mixed	7
Health communication	6
Nutrition – Biofortification	6
Breastfeeding promotion	6
Nutrition – Fortification	5
Nutrition – Education	3
Nutrition – Supplements	3
Nutrition – Deworming	1
Nutrition – Community-based care	1

Table 9 Studies by region (formal bounded study only)

Region	Count
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South Asia	13
East Africa	7
Latin America	5
South East Asia	5
West Africa	4
Europe	3
Southern Africa	3
Central Africa	2
various - unspecified	2
North America	1

Table 10 Studies by publication date (formal bounded study only)

Publication date range	Count
< 2000	2
2000 - 2004	5
2005 - 2009	15
2010 - 2014	12
> 2014	4

C.2 Costing approaches

The formal, 'bounded' review identified 38 studies covering a wide range of costing approaches due to varying intervention types and study purposes.

- 24 of the 38 studies calculate the **actual costs** of an intervention, while 15 **estimate costs** of a model – either as part of an ex-ante assessment or as a hypothetical exercise. Two of the studies estimate costs of **replication or scale up**, starting with actual costs and removing the development costs.
- 31 of the 38 studies use **financial costing** where they calculate actual cost of goods and services. Of these, five specified that they used ingredients based costing, two specified that they used activity-based costing (ABC), and one mentioned programme experience costing (these and other costing approaches are described in Annex B). Eight of the studies used **economic costing**, which forecasts full economic costs into the future and /or calculates opportunity costs of participants.
- 18 of the 38 studies used a **discount rate** to calculate present value of future costs and benefits, with 11 of these using 3 percent, which is the standard for health interventions. Of the rest, two studies specifically mentioned that they did not use discounting because the intervention timescale was so short (one year usually).
- 16 of the 38 studies reported using **sensitivity analysis** to examine the effect of using different estimated values in the cost-effectiveness calculations. The most common approach is univariate analysis, although one study was found to use multivariate analysis.
- 33 of the 38 studies use USD as the **currency** for costing, while 4 use international dollars. The remaining one used Euros.

The following section draws on both the formal study and informal less bounded study, both of which are available in supporting documentation to this report.

C.3 Types of intervention

In this section, we give an outline of the types of intervention that may produce comparable outcomes and impacts, with a commentary on a cost-effectiveness study that might be drawn on for endline comparability analysis.

Interventions to Avert Malnutrition in Infants

Supplementation has been ranked as an extremely cost-efficient public health intervention by the Copenhagen consensus (2008). However, there are multiple forms of supplementation, which may be delivered in different contexts, with different combinations of micronutrients and at different intervals. **Food Fortification / Industrial Fortification** is considered an extremely cost-effective way to combat micronutrient deficiency across whole populations (Copenhagen Consensus, 2008, WHO, 2017). It has a lot of advantages, including not needing to change existing food patterns, a more 'natural' level of nutrients compared to supplements and an existing delivery system, through the private sector. However, it is important to acknowledge that research and development, often not included in cost-effectiveness analysis, has significant costs in food fortification. 'These typically include start-up costs, the expense of conducting trials for micronutrient levels, physical qualities and taste, a realistic analysis of the purchasing power of the expected beneficiaries, the recurrent costs involved in creating and maintaining the demand for these products, as well as the cost of an effective national surveillance system to ensure that fortification is both effective and safe' (WHO, 2017). Two other types of programme were identified in the literature with sufficient information to enable comparison. A **Nutrition Education programme** in Peru targeting communities with mass media campaigns and working with schools to enhance nutritional education, and **conditional cash transfers** as a measure to prevent malnutrition as part of safety net approach (Waters et al., 2006).

Interventions Promoting Increased use of Healthcare Facilities for Pregnancy, Post-partum and Antenatal Care

Examples from the literature show that interventions have taken a range of different approaches to encourage increased use of healthcare facilities. Many of these interventions were of limited geographical scope, typically being implemented in remote, rural localities. They also focused on different outcomes. Although all addressed improved maternal care, the detailed design of studies focused on different specific interventions including HIV testing, vaccinations, antenatal visits, safe deliveries, emergency care and referrals etc. Examples are outlined below:

- **Improving Clinic Services.** A clear example of analysis has been the Ethiopian Millennium Rural Initiative (EMRI), an 18-month systems-based intervention to improve the performance of 30 primary health care units (PHCU) in rural areas of Ethiopia (Curry et al., 2013).
- **Mobile (travelling) Health Care.** Fox-Rushby and Foord (1995) examined the impacts of a mobile maternal health service in Gambia, at a place called Karantaba. The mobile health services were intended for those far away from existing services, and therefore less likely to attend. 'The aim of this service was to improve maternal care and reduce maternal mortality'.

- **Free Maternal Health Care.** Witter et al.'s (2009) study on a health policy to provide free delivery and caesareans in Senegal (Free Delivery and Caesarean Policy, FCDP). The intervention was costed from the health facility perspective, as this was the source of the policy funding.
- **Vouchers for Maternal Health Care.** Bangladesh's Ministry of Health and Family Welfare (MOHFW) implemented a pilot demand-side financing (DSF) maternal health voucher program in 33 upazilas (sub-districts) around the country. The program distributes vouchers to pregnant women entitling them to access free antenatal, delivery, emergency referral, and post-partum care services, as well as providing cash stipends for transportation and cash and in-kind incentives for delivering with a qualified health provider.
- **The Skilled Care Initiative.** The skilled care initiative in Burkina Faso aimed to increase skilled attendance at birth in low resource settings. 'Five policy priorities were identified as representing real chances of improving the safety of motherhood' (Meda et al., 2008).
- **Training Traditional Birth Attendants.** 'In many areas, traditional birth attendants (TBAs) are an essential source of basic obstetrical care. TBAs have proven effective in a variety of secondary roles in the community, such as serving as peer educators or breastfeeding counsellors, but their proximity to the mother/ infant pair and their location within the community suggests that TBAs could play a more direct role in reducing neonatal deaths as well' (Sabin et al., 2012). This was tested by Sabin et al., (2012) in a randomised control trial in Zambia called the Lufwanyama Neonatal Survival Project (LUNESP).
- **Community Based Practitioner Approaches.** Community-based strategies have the potential to expand access to essential health services, especially in light of critical shortages in the health workforce. McPake et al., (2015) conducted a comparison study of three community practitioner approaches in Ethiopia, Indonesia and Kenya.

Interventions to Promote Beneficial Infant and Young Child Feeding Practices

Chola et al., (2015) evaluated the cost-effectiveness of peer counselling to breastfeeding women with children between the ages of 0-6 months. Breastfeeding can ensure infants receive adequate nutrition in the first few months of life, as well as reducing diarrhoea prevalence as infants are not exposed to unclean water or foods. The qualitative research found that overall, knowledge about breastfeeding is generally good in Tanzania, although there remain a few issues of uncertainty, including the appropriate duration of feeding. 'Complementary feeding is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk' (WHO, 2017). Fabrizio et al., (2014) conducted a systematic review on the effectiveness of interventions to change behaviour regarding complementary feeding practices. They found few studies reporting any measure of cost-effectiveness.

Interventions to promote Net use and anti-Malarials

Malaria during pregnancy is associated with anaemia and other complications of pregnancy, such as an increased likelihood of delivering an underweight baby. Helitzer- Allen et al., (1993) compared interventions designed to encourage compliance with Malaria chemoprophylaxis regimens among pregnant women in Malawi – a non-bitter tasting chloroquine pill, and revised health education messaging.

In 2012, Ghana implemented a national campaign for the mass distribution of long-lasting insecticidal nets (LLINs). The campaign activities included pre-registration of persons and sleeping places, door-to-door distribution of LLINs by trained volunteers, as well as follow-up behaviour change communication activities. The study by Paintain et al., (2014) used outcome measures of number of people using LLINs (adults and children), and under five deaths averted.

Behaviour Change Communication (Methods)

Broadcast media in particular have an unparalleled ability to reach large numbers of people at relatively low cost, but reaching people is not necessarily enough to achieve the health outcomes desired, and Hutchinson & Wheeler (2006) point out that rigorous cost-effectiveness evaluations are rarely carried out. They studied a campaign in Bangladesh that involved radio, television, newspaper, and billboard advertisements and local promotion activities. The intervention aimed to encourage people to access family health services, and the study showed positive links to accessing antenatal care, vaccinations, but it did not measure health outcomes.

In many areas of sub-Saharan Africa, **radio** is the most widely used media format. Radio receivers are at least ten times more common than TV sets in developing countries (Mkbakor, 2013). It is used widely in both health and agricultural information programmes. Development Media International ran the first randomised control trial of a radio health information programme in Burkina Faso, and preliminary results showed significant increases in antenatal care attendance and facility delivery.

Child health weeks are commonly used as a means of providing high impact health services to children under 5. Many countries that initially established campaign-style vitamin A programmes have expanded the scope of activities to include vaccination and deworming, for example. In a study of Child Health Weeks in Zambia, Fiedler (2012) found that although administering vaccinations was relatively expensive compared to delivering vitamin A, the cost per DALY averted was lower. Despite being a very cost-effective intervention (based on the costs included), events can run into difficulties due to lack of funding (Fiedler and Semakula, 2014).

Interventions to increase dietary diversity

'Bio-fortification is the use of traditional crop breeding practices or modern biotechnology to produce micronutrient-dense staple crops to reduce micronutrient deficiencies' (Micronutrient Initiative 2009). Humans require 49 micronutrients to meet their metabolic needs and required intakes have been established (Welch and Graham, 2004). The international research effort on bio-fortification has focused on three micronutrients in particular: iron, zinc and vitamin A (Masset, 2011).

Stewart et al.'s systematic review (2016) found a large positive effect of programmes introducing orange flesh sweet potatoes on farmers' food security. A meta-analysis of five studies in Africa; South Africa (Faber et al. 2002), Mozambique (Low et al. 2007; Hotz et al. 2012b), Kenya (Hagenimana et al. 2009) and Uganda (Hotz et al. 2012a) found an effect size of 0.86, which translated into an increase of 39.8 percent in vitamin A levels among participating farmers. 'The meta-analysis of the three studies that assessed impacts on small holder farmer's income (South Africa (Hofs et al. 2006), Tanzania (Bulte et al. 2014) and Uganda (Matsumoto 2013)) yielded an effect size of 0.26. This represents a 12.4 percent

change in the levels of income among smallholders receiving the input innovation'. Unfortunately, consideration of costs was not present for all studies, yet 'in 2004 OFSP was the cheapest source of vitamin A on the market, costing 1 cent for 700 RAE¹⁰' (Low et al., 2007 in Stewart et al., 2016).

In Kenya, Self et al., (2014, 2015) evaluated the Mama-SASHA project, which aims to improve the health and nutrition of pregnant/ lactating women and children <2 years through an integrated orange-fleshed sweet potato (OFSP) and health service strategy in Western Kenya. Effectiveness data from a quasi-experimental study were used to estimate DALYs associated with changes in vitamin A deficiency, stunting, wasting, anaemia, diarrhoea, and mortality for children <2 years and their mothers. The authors used ingredients based micro-costing to estimate economic costs of agriculture, health and community interventions, including opportunity costs of labour for health workers, community volunteers and participants. Net economic cost over three years was US\$445,000. DALYs averted per year were mostly attributable to improvements in stunting and anaemia. The Incremental Cost-effectiveness Ratio (ICER) was US\$1,919 per DALY averted, which is two times Kenya's GDP per capita (US\$994 per person) and meets cost-effectiveness criteria set by WHO.

'Generally, home gardening refers to the cultivation of a small portion of land which may be around the household or within walking distance from the family home. Home gardens can be described as a mixed cropping system that encompasses vegetables, fruits, plantation crops, spices, herbs, ornamental and medicinal plants as well as livestock that can serve as a supplementary source of food and income' (Galhena et al., 2013). While some similarities exist across the board, each home garden is unique in structure, functionality, composition, and appearance as they depend on the natural ecology of the location, available family resources such as labour, and the skills, preferences, and enthusiasm of family members.

'The cultural acceptance of home gardening is also an important constraint' (Galhena et al., 2013). The cost-effectiveness is therefore highly dependent on the intervention method. A recent review of evidence for home gardening by the UK Department of International Development found 15 papers in English in peer-reviewed journals that had done an impact evaluation in low- or middle-income countries (DFID 2014a). Only seven reported a link between home gardening and micronutrient status, while 10 showed a link between home gardening and increased production and consumption of micronutrient-rich foods. The review mentioned that no cost-effectiveness study has been performed on home garden interventions (in Schreinemachers et al., 2016).

Since the DFID review, Schreinemachers et al., (2016) quantified the impact and cost-effectiveness of training poor rural women in Bangladesh in home gardening and nutrition. Households that had received the intervention harvested an average quantity of 108.7 kg of vegetables and fruit from their home garden. The difference-in-difference estimator suggested a 31.0 kg increase ($p < 0.01$) as a result of the intervention. This additional amount translates into a daily per capita quantity of vegetables of 16.5 g. 'Costs from October 2011 to September 2014 were calculated from project financial reports, project work plans and information obtained from key persons involved in the project'. 'To estimate DALYs saved, the micronutrient intake gap before and after the intervention was first calculated. The intake gap before the intervention is the ratio of current micronutrient intake and recommended nutrient intake (RNI), both based on secondary data published in Nahar et al., (2013)'. 'Based on the estimated reduction in the nutrient intake gaps for iron (4.5

¹⁰ Retinol Activity Equivalents.

percent), vitamin A (100 percent) and zinc (8.0 percent), we assumed a reduction in DALYs by the same percentages. This would mean a total of 122,610 DALYs saved if the intervention could reach all households affected by iron, vitamin A and zinc deficiencies (16.5 million households). Reaching these many households with a home garden intervention, assuming no economies of scale, would cost US\$375.1 million (US\$23.2 × 16.5 million) per year. This implies a cost of US\$3,059 per DALY saved’.

mHealth

There are few evaluations of the cost-effectiveness of mHealth interventions. A 2017 systematic review of mHealth interventions found that the vast majority (87 percent) of studies were conducted in upper or middle income countries, and all studies used different criteria of costs and metrics of economic analysis (Iribarren et al., 2017).

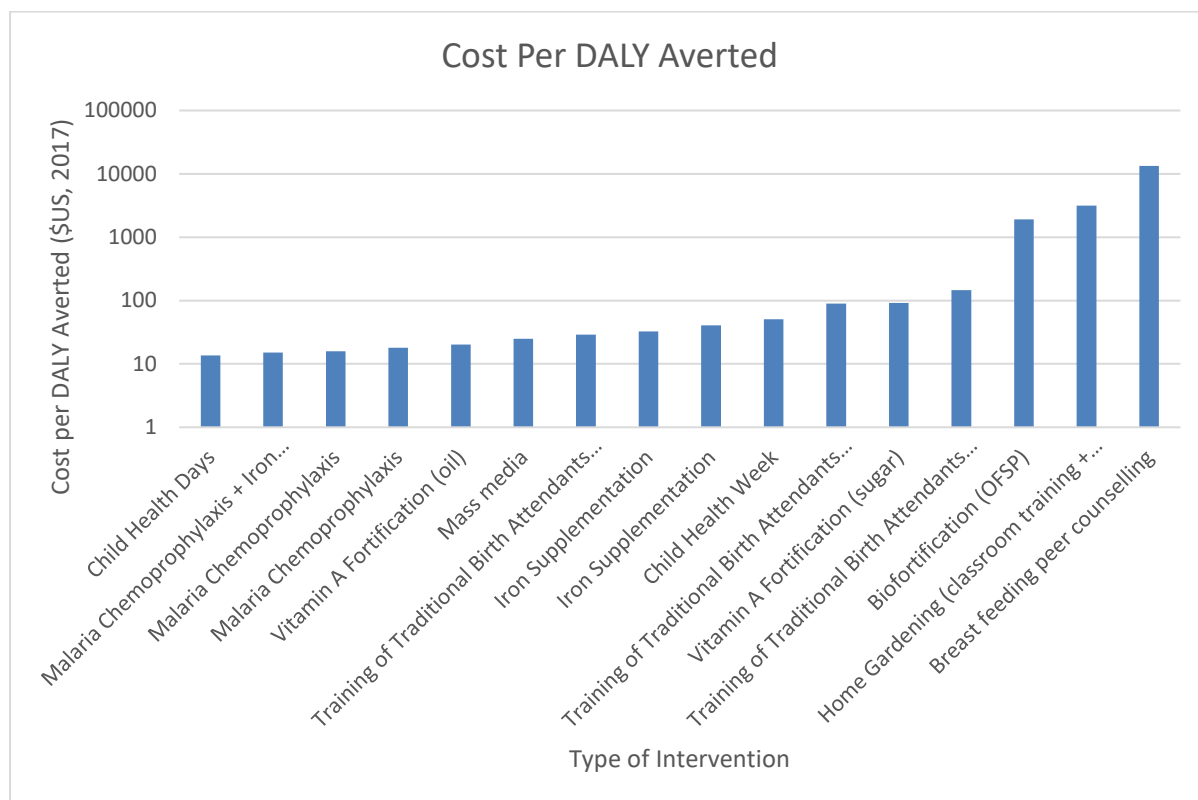
One of the interesting things about mHealth applications is the wide variety of approaches, including appointment reminders (SMS), dissemination of specific health information by SMS or recorded messages, two-way communication (call centres) and emergency toll free numbers. The mHealth Community of Practice in Tanzania, an informal grouping with around 100 members, shared a database inventory of 110 projects. An analysis of these projects showed that the majority of mHealth applications were designed to assist with various administrative tasks e.g. patient data, administration, aggregate data, supply chains, and human resources, although only one quarter are regarded as having reached any kind of meaningful scale.

The Wired Mothers intervention (Zanzibar) combined unidirectional text messaging and direct two-way communication in a free call voucher system to provide education on pregnancy, reminders for antenatal care visits and an emergency medical response system. Sondaal et al., (2016) found decreases in perinatal mortality rates. They also found that most studies do not mention costs, making it difficult to compare the relative cost-effectiveness of programmes.

C.4 Comparison of alternatives

Comparisons of studies of cost-effectiveness of interventions aiming to have similar outcomes to mHealth are difficult. Projects are vastly different; they are designed to achieve different outcomes, different costs are included, and they take place in different countries. Some rely on measurable outcomes, while some attempt to estimate long term impacts over several years. In addition, there are a vast number of different metrics used to estimate cost-effectiveness. Cost-effectiveness studies are also often estimated in different currencies, and in different years. This results in a huge variation in the basis of cost-effectiveness figures calculated, making it difficult to say definitively which health interventions are most cost-effective. To illustrate this, Figure 4 presents figures calculated by 16 studies that presented health benefits in terms of DALYs averted (making them comparable in at least this respect).

Figure 4 Cost per DALY Averted (\$US 2017) (constructed by authors from key references)



Authors own

It should be noted that without the resources to undertake a completely systematic review of the literature it is possible that some significant sources have been missed¹¹. For instance, no studies were found which present cost-effectiveness data for behavioural change communication interventions focusing on similar outcomes as the mNutrition programmes. The nearest were six studies on breastfeeding support programmes (Chee et al., 2006, Chee et al., 2004, Chola et al., 2011, Desmond et al., 2008, Hoddinot et al., 2012, Rice et al., 2010).

¹¹ We welcome pointers to other studies from colleagues.