

UNIVERSITY OF CAPE TOWN



Conducting a Cost Analysis to Address Issues of Budget Constraints on the Implementation of the Indoor Residual Spray Program. An Intervention to Control and Eliminate Malaria in Two Districts of Maputo Province, Mozambique

By

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DECLARATION

I, **Neide Mércia de Orlando Hussene Canana - Guilherme**, hereby declares that Conducting a Cost Analysis to Address Issues of Budget Constraints on the Implementation of the Indoor Residual Spray Program. An Intervention to Control and Eliminate Malaria in Two Districts of Maputo Province, Mozambique's thesis is based on my original work (except where acknowledgements indicate otherwise) and neither the whole work nor a part of it has been, is being, or is to be submitted for another degree purpose in this or any other university.

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Date: 08th February 2018

DEDICATION

This Master's thesis is dedicated to:

God Almighty — my creator; strongest pillar; and source of inspiration, wisdom, knowledge
and understanding.

In memory of my mother. This is for you, Mom: My endless love.

You had no personal dreams, instead, your dreams were to see us, your children triumph.

Thank you for inspiring and encouraging me

ABSTRACT

Introduction: Over the past few years, the capacity of the government of Mozambique to sustain the cost of payment of salaries to operationalize the Indoor Residual Spray (IRS), a widely recommended tool to control and prevent malaria, is facing numerous challenges. This is due to recent restrictions of the Official Development Assistance (ODA), an external aid scheme and the main source of financing of the Mozambican government budget.

Objective: The objective of this study was to estimate the cost of IRS operationalization activities in Matutuine and Namaacha districts health directorates, in Maputo Province, Mozambique.

Methods: A cost analysis using an approach from the provider's perspective was conducted in two district health directorates in the Maputo province, Matutuine and Namaacha. The institutions were purposely selected since in 2014 in both districts the expenditure on salaries to operationalize IRS was funded by the government budget. Cost information was collected retrospectively and both economic and financial costs were calculated. Uncertainty of results was tested using "one-way" deterministic sensitivity analysis.

Results: The average total annual economic cost was 117,351.34 US\$. The average economic cost per households sprayed totalled 16.35 US\$. On average the economic costs per person protected is 4.09 US\$ in total. In the financial analysis, the average total annual financial costs totalled 69,174.83 US\$. The average financial cost per household sprayed and per person protected were 9.84 US\$ and 2.46 US\$ respectively. Vehicles, personnel salaries and consumables were the major substantial cost components.

Conclusion: Setting aside the ODA restriction and focusing on the aim of implementing IRS within the existing resources, the study makes suggestions for improving efficiency by focusing on areas with a higher need and pays attention to cost drivers in order to reduce the costs.

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TABLE OF CONTENTS

DECLARATION	ii
DEDICATION	iii
ABSTRACT	iv
ACKNOWLEDGMENTS	v
LIST OF TABLES AND FIGURES	x
ABBREVIATIONS AND ACRONYMS.....	xi
PART A: THESIS PROTOCOL	1
Introduction	2
Statement of the Problem.....	3
Study Rationale	4
Study Purpose and Benefits	4
Study Objectives.....	5
Mini Literature Review	5
1.1 The Historical Context of the Dependence on Official Development Assistance and the ODA Restriction Context.....	5
1.2 The government Budget Process in Mozambique	8
1.3 Sources of funding for Indoor Residual Spray implementation in Mozambique	9
2.1 Methodology for Estimating Costs in Health Care Interventions	10
Study Methods.....	16
1.1 Study design.....	17
1.2 Study Areas.....	17
2.1 Approach: Conducting the Cost Analysis of IRS Operationalization in Matutuine and Namaacha	18

	Preamble
2.2 Data Analysis	28
Ethical Considerations	29
3.1 Ethics	29
3.2 Dissemination of results	29
Reference List	30
PART B: STRUCTURED LITERATURE REVIEW	37
Introduction	38
Literature Search Strategy.....	38
1.1 Country Context	38
1.2 Theoretical Background of Malaria.....	40
1.3 Theoretical Background of Indoor Residual Spray	45
2.1 Methods for Estimating Costs of Health Care Interventions	47
2.2 Concepts of Cost Analysis and Costs of Health Care Interventions	50
2.3 Review of Studies of Cost Analysis of Interventions to Control Malaria	52
Conclusion	54
Reference List	57
PART C: JOURNAL ARTICLE	63
Abstract.....	64
Introduction.....	65
Material and Methods	65
Results.....	69
Discussion	73
Study Limitation.....	75
Conclusion	76

	Preamble	
Ethical Approval.....		76
Author’s Contributions		76
Authors’ Information.....		76
Competing Interest		76
Reference List		77
PART D: POLICY BRIEF		79
Introduction.....		80
Key Messages.....		80
Study Methods and Results.....		81
Policy Implications and Recommendations.....		82
PART E: APPENDICES.....		84
Appendix 1: References Drawn from Search Strategies		84
Appendix 2: Journal Manuscript Instructions		86
Appendix 3: UCT Ethical Approval Letter.....		90
Appendix 4: Costing Interventions template (Abbreviated).....		91

LIST OF TABLES AND FIGURES

TABLES

Table 1: Approach and Sources for Data Collection.....	20
Table 2: Cost Categories, Components and Sources of Financing	23
Table 3: Methods for Cost Valuation and Estimation of Cost.....	26
Table 4: Assumptions on the parameters of uncertainty	28
Table 5: Economic Evaluation Techniques and Criteria for Measurement of Costs and Consequences.....	50
Table 6: Systematized information from the studies.....	55
Table 7: Economic costs (Total Annual Costs, Costs Per Households (per HH) Sprayed and Costs Per Person (PP) Protected).....	70
Table 8: Financial costs (Total Annual Costs, Costs Per Households (per HH) Sprayed and Costs Per Person (PP) Protected).....	71

FIGURES

Figure 1. Example of a Tornado Diagram.....	16
Figure 2. Essential Steps in Conducting the Cost Analysis.....	18
Figure 3. Distribution of the Average Costs Categories (%).....	72
Figure 4. Distribution of the Average Costs Components (%).....	72
Figure 5. A Tornado diagram summarizing the impact of the “one-way” sensitivity analysis on the annual average economic cost.....	73
Figure 6. A Tornado diagram summarizing the impact of the “one-way” sensitivity analysis on the annual average financial cost	73
Figure 7. Distribution of the average cost categories of IRS operationalization	81
Figure 8. Distribution of the average cost components of IRS operationalization	81

ABBREVIATIONS AND ACRONYMS

CBA	Cost benefit analysis
CEA	Cost effectiveness analysis
CMA	Cost minimization analysis
CUA	Cost utility analysis
DSA	Deterministic sensitivity analysis
DNSP	Direção Nacional de Saúde Pública (National Directorate of Public Health, in Mozambique)
DPSM	Direcção Provincial de Saúde de Maputo (Provincial Directorate of Health in Maputo)
EE	Economic evaluation
GDP	Gross domestic product
HDI	Human development index
ICER	Incremental cost effectiveness ratio
IRS	Indoor residual spraying
ITN	Insecticide-treated net
INE	Instituto Nacional de Estatística (National Institute of Statistics, in Mozambique)
IMF	International Monetary Fund
MAE	Ministério da Administração Estatal (Ministry of State Administration, in Mozambique)
MEF	Ministério da Economia e Finanças (Ministry of Economy and Finance, in Mozambique)
MISAU	Ministério da Saúde (Ministry of Health, in Mozambique)
MZN	Metical (The official currency of Mozambique)
NGO	Non-governmental organization
ODA	Official Development Assistance
PMI	President's Malaria Initiative
PSA	Probabilistic sensitivity analysis
PNCM	Programa Nacional de Controlo da Malária (National Malaria Control Program, in Mozambique)
RBM	Roll Back Malaria
SSA	Sub-Saharan Africa
UN	United Nations
UNICEF	United Nations Children's Fund
WHO	World Health Organization
\$US	United States Dollar

PART A: THESIS PROTOCOL

Introduction

Malaria is the deadliest disease in Mozambique and one of the major contributors to underdevelopment in the country, as a result of the disease's influence on economic productivity. Upon the government of Mozambique recognizing the impact of malaria on population health and country's development, Indoor Residual Spraying (IRS) - a globally recognized intervention to control and prevent the spread of malaria -, was identified by the government as the main strategic tool for malaria control (INE, 2011; DNSP, 2012; RBM, 2017; PNCM, 2017).

Currently, IRS operationalization activities in the country are financed from three main sources, including international and domestic. International funds come mainly through grants from the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) and Non- Governmental Organizations (NGO's) including Good-Bye Malaria; and The Bill and Melinda Gates Foundation. The bulk of domestic funds are from loans from Official Development Assistance (ODA) a scheme of external aid assistance and the main source of funding for the government budget in Mozambique.

However, despite accounting for a significant chunk of the government budget, in the last few years ODA disbursements to the government budget have been restricted (UNICEF, 2016; The Economist, 2016; The World Bank, 2017). Consequently, an immediate issue emerging from this restriction is the severely limited government budget's ability to sustain national commitments, including health care priorities directly financed by the government budget, with the IRS operationalization's activities being no exception (UNICEF Mozambique, 2016a).

Hence, in areas where the government budget fully finances personnel salaries for IRS (including payment of spray operator's salaries and activities such as payment for recruitment and selection of spray operators, training of spray operators, social mobilization, and supervision), IRS operationalization are facing serious challenges. These include a reduction in the number of targeted districts for IRS and delayed spraying for the scheduled period (DPSM, 2017). Thus, in this context it is imperative that the country's healthcare decision-makers are aware of the need to adopt prudent analysis to operate within the available - already inadequate - budget, in order to operationalize IRS activities in the actual context of budget reduction.

Statement of the Problem

The government of Mozambique funds its expenditure through domestic and external aid, however, the main source of funding is the aid that comes from external sources channelled through ODA (MEF, 2016). To illustrate this, through domestic resources, the government of Mozambique is able to finance the government budget at an average of only 23%, meaning that the remaining 77% of it is financed from ODA, including grants (14%) and loan funding (63%) (MEF, 2016). This has been the case for a while. A 2010 UN report shows that in 2008, the ODA financed 56% of Mozambique's government budget expenditure. De Renzio and Hanlon, (2007) show in their study that from 1992 until 2005, grants and loans were the largest flow of financing for the government budget, accounting for more than half at that time.

Despite the heavy reliance of Mozambique on this assistance, ODA funds to the country have been restricted in the last few years due to a breach of ODA disbursement practices by the Mozambican government (UNICEF, 2016; The Economist, 2016; The World Bank, 2017). This restriction is mainly the result of undisclosed government borrowing from donors, bondholders and the public since 2014, which has led to a weakening of trust in the Mozambican government on the part of the donors. This secret borrowing led international institutions funding the government budget, mainly the International Monetary Fund (IMF), to suspend/freeze their aid programs in the country (UNICEF, 2016; The Economist, 2016; The World Bank, 2017).

Hence, in recent years, the government capacity to finance its expenditure, including those related to IRS have deteriorated, and as a result the government has been forced to downsize its efforts to achieve its determined targets (UNICEF, 2016a). To illustrate, in 2016, the government of Mozambique was forced to review targeted activities that were scheduled to be financed by the government budget to reflect the new and lower expected spending levels, resulting in almost 70 planned activities being dropped, including several that were related to health, including the IRS (UNICEF, 2016a and MEF, 2016).

As such, the future of the IRS in the areas where payment of salaries for its operations are fully reliant on the government budget is uncertain, and therefore evidence that will guide decision-making in relation to IRS spending within a context of significantly limited resources is needed.

Study Rationale

Much is known about the morbidity and mortality associated with malaria in Mozambique and the costs and effectiveness of IRS is clearly understood. For example, national reports, including those from INE (2011) and PNCM (2017) were able to report rates of malaria mortality and morbidity in the country, and the study by Conteh et al., (2004) focused on assessing the costs and cost effectiveness of IRS in two regions of the country where IRS is funded from different private initiatives. The study was able to show the costs of IRS in the setting of analysis, making an illustration of the economic and financial costs as well as the costs per person protected by IRS. However, few cases of single cost analysis for IRS operationalization have been drawn up internationally and to date and no single cost analysis for IRS operationalization to inform health care decision makers has been drawn up in Mozambique.

This study will be the first single cost analysis of IRS operationalization and the evidence produced in this study intends to provide decision-makers and managers of the IRS intervention with insight into where they need to pay close attention in future planning in order to operationalize IRS with the existent budget.

Study Purpose and Benefits

While research into the costs of interventions to control malaria has been attracting interest in African settings including Mozambique, there are no single cost analyses of IRS operationalization that intend to inform health care decision makers in Mozambique. This study aims to present the first financial and economic single cost analysis from the provider perspective of IRS operations in Mozambique. It therefore offers an important contribution to the evidence of how much IRS operational costs. It is also believed that this information will be useful for health care decision-makers by assist in improving IRS operationalization in the reality of serious budget restriction scenario.

Study Objectives

Study Aim

The aim of the study is to estimate the costs of IRS operations in Mozambique in the context of budget constraints due to ODA restrictions on the national government budget.

Specific Objectives

1. To conduct a cost analysis in order to estimate economic and financial costs of IRS operations in Maputo province, specifically in the Matutuine and Namaacha districts.
2. To formulate policy recommendations regarding how operationalize IRS intervention in the context of budget constraints due to ODA restrictions on the national government budget.

Mini Literature Review

Introduction

The objective of this literature review is firstly to explain, based on previous literature, why the government budget of Mozambique relies on the ODA, why the ODA has been restricted in the country and how this restriction is affecting IRS expenditure, mainly personnel salaries. Secondly, this mini literature review intends to review the main methods of estimating cost of health care interventions. It is divided into two chapters: The first includes three parts, the context of government budget dependence on ODA, the government budget process in Mozambique and providers of IRS in Mozambique. The last chapter includes, mainly, the methodology for estimating costs of health care interventions.

CHAPTER ONE

1.1 The Historical Context of the Dependence on Official Development Assistance and the ODA Restriction Context

To provide an overview of the restriction and the dependence of the Mozambican government budget on the ODA, it is important to contextualize the historical process of ODA dependence.

In Mozambique, the inflow of ODA support began a few years after the start of the country's 16-year civil war in 1977 (De Renzio and Hanlon, 2007). In those years, the government of Mozambique was economically and politically supported by global socialist blocs, whose

political ethos it aligned with. This socialist influence meant the government prioritized the central management of resources, so that all single companies and services – such as clinics, schools and farms – were nationalized and managed by the state (Batley, 2005; De Renzio and Hanlon, 2007; UN, 2010). However socialist countries were, at that time, facing pressure from international financial institutions such as the IMF and The World Bank to transition from planned to market economy frameworks, which consequently hindered the bloc's ability to support Mozambique financially (De Renzio and Hanlon, 2007; UN, 2010). This also had political consequences. By the beginning of the 1980s, the government of Mozambique began facing difficulty in maintaining policy control and supporting the economy enough to maintain even minimal functioning of state-controlled institutions (De Renzio and Hanlon, 2007; UN, 2010). Evidence from studies by Kulipossa (2006) and Jones (2006) reflected a strong decline in the Mozambican gross domestic product (GDP) in the early 1980s. This triggered the government's inability to ensure a balance of payments on its expenditure, resulting in a failure to deliver public services and the ranking of the country as the poorest in the world.

Recognizing these conditions, and to ensure a steady inflow of resources to sustain its expenditure, in 1984, the Mozambican government agreed to shift from the socialist approach towards a market economy. This led to the development of agreements with the World Bank and the IMF on the implementation of several structural adjustments, which were mainly concerned with denationalization and, subsequently, privatization of state companies. This approach was regarded by the IMF as the key to reducing the role of the state in the economy, boosting investor confidence and thus opening the door for private investment to play an increasingly important role in Mozambique's growth (De Renzio and Hanlon, 2007). Indeed, with the implementation of the necessary structural adjustments, Mozambique displayed very impressive economic growth (among the highest in the world at that time). From being the poorest country in the world, with an estimated economic growth of 0% in the 1980s, the country's economy grew, on average, by 8% per year from the early 1990s until 2014, making Mozambique the fastest-growing non-oil economy in Sub Saharan Africa (SSA) over that period (Nucifora and Pereira, 2009; MEF reports on budget execution, 2005-2016; The World Bank ,2017).

Despite the civil war that ended in 1992, the implementation of structural adjustments and stunning economic growth improved donor perceptions of Mozambique, leading to an increasing number of donors viewing the country as a credible candidate for their funding. This

stimulated an uptick of aid into the country, which was necessary to support the emergency assistance required because of the civil war (De Renzio and Hanlon, 2007 and Nucifora and Pereira, 2009). By 1992, external aid assistance disbursements accounted for 87% of the Mozambican government budget, which meant Mozambique was the largest aid recipient of all aid-receiving nations and the most aid-dependent country in the world (Pavignani and Durão 1999; Batley 2005; Kulipossa, 2006).

The ending of the civil war in 1992 was followed by the signing of a peace accord in 1994 that allowed for a shift of funding focus from emergency assistance to post-war reconstruction and development aid (De Renzio and Hanlon, 2007). Against this backdrop, aid assistance through ODA was introduced in the country in the late 1990s and, since then, has been the cornerstone of Mozambique's reconstruction and development (UN, 2015).

By definition ODA involves disbursement of loans and grants by donors usually into a national government budget and/or specific projects to promote economic development and welfare in eligible countries such as Mozambique (Yasin, 2005). However, disbursement of ODA is conditional on several factors. First, according to the Independent Evolution of Budget Support Report of 2014 by the European Commission, in Mozambique, the disbursement of donor funding to the national government budget depends on the following indicators, among others: (I) good governance, including anti-corruption and justice sector performance, and (II) satisfactory progress concerning the targets of government's main strategy documents, such as the Plan for Poverty Reduction (PARPA)¹ and the Economic and Social Plan (PES)² (European Commission, 2014).

However, despite accounting for a bulk of the government budget in Mozambique in the last few years, ODA funds to the country have been restricted due to a breach of ODA disbursement conditions by the Mozambican government (UNICEF Mozambique, 2016; The Economist 2016; The World Bank, 2017).

1 PARPA, a document designed by the government of Mozambique and endorsed by the IMF and the World Bank, is the main document for both government and donors' policy prioritization. Its implementation and results are based on the decisions by donors about their future disbursements of aid (MEF 2010).

2 PES can be defined as a strategy document for the annual operation and monitoring of PARPA's targets by the state. It includes the programming of all priority activities to be realized and the projection of the necessary budget.

This restriction is mainly the result of undisclosed government borrowing from donors, bondholders, and the public since 2014, which has led to a weakening of trust in the Mozambican government on the part of the donors. This undisclosed borrowing led international institutions funding the ODA, mainly the IMF, to suspend their aid programs in the country (UNICEF, 2016; The Economist, 2016; The World Bank, 2017). Consequently, Mozambique is facing further deterioration of its macroeconomic status, with the current state characterized by high inflation rates, increasing government deficits and debts, depreciation of the national currency, and a reduction in economic growth. In this regard, World Bank representatives in Mozambique reported a drop in the GDP from 6.6% in 2015 to 3.3% in 2017, its lowest level since the civil war era (UNICEF, 2016 and The World Bank, 2017).

Other consequences included Mozambique's national currency, the metical (MZN), depreciating by 57% against the US\$ in 2016 and 42% in 2017 (The World Bank, 2017). In addition, Foreign Direct Investment, which was the main source of taxes collected in the country, fell by 24% in 2015 and exports declined by 14% (The World Bank, 2017). Inflation, driven by the depreciation of the national currency, accelerated by 25% in 2015 and 16,7% in 2016 (The Economist, 2016 and The World Bank, 2016).

1.2 The government Budget Process in Mozambique

A government budget is the financial plan converging the prediction of expenditure and revenue during a certain period to achieve public targets through state agencies (i.e. provincial and district directorates) (Hagen and Harden, 1995 and Goode, 2010). Considering this definition, in Mozambique, two main rules stand out in terms of the government budget process including resource mobilization and government expenditure (Hodges and Tibana, 2004). Government expenditure refers to all government consumption related to providing public services and achieving public targets. Resource mobilization refers to the sources of financing the expenditure, including taxation of domestic and external resources and securing grants and loans in a policy-driven manner (Hodges and Tibana, 2004).

Mozambique's government budget has two main sources of revenue: domestic sources (which include tax revenue collected on domestic resources and social contributions) and ODA from leading international financial institutions (De Renzio and Hanlon, 2007; UN, 2010; MEF, 2016).

According to the country's financial reports, such as those published by the MEF, within the last decade, domestic sources of government budget funding accounted for about 23% of the total

government budget; meaning the remaining 77% was received from ODA. Currently, ODA is given in two main modalities in Mozambique: (I) grants into direct annual budget support (known as general budget support (GBS) and (II) loans (Procopio, 2005 and De Renzio and Hanlon, 2007). A grant is not the same as a loan. A loan refers to a sum of money borrowed from a financial institution or bank by an individual or entity that requires repayment along with interest after the term expires. On the other hand, grants are a type of financial assistance that is non-repayable (Procopio, 2005 and De Renzio and Hanlon, 2007). In summary, in Mozambique, despite grants and loans being under the ODA scheme, grants that are characterized as a mode of GBS are used to directly finance government expenditure, while loans have been used to finance the budget deficit. (Procopio, 2005 and De Renzio and Hanlon, 2007).

Reports by the MEF show that between the years 2005 and 2016 the GBS accounted for, on average, 14% of the government budget (MEF reports on budget execution, 2005-2016). Therefore, domestic and GBS or grant funds cumulatively account for 37% of the government expenditure, which is evidently not sufficient for the government's activity expenditure planning. As a result, Mozambique has registered continued deficits in its government budget. Thus, in addition to domestic and GBS funds, Mozambique relies on loans as another ODA modality to cover around 63% of the government budget's deficit. In fact, De Renzio and Hanlon (2007) show that loans are the largest flow of ODA modality in the country, accounting for more than half of the ODA.

1.3 Sources of funding for Indoor Residual Spray implementation in Mozambique

Funding to implement IRS in Mozambique has generally been delivered through two main sources (Conteh et al., 2004; PMI, 2013; PNCM, 2017). Firstly, support from the Global Fund that goes back to 2002 and provides the main funds for procurement and purchasing of the major consumables for IRS. The other international source for financing the IRS are several NGO's such as the Bill and Melinda Gates Foundation.

The government budget of Mozambique is the other source, however, unlike the Global Fund and NGOs, it primarily funds personnel salaries (Conteh et al., 2004; PMI, 2013; PNCM, 2007, 2017).

CHAPTER TWO

2.1 Methodology for Estimating Costs in Health Care Interventions

When the concern is the scarcity of resources among health care interventions and the objective is the health of the people, Economic Evaluation (EE) has an important part to play as it helps to identify the most effective and least costly alternatives among health care interventions. The base definition has been described as the comparative analysis of alternative courses of action in terms of both costs and consequences with the objective of informing resource allocation (Drummond et al., 2015).

There are different types of EE techniques, which can be divided into full and partial. The full EE techniques include the analysis of both costs and outcomes. Four full EE techniques are known, namely: cost minimization analysis, cost benefit analysis, cost effectiveness analysis, and cost utility analysis (Edejer et al., 2003 and Drummond et al., 2015). On the other hand, partial EE techniques can be distinguished from full technique as they only include the analysis of the costs and provide no information on the health outcome of interest (Drummond et al., 2015). A partial EE technique is the cost analysis that is often used to estimate how much a health care intervention costs (Edejer et al., 2003; Hoomans and Severens, 2014; Drummond et al., 2015). However, irrespective of whether it is full or partial EE technique, a common part of all EE techniques is the analysis of costs.

The literature suggests several standard preliminary considerations and essential steps in estimating costs of health care interventions, including those for cost analysis of interventions to control malaria (Edejer et al., 2003 and Drummond et al., 2015). The preliminary consideration includes determining the study perspective.

The study perspective refers to the viewpoint the study will take as certain resources may be costly for some but not for others. Additionally, the perspective of analysis will determine the source of resources (direct or indirect) and how resource costs will be quantified (Edejer et al., 2003 and Drummond et al., 2015). Three distinguished perspectives are often taken – i.e. societal, provider, or patient (WHO, 2008 and Drummond et al., 2015). The provider perspective implies that only costs borne from the provider of health care intervention will be included in the analysis and only direct costs of the intervention are included. Examples of these costs are personnel salaries. The patient perspective implies that only costs incurred by

patients and their families, such as travel costs and time spent seeking care will be included in the analysis. Analysis from the societal perspective implies the consideration of both provider and patient costs (WHO, 2008 and Drummond et al., 2015).

Several researchers claim that EE should include costs borne by society irrespective of who pays these costs. This argument is based on the view that in making decisions, governments are primarily concerned with the welfare of all members of society. In light of this thinking, the societal perspective provides more benefits than the other two perspectives and is, therefore, always relevant (Byford and Raftery, 1998; Edejer et al., 2003; Haddix et al., 2003). In contrast, most literature suggests going beyond such a strict view. For instance, according to Drummond et al., (2015), the purpose of the analysis, the specific context and the availability of data play a vital role in the selection of the appropriate perspective. In fact, cost analyses of interventions to control malaria have generally been conducted from the perspective of the provider of the intervention as the main intent of this perspective is to inform decision makers on how much a health intervention costs. This argument is in line with studies done by Manzi et al., (2008), Rahman et al., (2016), and Dambach et al., (2016), who all acknowledge that in their studies, the provider perspective was adopted because the primary purpose of their work was to inform decision-making at the government level.

After the consideration of the perspective for costing, several steps are generally used to conduct the analysis of costs in EE.

First is the identification of cost categories that impact the analysis. Indirect and direct costs are the two ways to identify the costs in the analysis of health care interventions. Indirect costs are those costs outside the health care sector and are borne by the patients. Examples are travel costs, time costs such as production loss, lost leisure time, and costs associated with seeking care. Direct costs refer to the resources required to produce a specific health care intervention and are borne by the provider of the intervention. Traditionally, cost analysis experts such as Creese et al., (1994), Edejer et al., (2003), and Drummond et al., (2015), have aimed to include only direct costs of providing an intervention when adopting the provider perspective.

Direct costs are often broken down in two categories, recurrent and capital costs (Edejer et al., 2003). Recurrent costs refer to those resources purchased regularly and are used during a year. When the intervention ends, these costs also end. This includes costs such as (I) intervention costs - examples are insecticides, protective clothes for sprayers, rental for buildings and

vehicles, and vehicle maintenance. (II) Personnel or staff costs are those costs that relate to the time spent by staff directly involved in the intervention. Examples of personnel costs are the ones related to salaries of staff involved in the intervention; (III) overhead costs include costs that can be shared across various interventions. Examples are utility costs for electricity, water, telephone and office material, (Johns et al., 2003; Edejer et al., 2003; Drummond et al., 2015).

The other category of direct costs are capital costs and are classified as those items that last for more than one year, meaning these costs may remain even when the intervention is completed. Examples of capital costs include buildings, vehicles, furniture, and equipment costs. These costs are assessed using the 'equivalent annual costs' calculation. The term will be discussed below.

However, besides the identification of costs being directly related to the perspective of analysis, it is also related to the availability of data (Edejer et al., 2003; Sarowar et al., 2010 and Drummond et al., 2015). There are two approaches usually used to identify costs from the data and those include the micro or gross costing approach. The micro costing approach involves a bottom-up assessment of all resources used in the provision of the intervention and is employed to arrive at the most precise cost estimates, however, it tends to be time and resource consuming and thus may not always be feasible. For instance, micro costing would identify the costs of electricity per month or per day to calculate total annual costs (Hale et al., 2003; Ghali et al., 2009; Frick, 2010; Ruth, 2015). On the other hand, gross-costing involves top-down data collection and requires considerably less time and consumes less resources; however, it is also considered less reliable and accurate and provides a limited level of detail compared to micro-costing. For instance, in gross costing only the total annual costs of electricity extracted from the annual report will be assigned in the analysis (Johns et al., 2003; Edejer et al., 2003; Drummond et al., 2015).

Nonetheless, despite the advantages and disadvantage associated with both approaches, the consensus in the literature is that the choice between either depends on the availability and quality of data (Raftery, 2000; Drummond et al., 2005; Ghali et al., 2009; Hendriks et al., 2014). Furthermore, many argue that the combination of the micro and gross costing is considered to result in the most accurate cost estimates for healthcare service activities because all cost items are identified and valued at the most detailed level and problems of lack or deficiency of data and resources can be avoided (Johns et al., 2003; Edejer et al., 2003; Drummond et al., 2015). For example, Dambach et al., (2016) and Rahman et al., (2016) measured all direct costs of their interventions using the micro costing approach and for other costs used the gross costing

approach, illustrating the potential to combine both approaches successfully.

Second is the measurement or quantification of costs. The costs of all resources (financial and economic) used in the intervention must be quantified in accordance with their actual expenditure that could be financial or economic (Johns et al., 2003; Edejer et al., 2003; Drummond et al., 2015). Financial costs represent how much was actually paid to provide a health intervention (Edejer et al., 2003). Examples of financial costs include salaries of personnel (Edejer et al., 2003). On the other hand, economic costs, include the opportunity costs of resources for which there might not be a financial payment (Edejer et al. 2003 and Drummond et al. 2015). Examples of opportunity costs are donated goods and services. Both financial and economic costs will be explained further in part B of this thesis.

In cost analysis, the measurement of costs is often distinguished in a number of cost categories. Total cost refers to all costs consumed by the intervention, while, average or unit cost refers to cost spent per unit of production. Usually, cost analysis of IRS standardizes unit costs as cost per person protected or covered by IRS and/ or cost per household or dwelling sprayed or covered by IRS (Guyatt et al., 2002 and Conteh et al., 2004).

The third step comprises of the methodologies used to validate the economic costs resulting from the use of all resources involved in the intervention. For example, donated or subsidized goods and services and voluntary time, translated in EE as an opportunity cost may not reflect the real prices of the resources (Edejer et al., 2003; Drummond et al., 2015; WHO, 2017). For example, for a donated resource, the observed or financial price in the receiving country may be higher than the actual cost in the donor country because price in the receiving country may be influenced by the exchange rate or inflation (Edejer et al., 2003; Drummond et al., 2015; WHO, 2017).

Therefore, criteria must be considered to validate recurrent and capital opportunity costs. However, an important distinction between recurrent and capital costs have to be considered when validating costs. To illustrate this, the investment of capital costs is done at a single time point, often at the beginning of the intervention. On the other hand, the investment of recurrent costs is often done in daily, monthly or even annual sums (Drummond et al., 2015). Thus, the amount initially invested in capital assets depreciates over the duration of the intervention whereas recurrent costs do not. Therefore, capital costs cannot simply be included in the analysis without any adjustment (Edejer et al., 2003; Drummond et al., 2015). Hence experts in EE suggest that the initial costs of a capital item have to be annuitized, in other words, calculating the equivalent annual costs of the capital item by incorporating both opportunity costs and

depreciation aspects (Floyd, 1999; Johns, Baltussen and Hutubessy, 2003; Drummond et al., 2015). The calculation of equivalent annual costs involves key information such as the purchase price of the resource in the year of analysis, useful life of the capital resource, interest rate, and annuitization factors (Floyd, 1999; Edejer et al., 2003; Drummond et al., 2015), and is given by Formula 1, taken from Drummond et al., (2015). The choice of the interest rate will depend on the setting of analysis and literature recommends the use of the rate of return on long-term government bonds (Johns, Baltussen and Hutubessy, 2003; Edejer et al., 2003; Drummond et al., 2015).

Formula 1: Equivalent Annual Costs

$$\text{Equivalent Annual Costs} = PV \div A$$

considering:

$A = r, n;$

A= is the annuity factor;

PV = present value of the capital resource (the price of the capital resource in the year of the analysis);

r = interest rate;

n= the useful life of the capital resource.

The value of ‘A’ is provided by literature such as Drummond et al., (2015) and the WHO–Choice publications (WHO, 2018) and is standard for all countries. In relation to the initial prices and prices in the year of the analysis, the literature suggests that these can be verified through established catalogues or market prices. Finally, in relation to the useful life of the resource, standardized tables that include useful life of capital resources are available in literature such as WHO – Choice publications (WHO, 2018).

Due to issues concerning standardization between domestic and international currency – and for the purpose of international comparisons – it is recommended that a common currency such as the United States Dollar (US\$) is used (Edejer et al., 2003). Converting domestic currency to international currency involves the use of the official exchange rate by essentially multiplying the domestic price by the official exchange rate of the international currency (Edejer et al., 2003).

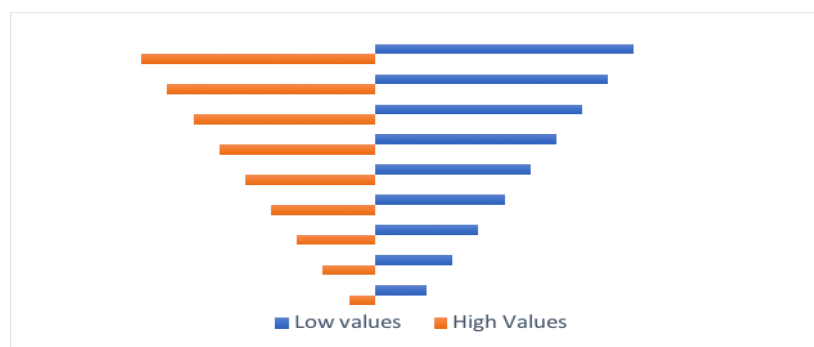
The final step of cost analysis focuses on the uncertainty in the data. Uncertainty is defined as the lack of exact knowledge in a parameter, regardless of the cause of this deficiency (Baltussen et

al., 2002). An important level of uncertainty is the parameter uncertainty. This arises due to variation around estimates of variables, such as time spent in the intervention by staff, and assumptions taken due to, for example, missing or old data. Other important levels of uncertainty include model uncertainty and generalizability uncertainty.

The principal method for handling uncertainty in costs analysis is by performing a sensitivity analysis that is defined as a method to test the robustness of the conclusions of an EE and involves systematic assessment of the impact of changes in the assumptions made (Briggs et al., 2001; Baltussen et al., 2002; Edejer et al., 2003; Simoens, 2009).

According to literature, sensitivity analysis is usually assessed using two analyses: the deterministic sensitivity analysis (DSA) or the probabilistic sensitivity analysis (PSA). In the DSA individual parameters are varied using point estimates (e.g. lowest and highest value) to determine the influence of each parameter on the results. This includes: “univariate or one-way” sensitivity analysis that explores the impact on the results caused by the changes in one input variable, i.e. one parameter is changed at a time. DSA also includes “multivariate or multi-way” sensitivity analysis, recognizing that there may be more than one uncertain parameter in the model, therefore involving varying two or more inputs at the same time and studying the effect on results (Baltussen et al., 2002; Edejer et al., 2003; Simoens, 2009). The results of DSA are usually represented using Tornado Diagrams. An example of a Tornado Diagram is illustrated below.

Figure 1. Example of a Tornado Diagram



Source: author

The other type of sensitivity analysis is the probabilistic sensitivity analysis (PSA). This is based on the Monte Carlo simulation, which is a simulation technique that selects variables using random number distribution with the aim of sampling (specifying) from these numbers. The process of repeated random sampling is known as Monte Carlo simulation (Briggs et al., 2001;

Baltussen et al., 2002; Edejer et al., 2003; Simoens, 2009). The PSA analysis allows specifying distributions (samples) to represent parameter uncertainty in their estimation (Briggs et al., 2001; Baltussen et al., 2002; Edejer et al., 2003; Simoens, 2009). In PSA, parameters of uncertainty are considered random variables that can take a range of values described by the specified distribution (Briggs et al., 2001).

The literature advocates that the preferred type of sensitivity analysis that should be adopted to capture uncertainty in the analysis of costs should depend on the amount and quality of available data, the type of parameter of uncertainty, the objective of the analysis and the needs of the decision-maker (Briggs et al., 2001; Baltussen et al., 2002; Drummond et al., 2015).

Study Methods

Introduction

To analyse the costs of IRS operations in malaria-prone Mozambique this study adopted the cost analysis. This decision was based on recommendations in the literature from Johns et al., (2003), Edejer et al., (2003) and Drummond et al., (2015). For instance, it has been argued that the cost analysis methodology is the most appropriate when seeking to accurately estimate an intervention's budget in order to inform decision-making regarding ways to sustain it (Edejer et al., 2003; WHO, 2008; Simoens 2009; Hoomans and Severens, 2014; Drummond et al., 2015).

This method allows for the collection of all costs associated with a health care intervention to which is relevant to the main concern of the present study (i.e. determine accurate costs of IRS activities). This methodology section is divided into three chapters: the first describes the study design and includes the approach and perspective of analysis. The study area or setting of analysis was also described in this part and thereafter each step followed to conduct the study is described. The final chapter describes the ethical considerations undertaken.

CHAPTER ONE

1.1 Study design

This was a cost analysis carried out retrospectively from the perspective of the provider of the IRS, i.e. Matutuine and Namaacha District Health Directorate. It was based on the micro and gross costing approach that enabled the study to reflect all resources, including financial and economic or opportunity costs used to facilitate the intervention, in order to estimate total costs and unit costs of IRS operations.

1.2 Study Areas

The study was conducted in the Matutuine and Namaacha districts, both districts of Maputo province. Personnel salaries to operationalize IRS in both districts are funded by the government budget and are thus susceptible to shocks due to ODA funding restrictions. 2014, the year of analysis, was taken into consideration as it was, according to the DPSM, the last year before 2018 that IRS was implemented in these sites. This informed the choice of districts as the study settings and the year of analysis of the study.

In both districts malaria is seasonal, with the highest transmission occurring during and immediately after the rainy season from October to March (Zacarias and Majlender, 2011). Together Matutuine and Namaacha are considered areas with low risk of malaria transmission in relation to other areas of the country, however, in both districts, malaria is the leading cause of demand for health care in health units, and the second cause of mortality after HIV/AIDS (DPSM, 2014).

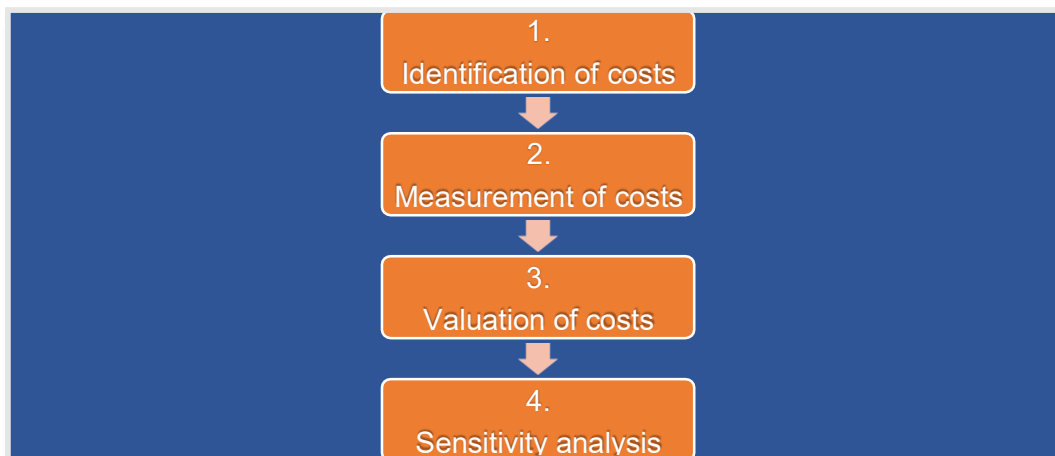
According to the 2014 IRS report by the DPSM, in 2014, Matutuine had a total estimated population of 17,501 aggregated into 7,479 households and Namaacha 27,597 aggregated into 8,839 households (DPSM, 2014). Additionally, according to the last available census conducted in 2007 by the INE, both Matutuine and Namaacha had, on average, four people per household (INE, 2011).

CHAPTER TWO

2.1 Approach: Conducting the Cost Analysis of IRS Operationalization in Matutuine and Namaacha

The steps used to conduct the costs analysis of IRS operationalization were adapted from Johns et al., (2003), Edejer et al., (2003) and Drummond et al., (2015) and are summarized in Figure 2. The explanation of each step undertaken is given below in Figure 2.

Figure 2. Essential Steps in Conducting the Cost Analysis



Step one: Identification of Costs

Because this study was from the provider perspective, only direct resources involved in the intervention were identified. These categories of costs were identified taking into account both micro and gross costing approaches. For example, to identify intervention and personnel costs, the micro costing approach was used, as it requires the listing of all resources and their quantification. On the other hand, to identify overhead and capital costs, the gross costing approach was used. In this case, the data on annual costs or the overall costs of each item was listed without details of how much was spent per month or per piece of that item that was used.

Additionally, to ensure that all direct relevant cost data was included, information pertaining to costs was derived from various sources, which includes IRS's 2014 financial report and other relevant technical documents available from the finance departments in each District Health Directorate as well as the provincial financial department of the Provincial Health Directorate.

Other insight regarding costs information was obtained from the Ministry of Health of Mozambique known as MISAU (Ministério da Saúde de Moçambique). Information regarding

market prices was obtained from secondary data such as the national market and in the literature. Table 1 summarizes the approach used to identify costs and the primary and secondary sources of data.

Table 1. Approach and Sources for Data Collection

Information	Approach	Data required	Type of document	Source
Salaries; recruitment and selection, training, social-mobilization and supervision	Micro costing	Staff salary and working hours	Expenditure on salaries of 2014 and IRS financial annual report of 2014	District Health Directorate's IRS Report (2014)
IRS Consumables and stationery	Micro costing	Prices of resources and quantities consumed	Expenditure, purchase invoices	MISAU
Transport (rent and fuel costs)	Gross costing	Total annual fuel and rent costs, and quantities consumed	Expenditure records	District Health Directorate's IRS Report (2014)
Maintenance of vehicle (material, lubricants, fuel, fees, batteries and spare parts)	Gross costing	Total annual maintenance and rent costs and quantities consumed	Expenditure records	District Health Directorate's IRS Report (2014)
Utilities (water, telephone, cleaning material, securities services, office material)	Gross costing	Total annual costs	Expenditure records	District Health Directorate's IRS Report (2014)
Building	Gross costing	Equivalent price per square meter, interest rate for annuitization, life years	Local market prices	DPSM

Information	Approach	Data required	Type of document	Source
Equipment, furniture and fixtures	Micro costing	Equivalent price per resource, interest rate for annuitization, life years	Local market prices and standard tables on international costs and price	Local market and WHO – Choice Analysis publications (WHO, 2018)
Vehicle	Gross costing	Equivalent price per resource, interest rate for annuitization, life years	Local market prices	Local market
Useful years of life	-	Number of years of each capital resource	Standard tables on useful years of life of resources	WHO – Choice Analysis publications (WHO, 2018)
Annuity factors	-	The result of interest rate and useful years of life	Book – Methods for the Economic Evaluation of Health Care Programmes	Drummond et al. (2015)
Official exchange rate	-	Official exchange rate between MZN and US\$ in 2014	Official documents from the Central Bank of Mozambique (2018)	Central Bank of Mozambique (2018)
Interest rate	-	Official interest rate in 2014	Official documents from the Central Bank of Mozambique (2018)	Central Bank of Mozambique (2018)

Information	Approach	Data required	Type of document	Source
Number of households covered	-	Number of household coverage by IRS operationalization in 2014 in the settings	IRS's annual report OF 2014	DPSM's IRS Report (2014)
Average size of population per household	-	Average number of people living in one household in the settings of analysis	National population census of 2007	INE (2011)

After identifying and listing all resources, they were decomposed in recurrent and capital costs. Recurrent costs were allocated as intervention, personnel, and overheads. Capital costs were allocated as capital costs. Table 2 describes the cost categories, their components and sources of financing.

Table 2. Cost Categories, Components and Sources of Financing

Cost category		Cost Components	Source of Financing
Recurrent	Intervention	Consumables: DDT and deltametrina insecticide (per kg), spray filters, spray containers, pressure gauges, capsules, megaphones, protective clothing for sprayers, protective boots for sprayers, protective hats, disposable masks, gloves, bags, buckets, megaphone batteries, soup.	Global Fund
		Stationery: pens, pencils, erasers, notebooks, paper (A4), chalk box, markers, calculators, staplers, paper punches and folders.	District Health Directorate
		Transportation (rent of vehicles and fuel costs)	District Health Directorate
		Maintenance of vehicles	District Health Directorate

Cost category		Cost Components	Source of Financing
Recurrent	Personnel	Salaries and benefits of direct staff: sprayers, team leader, supervisors, district hospital director, district chief medical doctor and hospital administrator	Government Budget
		Other salaries and benefits: driver, guard responsible for the storeroom, community mobilizer, activist, Institute of Social Communication operator and security	
		Social mobilization	
		Recruitment and selection	
		Training	
	Supervision		
Overheads	Electricity, water, telephone and cleaning materials	District Health Directorate	
	Material and suppliers: office material		
Capital	Capital	Building: office space IRS, office space accountability and storeroom.	State
		Equipment, furniture and fixtures: desktop computers, printer, scanner, office chairs, office desks, office cabinets, lockers, bookcase, bins, plastic fan and water container	District Health Directorate
		Vehicles: Toyota Hilux 4X4, Ford Ranger 4X4, Toyota Lander Cruiser	Donated

Step Two: Measurement of Costs

The estimation of costs involved the inclusion of financial and economic costs, which is suggested practice when conducting a cost analysis (Drummond et al., 2015). Thus, total costs were distinguished as total annual economic costs and total annual financial costs. Therefore, total annual economic costs were based on the sum of the total recurrent and capital costs, including estimating costs for any donated items. On the other hand, total annual financial costs were based on the sum of the total recurrent costs and capital costs. However, in this category, the equivalent costs of all donated resources, were excluded. Furthermore, unit or average costs were calculated. However, it should be noted that a direct comparison of the study's estimated costs per household (the outcome used by the provider of IRS operationalization in 2014) sprayed with the estimated costs provided in the literature is challenging as most of the literature review of IRS use cost per person protected per year. Thus, for matters of comparison with other study methods, besides cost per households sprayed, costs per person protected by IRS was also calculated. The first was based on the total costs of IRS operationalization and the number of households sprayed in Matutine and Namaacha. In regard to the cost per person protected, those were captured based on the total costs of operationalization and the number of households sprayed multiplied by the average number of people per household in Matutine and Namaacha.

Therefore, total economic and financial costs, economic and financial costs per household sprayed and economic and financial costs per person covered were the primary outcomes of measurement. All were presented as a total amount across both district settings, and for each district separately. The following formulas illustrate the data and methods used to estimate each outcome.

Formula 2: Total annual economic costs

$$Total\ Annual\ Economic\ Costs = \sum Total\ Annual\ Recurrent\ and\ Capital\ Costs\ 3$$

Formula 3: Total annual financial costs

$$Total\ Annual\ Financial\ Costs = \sum Total\ Annual\ Recurrent\ and\ Capital\ Costs$$

³ Including market values for all donated items

Formula 4: Economic cost per household sprayed formula

$$\text{Economic Cost per Household Sprayed} = \frac{\text{Total Annual Economic Costs}}{\text{N}^\circ \text{ of Household Sprayed}}$$

Formula 5: Financial cost per household sprayed formula

$$\text{Financial Costs per Household Sprayed} = \frac{\text{Total Annual Financial Costs}}{\text{N}^\circ \text{ of Household Sprayed}}$$

Formula 6: Economic costs per person protected

$$\frac{\text{Total Annual Economic Costs}}{\text{N}^\circ \text{ of Household Sprayed} \times \text{Average Size of Household}}$$

Formula 7: Financial costs per person protected

$$\frac{\text{Total Annual Financial Costs}}{\text{N}^\circ \text{ of Household Sprayed} \times \text{Average Size of Household}}$$

Step Three: Valuation of Costs

Resource costs were adjusted or validated to ensure that market prices represent opportunity costs. All costs were collected in MZN however, estimated and expressed in US\$. The US\$ costs were exchanged using the official exchange rate of 2014 from the Central Bank of Mozambique in the year of the analysis, in which case 1 US\$ was correspondent to 30,57 MZN (Banco de Moçambique, 2018). Table 3 summarizes the categories of costs that were considered, together with the methods used to estimate and value these costs.

Table 3. Methods for Cost Valuation and Estimation of Cost

Cost categories	Valuation	Estimation
Personnel Salaries	Government salary data	Percentage of time allocated to IRS × salary per day × quantity of staff
Consumables	Market prices	Quantities of units of resources used × unit costs
Stationery	Market prices	Quantities of units of resources used × unit costs
Transportation	Total annual expenditure	Time spent × Total annual costs (rent and fuel costs)

Maintenance	Total annual expenditure	Time spent × Total annual costs
Overhead	Total annual expenditure	Quantities of units of resources used × total annual costs
Building	Equivalent costs in 2014	Present value of the resource per m ² in 2014 / annuity factor*
Equipment, furniture and fixtures	Equivalent costs in 2014	Present value of the resource in 2014 / annuity factor*
Vehicle	Equivalent costs in 2014	Present value of the resource in 2014 / annuity factor*

*Annuity factor was calculated on the base of the interest rate and useful years of life and is available from standard tables (Drummond et al, 2015).

Step Four: Sensitivity Analysis

It was assumed that uncertainties that would be most relevant in the study was regarding parameters including those related to significant cost drivers (vehicle, personnel salaries, consumables and interest rate on capital costs). Thus, to test uncertainty and assumptions of this study, “one-way” sensitivity analysis was performed on these key variables. The interest rate was changed from 8% (Central Bank of Mozambique, 2018) to 5,3% as assumed in the study of Goodman et al., (2001) and Conteh et al., (2004). Regarding vehicles, personnel salaries and consumables it was assumed a range tasting of \pm (above and under) 25% change in all cases. However, it should be noted that this choice in range variation was an arbitrary choice once the baseline values were taken from the results of the study and no confidence intervals were calculated to fix the minimum and maximum values on variation as it is usually in CEA studies. This arbitrary choice of \pm 25% fluctuation range taken is based on the literature of other studies that reported the analysis of IRS cost (Howard et al., 2017). It is assumed that a \pm 25% change should be able to identify a more meaningful value change for those variables selected.

The results are presented as a tornado diagram. Table 4 below provides information regarding the assumptions and the sensitivity analysis undertaken in the study.

Table 4. Assumptions on the Parameters of Uncertainty

Parameters	Assumption	Sensitivity analysis
Vehicles costs	Due to the high inflation the country faced in the year of the analysis, there was fluctuation in the exchange rate. The currency exchange rates of 1.00 US\$ to MZN 30,7 (Banco de Moçambique) was assumed to reflect the period under consideration (2014).	Decrease and increase costs 25% each
Personnel salaries	The data demonstrates lack of efficiency on the allocation of resources.	Decrease and increase costs 25% each
Consumables	Due to the high inflation the country faced in the year of the analysis the currency exchange rates of 1.00 US\$ to MZN 30,7 (Banco de Moçambique,2018) was assumed to reflect the period under consideration (2014).	Decrease and increase costs 25% each
Interest rate	Due to context-specificity, the study assumed an interest rate of 8% according to the Central Bank of Mozambique (2018). Other studies used an interest rate of 5.3% in Mozambique.	Decrease the interest rate to 5% following similar studies in the literature.

2.2 Data Analysis

Fieldwork for this study was conducted at the research sites between January and February 2018, and data analysis commenced in March 2018. A structured checklist using Excel (Microsoft Office 2016 - Microsoft Corporation, USA) was used to enter and analyse data.

During the fieldwork, cross-checking mechanisms for the data were of an evolutionary nature, i.e. those costs that were unclear were clarified and refined during the process of gathering data. The results of the study were tabulated and discussed in a narrative review using Microsoft Office 2016.

CHAPTER THREE

Ethical Considerations

3.1 Ethics

In conducting this study, key principles relating to the ethical conduct of the research as stipulated by the Human Research Ethics Committee of the University of Cape Town were observed.

Autonomy: Regarding approval, ethical clearance was requested from and granted by the Human Research Ethics Committee of the University of Cape Town (approval ID: HREC REF: 821/2017). Permission was also sought from the Provincial Health Directorate in Maputo province.

Confidentiality: Data was strictly used for the purpose as outlined in the protocol of the study. All data was held in strict confidentiality in the settings of analysis. For information dissemination no personal identifiers will be used.

Risk: This study is not likely to involve the handling of sensitive information which may result in injury to the settings of analysis and for the health system in general as it used existing data, with no new data being collected.

Benefits: This study's intent is to benefit the setting of analysis and the health system of Mozambique as well as other international health systems in a sense that through the study they will learn to deal with the scarce resources to achieve affordability of health care interventions.

3.2 Dissemination of Results

A full report will be sent to health care decision-makers including the Ministry of Health, National Malaria Control Program and Chief Medical Officers in the settings of analysis in the form of copies (soft copies) using communication channels such as e-mails. This will ensure that the results of this study reach those who need it to make informed decisions to improve the coverage of IRS in Mozambique considering restricted national government budget due to reduced ODA disbursements. Another dissemination tool that will be used is publication in an academic/research journal and a policy brief.

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PART B: STRUCTURED LITERATURE REVIEW

Introduction

The objective of this literature review is to critically appraise the theoretical, methodological, and empirical literature focused on the costs of IRS. It will also identify the current gaps in the literature regarding the cost analysis of IRS in Mozambique.

Literature Search Strategy

The literature search was designed to identify studies reporting a costs analysis of IRS. Peer-reviewed articles, books, reports and master's and PhD dissertations conducted between 1995 and 2017 were included. The literature search was performed through both online databases (PubMed, Medline, Google Scholar and MEDLINE) and manual searches on publication or information from providers of IRS in Mozambique, the Central Bank of Mozambique and the National Institute of Statistics.

The first chapter of the literature specifically focused on giving an overview of Mozambique and theoretical description of the key concepts of this study: malaria and IRS. It is divided in three parts including country context as the first part, the second part including the theoretical background of malaria, then the theoretical background of IRS being described in the third part. The second chapter of the literature review focuses on giving first an overview of the main EE techniques, then the definition of costs in a cost analysis perspective and finally focuses on critical appraisal of the methodological steps of the available literature that would generate sufficient information to address the methodical steps of conducting a cost analysis of IRS.

CHAPTER ONE

1.1 Country Context

Demographic Characteristics

In 2016, Mozambique had approximately 27 million inhabitants, with the number estimated to be growing, on average, at 2.5% per year (INE, 2011 and Indexmundi, 2017). Over 67% of the total population comprises children and women who live in rural areas (INE, 2011 and Indexmundi, 2017). The country is in the Sub-Saharan Africa (SSA) region, which is in the southern region of the African continent. It is bordered by Tanzania to the north, Malawi, Zambia and Zimbabwe to the west, and Swaziland and South Africa to the south. To the east of Mozambique is the Indian Ocean (INE, 2011). It is divided into 11 administrative provinces, with Cabo Delgado, Nampula, Niassa, and Zambezia in the northern region being the most

populous, cumulatively accounting for about 40% of Mozambique's population. Chimoio, Manica, Sofala, and Tete are the central region provinces. Gaza, Inhambane, and Maputo are in the southern region of the country. Maputo is the capital city of the country wherein the Matutuine and Namaacha are located (INS, 2011).

Economic Characteristics

Mozambique is a low-income country and is ranked 180 out of 188 countries in the 2016 United Nations Development Program, a reflection of the dire conditions in the country (Human Development Index Report, 2017).

At the peak of its impressive economic performance, between 1992 (following the end of the civil war) to shortly after 2010, Mozambique's GDP grew annually at an estimated 8%. However, economic and social conditions have deteriorated, a rapid deterioration of the country's economy saw GDP growth drop to 6.6% in 2015 and 3.3% in 2017 (The World Bank, 2017). The literature points to several factors in explaining the deterioration of the country's economic standing, including lack of access to external aid due to aid partners discontinuing financial aid to Mozambique as a result of undisclosed debts, political instability due to ongoing conflict in the north of the country, a decline of foreign direct investment, high inflation, and weak exchange rates between the Mozambican Metical and the US\$ (The World Bank, 2017).

Health Characteristics

With a government allocation of approximately 9% in 2014 and 7% in 2018 of the total budget to the health sector, the country is heavily reliant on external development partners to fund public health interventions (WHO, 2017).

According to WHO (2017), only approximately 44% of the population have access to an acceptable level of health care; approximately 36% of inhabitants have access to a health facility within 30 minutes walking distance from their home; and 30% of the population is not able to access any kind of health services, and in rural areas the figure is higher (72%) than in urban areas (14%) (WHO, 2017).

Mozambique's life expectancy is estimated to be 58.7 years at birth, placing it among the lowest in the world (Indexmundi, 2017). Each day, 3,105 live births and 917 deaths are recorded. Infant mortality is at 78 per 1,000 live births, which is among the highest in the world

(Indexmundi, 2017). Malaria, HIV, and Tuberculosis are the three main causes of disease and death (morbidity and mortality) across the entire population and among the three diseases, malaria is the leading cause of death in the entire population (WHO, 2017).

1.2 Theoretical Background of Malaria

Malaria

Malaria is defined as a fatal but preventable and treatable disease caused by the protozoan parasite, Plasmodium “P”. Malaria infection occurs through bites by infected female Anopheles mosquitoes which are malaria vectors (WHO, 2015 and Ferrão et al., 2017). These vectors transmit the malaria parasite from one host vector to another vector (WHO, 2012).

Research has shown that not all vectors can transmit malaria parasites” (WHO, 2012). Of the thousands of mosquito species described, only a fraction of those in the genus *Anopheles* serve as a vector (WHO, 2012). Four main parasites that transmit malaria are known, namely: *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*. Of these, *P. falciparum* is considered the most common and dangerous, accounting for most malaria-related deaths globally and accounting for about 90% of all malaria infections in Mozambique (Mabunda, 2006; INE, 2011; WHO, 2015; PNCM, 2017).

Malaria is contracted when the infected vector in this case, *Anopheles* mosquitoes, bites the human body and infects the red blood cells with the parasite, resulting in multiplication of parasites in the individual’s blood (WHO, 2016). Although malaria infection is non-discriminatory, i.e. any individual can be infected, the development of clinical manifestations of the disease is significantly influenced by the individual’s immune status (WHO, 2016). As such, infants, children under five years of age, pregnant women, and patients with HIV/AIDS are most susceptible to contracting malaria and tend to experience the disease more severely as a result of the reduced capacity of their immune systems to tolerate infection (Mabunda, 2006 and WHO, 2016).

The most common malaria symptoms are fever, headache, vomiting, chills, malaise, and diarrhoea (Mabunda, 2006). Health complications, which generally occur when malaria progresses more aggressively (including due to late detection), may include anaemia,⁴ and cerebral malaria,⁵ which are all fatal if remain untreated (Mabunda, 2006).

Malaria Risk Factors

Malaria is largely associated with three main risk variables (I) socio-economic factors, which influence the ability to afford malaria treatment; (II) geographic and climatic status – where regions with tropical temperatures and high relative humidity and rainfall are the most susceptible to malaria, influencing both the lifecycle and development of both the mosquito vector and parasite. In fact, malaria is found in roughly 91 of 194 regions and territories of the world (WHO, 2015). The affected countries are concentrated in the most tropical regions of the world, mainly in Africa, Southeast Asia, Latin America, the Middle East, and the Eastern Mediterranean. The last variable is (III) migration, mainly the processes of urbanization that brings people from rural to urban areas (WHO, 2015). The SSA region is by far the greatest affected malaria burden worldwide and is currently undergoing a profound demographic change, with a growing proportion of its population moving to urban areas. Urbanisation is generally expected to reduce malaria transmission, however the disease still persists in African cities, thus affecting population movements (Mabunda, 2006; De Silva e Marshall, 2012; WHO, 2015; Vajda and Webb, 2017).

In Mozambique, two main risk factors are related to malaria in the country: climatic and economic factors (DNSP, 2011 and PNCM, 2017). Mozambique has a tropical climate that brings high temperatures, relative humidity and precipitation, which, exhibits favourable factors for malaria vector and parasite development (DNSP, 2011). For instance, while the entire population of Mozambique is considered to be at risk of contracting the disease, the risk is especially high in the northern regions of the country that experience regular rainfall and high temperatures in comparison with other regions of the country (PNCM, 2017). In fact, Zacarias et al., (2011) and DNSP (2012) observed a strong correlation between climatic factors and malaria prevalence in Mozambique. They argue that the risk of being infected with the disease is related to the country's tropical and sub-tropical climate.

4 Anemia is a condition in which red blood cells are unable to carry enough oxygen around the body to cells that needs it, leading to drowsiness and weakness (Mabunda 2006).

5 Cerebral malaria is a condition in which small blood vessels leading to the brain become blocked, resulting in seizures, coma, and/or brain damage (Mabunda 2006).

Parts of the country have more regular rainfall and high temperatures, thus these regions record a higher prevalence of infection (Zacarias et al., 2011; DNSP, 2012). More specifically, the southern region of the country records less rainfall than the central and northern regions, so malaria infection rates are higher in the northern region and decrease when approaching the central, even more so when approaching the southern region.

In addition, the economic factors influence the burden of malaria in the country. Malaney et al., (2004), Mabunda (2006) and the RBM (2017) demonstrated in their work that malaria and poverty are inextricably linked. In fact, this finding is relevant to Mozambique where studies reveal that 34% of the entire Mozambican population faces difficulty in affording malaria treatment and hospitalization (Castillo-Riquelme et al., 2008).

The Burden of Malaria Globally and in Mozambique

Recent estimates reveal that 212 million cases of malaria were reported worldwide in 2015; of these, 429 000 cases resulted in death (WHO, 2016). Africa, in particular, records the highest number of malaria cases globally, accounting for 88% of globally reported cases (WHO, 2016). The highest concentration of these cases is in the SSA region, where Mozambique is located. In 2015, the SSA region accounts for roughly 91% of reported malaria cases and deaths globally (WHO, 2016). Nevertheless, the data suggests that the burden of malaria worldwide decreased. According to data, between 2000 and 2015, the number of malaria infections and deaths globally decreased by 21% and 29%, respectively, and within Africa, infections and deaths declined by 42% and 66%, respectively (WHO, 2016).

Mozambique is presenting a contrary trend. To illustrate, between the 1990s to the early 2000s, Mozambique made great progress in stemming malaria infection rates. For instance, the 2011 Demographic and Health Survey by the INE, as reported by the PNCM in 2017, shows an overall reduction in malaria prevalence in all age groups between 2007 and 2011: from 51.5% to 38.3%. In children under five years of age, infections declined by 36% between 1999 and 2003. Between 2007 and 2011, malaria-related deaths of the same group declined from 152 to 97 deaths per 1,000 live births (PNCM, 2017).

However, malaria cases in Mozambique are now on the rise, suggesting an increase of the burden of the disease in the country (Mabunda, 2006; Arroz, 2016; PMI, 2016; Ferrão et al.,

2017, Lee et al., 2017). The 2016 PMI report – based on data from the 2011 Demographic and Health Survey and the health information systems of 2013 and 2014 – indicated a rise in reported malaria cases in all ages, from just over 3 million in 2013 to 5.5 million by 2016 (PMI, 2016). In addition, a study by Lee et al., (2017) reported that malaria cases increased by 40% from 2013 to 2014, outpatient visits increased by 5%, and deaths increased by 10%. In children, this is not an exception. A cross-sectional study by Arroz (2016) using national weekly epidemiological bulletin data found an increase in the incidents of the disease mainly among children, while Ferrão et al., (2017) noted an increase in malaria infection and mortality cases in Chimoio, a province in the central region of the country, between 2010 and 2014 specifically, highlighting an increase of 25% of malaria mortality in children under five years of age.

The above findings are in line with a recent pronouncement by the Minister of Health in Mozambique, cited by Frey (2017), that Mozambique recorded an increase of 20% in malaria cases in the first half of 2017 leading to more than two million cases of malaria compared with 1,873,303 cases reported in the same period in 2016. It is worth noting that this occurrence is in contrast to the global trend of decreasing malaria infection and deaths.

The Economic Burden of Malaria Globally and in Mozambique

Research shows that malaria can have a significantly negative influence on the macroeconomic performance of a country, and it is a determinant of the long-term economic growth and development of affected countries (Malaney et al., 2004). To illustrate, Gallup and Sachs (2001) and Malaney et al., (2004) reported that malaria-endemic countries record growth rates of 1.3% per capita GDP points lower per year than those of non-malaria endemic countries. A 10% reduction in malaria is estimated to lead to about 0.3% economic growth.

Artadi and Sala-i-Martin's (2003) study investigating the factors influencing economic growth in Africa in the 20th century pointed to malaria as one of the reasons behind the dismal economic growth performance of the continent as a whole. The authors estimate that, all things being equal, if Africa had no malaria over the last four decades, its annual growth rate would have been 1.25% points higher. One of the examples that support this finding is provided by Onwujekwe et al., (2010), who made reference to the fact that in 1993, Malawi—one of the poorest countries of the world—lost about 3.22% potential annual economic growth due to the impact of malaria in the country.

These findings complement those of Malaney et al., (2004), Mabunda (2006), RBM (2014), and WHO (2016) in viewing malaria as being inextricably linked to poverty. These authors argue that the highest malaria mortality rates are seen in countries with the most severe levels of poverty. This highlights the fact that the effect of the disease is particularly burdensome on the poorest of the poor. In fact, according to the World Malaria Report published by the WHO in 2016, 91% of global malaria cases are recorded in SSA region, one of the poorest regions of the world (WHO, 2016).

In Mozambique, several references, such as INE (2011) and PNCM (2017), identify malaria as the leading cause of absenteeism from school and work in Mozambique, particularly as a result of time lost due to malaria-related complications such as severe anemia, thus affecting the level of education of the country. An examination of the number of Mozambicans attending schools in the country indicates that Mozambique's adult illiteracy rate is at 51.9%. Specifically, 33% of women and 19% of men have never received schooling, and only 39% of children are completing primary level schooling (INE, 2011 and PNCM, 2017).

Another illustration is given by a study that evaluated and compared the financial impact of malaria and time lost due to malaria-related events in southern Mozambique and South Africa. This study found that in Mozambique, malaria costs – mainly those pertaining to medication – have been causing catastrophic costs⁶ to about 34% of the population (Castillo-Riquelme, et al., 2008). In fact, although some medications are subsidized, most of it is not available in public pharmacies, meaning households have to incur the costs of purchasing from private institutions. These costs make malaria-related costs significant, i.e. resulting in impoverishment and vulnerability of households due to malaria episodes, for 32%–34% of households in the country, compared to 9%–13% of households in South Africa (Castillo et al., 2008).

In seeking to determine the association between malaria and economic, educational, and geographical factors based on the results of the 2011 Demographic and Health Survey by the INE (2011), Ferrão et al., (2017) showed that the occurrence of malaria is higher in the poorest areas of the country, specifically rural areas, more than urban areas, at 58% and 43%

⁶ This refers to when out-of-pocket payments for health exceed the households' available income and push the individual or family unit beyond the poverty line.

respectively. The same survey concluded that in Mozambique, children from more privileged families (58%) are more likely to be protected against malaria compared to children from poor families (43%).

1.3 Theoretical Background of Indoor Residual Spray

Current Criteria for Vector Control Intervention: Global and Mozambique Perspectives

The first pillar of the Global Technical Strategy for Malaria 2016-2030 by WHO is vector control through insecticide treated bed nets (ITNs) or, where appropriate, the application of IRS (WHO, 2015). This means that all persons at high risk of contracting malaria should be targeted by at least one of the two core interventions, i.e. IRS or ITNs (WHO, 2015).

The National Strategy for Malaria Prevention and Control in Mozambique (2012-2016) recognizes IRS as the most effective tool for vector control and has been the primary strategy by which to control the malaria vector since 1949, the year Mozambique commenced its fight against the disease (DNSP, 2012 and PNCM, 2017). However, in line with the Global Technical Strategy for Malaria 2016-2030, the intention of the government of Mozambique is to scale up preventive measures to fully cover its population; thus, there is recognition in the National Strategy for Malaria Prevention and Control (2012-2016) that a single strategy may not be effective in fully controlling malaria in the country. The motivation for the combination of multiple strategies to prevent malaria is strengthened by numerous studies such as Fullman et al., (2013), Guyatt et al., (2002) and Hamel et al., (2011), who argued that when applied in combination, interventions produce a greater impact on the health of the population than when the interventions are applied independently.

Therefore, even though IRS is the core strategy for malaria control in Mozambique, the use of both IRS and ITNs is part of an integrated strategy (DNSP, 2012). To this end, its approach has been focused on distributing ITNs to vulnerable groups, mainly pregnant women and children under 5 years of age, and/or providing ITNs at the lowest possible price for other population groups in areas where IRS coverage is limited.

Indoor Residual Spray

As previously cited, IRS is one of two core strategies recommended for vector control and the prevention of malaria (WHO, 2015). It is defined as the careful and controlled spraying of long-

acting chemical insecticides along household walls, roofs, ceilings, and other places where malaria-transmitting mosquitoes reside (WHO 2006 and 2015). Four main classes of insecticides are recommended for use for IRS activities, namely: (I) Organochlorine that includes Dichlorodiphenyltrichloroethane (DDT), (II) Pyrethroids that includes Alphacypermethrin, lambdacyhalothrin, and deltamethrin), (III) Carbamates, and (IV) Organophosphates (WHO 2006 and 2015). The objective of IRS is to minimize vector- transmission capacity, as the objective of its implementation is to reduce the vector's lifespan to less than the time it takes for malaria vectors to develop. In this way, the vector can no longer transmit malaria parasites from one person to another, essentially reducing vector density by killing it immediately (WHO 2006 and 2015).

Globally, IRS has proven to be very effective in eradicating or greatly reducing malaria as a public health problem in several countries, mainly in Western Europe, Latin America, and Asia (WHO, 2006). In Africa, including in Mozambique IRS has been essential in controlling the spread of the disease. Further work on this can be found in, Mabaso et al., (2004), Skarbinski et al., (2012) and PNCM (2017), who illustrated considerable reduction in malaria prevalence and vector densities upon the implementation of IRS initiatives during the 1990s.

Current Criteria for Indoor Residual Spray Implementation: Global and Mozambique Perspectives

In order to have a significant impact on vector control and prevent malaria transmission, the WHO's latest operational manual for implementing IRS provides a set of crucial recommendations. Mozambique has implemented its IRS program according to WHO recommendations translated in the organization's country-specific guidelines (DNSP, 2012 and PNCM, 2017). These recommendations include:

- Recommendation 1: Ensure the highest possible level of coverage. The minimum target is 80% of houses or structures in any spray round/cycle.
- Recommendation 2: Strategic scheduling of spray rounds/cycles. Spraying should be scheduled to coincide with the build-up of vector populations just before the onset of the peak transmission season.

- Recommendation 3: Number of spray rounds per year. The number of cycles should not exceed two per annum and ideally should be completed within 2 months based on a weekly work routine of 5–6 days on and 1–2 days off.
- Recommendation 4: Careful selection of insecticide. The use of only good quality insecticide is recommended and should take into account susceptibility and vector behaviour, safety for humans and the environment, community acceptance of house spraying and cooperation, and affordability of the insecticide.
- Recommendation 5: Ensure adequate IRS management, planning and operational capacity at all levels of the health system, including the availability of skilled operational staff and resources (logistics, transport, communication, financial), and household cooperation.

CHAPTER TWO

2.1 Methods for Estimating Costs of Health Care Interventions

Economic Evaluation of Health Care Interventions

EE is essential in the era of limited resources as a means to help make choices regarding how to commit these in order to ensure the successful implementation of health interventions and the timeous delivery of key objectives (Drummond et al., 2015). In the health field, it has been described as the comparative analysis of health care interventions in terms of their cost (input) and outcomes (outputs) (Johns et al., 2005). In more detail, Drummond et al., (2015) define EE for the health sector as providing input into decision making (or which choice to consider adopting) by quantifying costs and health benefits between the compared interventions, e.g. a current intervention and a new intervention (which may or may not produce additional health outcomes).

A common premise of EE experts is that in a scenario of scarce resources, it is essential to establish priorities clearly, thus, identifying the most appropriate choices to make considering limited resources is the objective of the EE. Therefore, EE's architecture is built upon achieving efficiency in the allocation and use of health care resources.

The term efficiency refers to a measurement of whether resources are being used to obtain the best value for money. Health interventions are said to be efficient when they provide more

benefits than the use of an alternative set of resources (Creese and Parker, 1994 and Palmer and Torgerson, 1999). Efficiency is thus concerned with the relationship between resource inputs (costs, whether recurrent or capital) and either intermediate outputs (number of houses sprayed, time spent spraying, etc.) or final health outcomes (years of life saved, deaths averted, etc.)

Palmer and Torgerson (1999); Hale et al., (2003), and Hutubessy et al., (2003) showed that two main types of efficiency are often related with EE; those are technical efficiency and allocative efficiency. The technical efficiency refers to when the maximum possible outcomes in a given health intervention is obtained from a set of fixed resource inputs. In other words, technical efficiency attempts to identify ways of allocating resources without wastage, so as to move from an actual point to an improved point (Palmer and Torgerson, 1999; Hale et al., 2003, and Hutubessy et al., 2003).

The literature considers that in making decisions, it is not enough to know only which inputs will be allocated and how to better allocate costs to increase output. Rather, it's important to actually ensure that in the particular context, it is even worth allocating these resources to provide the specific intervention (Hale et al., 2003). Therefore, to establish priorities in relation to resource allocation, careful consideration regarding the distribution of resources is required. In this case, allocative efficiency should be employed as it considers the distribution of resources among different interventions in order to achieve the maximum possible socially desired outcome (Hale et al. 2003 and Hutubessy et al., 2003).

However, Palmer and Torgerson (1999), Hale et al., (2003), and Hutubessy et al., (2003) further argue that allocative efficiency, unlike technical efficiency, should operate on a stage of choosing the optimal mix of various health interventions with different health objectives. For example, allocative efficiency allows decision-makers to address how best to distribute the same fixed budget between different disease programs such as malaria and HIV/AIDS.

Thus, according to the literature, in a scenario of scarce resources in health interventions, technical and allocative efficiency should be considered.

Types of Economic Evaluation Techniques

To assess the optimal distribution of resources among health interventions by comparing both costs (resource use) and consequences, according to Edejer et al., (2003), Hoomans and

Severens (2014), and Drummond et al., (2015), four full EE techniques and one partial EE technique should be employed. According to them the full techniques include: (I) cost minimization analysis that compares health alternatives that are assumed to have equivalent or similar health benefits in order to identify the least costly among alternative interventions; (II) cost benefit analysis (CBA) which compares costs and benefits, both of which are quantified in common monetary values – using various techniques e.g. human capital approach and willingness-to-pay methods. The CBA is usually associated with allocative efficiency and its primary goal is to identify if the intervention's net social benefits exceed its costs. If the intervention presents net social benefits, it is considered as worthwhile for implementation; (III) cost effectiveness analysis (CEA) that compares programmes which have a common health outcome with costs in monetary units and outcomes expressed in health benefits such as life years saved. For example, in the context of malaria, IRS and ITNs are two different interventions to control malaria; however, both aim to improve population life expectancy or reduce mortality by cases averted, thus CEA could be applied. CEA is concerned with the assessment of technical efficiency of health interventions; and finally (IV) cost utility analysis (CUA) is considered by some to be an extension of CEA. It compares costs in monetary units and health outcomes combine mortality and morbidity into a single generic measure that is measured and expressed in more generalized health outcomes, such as quality-adjusted-life-years (QALY)⁷ or disability-adjusted-life-years (DALY)⁸ (Drummond et al. 2015). As such, the intervention that produces more QALYs for society within a given fixed budget is the preferred route; CUA therefore deals with allocative efficiency.

The partial EE technique is the cost analysis, that is a form of partial EE studies, where there are no explicit comparisons between alternative interventions in terms of both costs and benefits, but it can contribute useful evidence to the understanding of economic aspects of interventions such as the value of resources devoted to an intervention (Drummond et al., 2015).

Although this proposed study recognizes the importance of the full EE approach principles in decision-making in the health care sector, in the context of IRS – where

⁷ QALY is a measurement of the state of health of a person that involves both quality and quantity of life (length of life) gained due to following a particular health intervention (Drummond et al. 2015).

⁸ DALY is a measurement of the years of life lost due to ill-health, disability or early death (Drummond et al. 2015).

effectiveness has already been established and the decision to implement has been made (DNSP, 2012) – full EE techniques are less relevant. Instead, given current ODA restrictions, the suitability of IRS operationalization has become a considerable barrier in the implementation of this effective malaria intervention. Thus, to achieve the purpose of this research, cost analysis is the most appropriate technique.

Table 5. Economic Evaluation Techniques and Criteria for Measurement of Costs and Consequences

Type of Technique	Measurement of costs	Measurement of consequences
Cost minimization analysis	Monetary units	Equivalence demonstrated or assumed in comparative groups
Cost benefit analysis	Monetary units	Monetary units
Cost effectiveness analysis	Monetary units	Single natural units (e.g. life years gained, disability days saved, points of blood pressure reduction, etc.)
Cost utility analysis	Monetary units	Multiple natural units (e.g. healthy life years typically measured as QALYs or DALYs)
Cost analysis	Monetary units	None

Source: (Drummond et al., 2015)

2.2 Concepts of Cost Analysis and Costs of Health Care Interventions

Experts in this method usually frame cost analysis definitions from a common point of view. It is the part of EE and currently a commonly used tool to evaluate how much a health care intervention costs (Swderlund et al., 1999; Johns et al., 2003; Drummond et al., 2015; Hutubessy et al., 2015). This is done in order to make health care decision-makers aware of the real costs of implementing health interventions and to enhance the use of resources.

Given the pivotal role that costs play in EE, and as the major issue for the implementation of health interventions due to scarcity of resources, it is important to describe this concept from an economic point of view. By definition, the costs of providing health interventions such as IRS are expressed by the value of resources used in making the intervention available (Edejer et al., 2003 and Drummond et al., 2015). However, the literature shows that due to the scarcity of resources surrounding the implementation of health interventions, in EE, costs are perceived not

only as countable values of money but also as implicit values (or opportunity costs) (Edejer et al., 2003; Hale et al., 2003; Drummond et al., 2015). This implies that because of the scarcity of resources, by choosing to use available resources in one way – IRS for example – we forgo other opportunities to use these same resources, i.e. in other health interventions. Thus, in the context of evaluating costs, researchers have determined two major types of costs: opportunity (or economic) costs and financial costs.

The concept of financial costs implies the value of the resources determined by the market on goods and services and therefore represent how much money was paid to provide a health intervention (Edejer et al., 2003). This category includes interest payments, taxes, insurances, subsidies and duties. Examples of financial costs include salaries of personnel that are mostly covered by the government budget in Mozambique.

It is important to note that for health interventions, not only the market prices are included but also those costs related to volunteered time, and donated and subsidized goods and services. Thus, costing in EE is based on the concept of opportunity costs. This concept of opportunity cost implies that using a resource in one activity means that the same resource cannot be used in another activity. Hence, the opportunity cost of a resource can be described as the “value forgone of not using the same resource in its next best alternative” (Edejer et al., 2003 and Drummond et al., 2015).

However, unlike the financial costs, those costs reflect both economic and financial costs in that the first will include the opportunity costs meaning that in economic costs, market prices and opportunity costs are included (Edejer et al., 2003 and Drummond et al., 2015). For example, the cost of volunteer workers, when applying the principle of opportunity cost, includes the costs of his/her time, which could have been devoted to an alternative activity (such as cultivating the land). As such, the volunteer workers’ time will be valued as the equivalent to the cost of hiring personnel with similar qualifications (Edejer et al., 2003; Drummond et al., 2015; WHO 2017).

This opportunity cost is captured through the process of equivalent costs. Another example related to capital items on the delivery of IRS, there is an opportunity cost of using a vehicle to transport spray operators in that the vehicle could have been used to transport patients. In practice, this opportunity cost is captured through the process of annuitization outlined below (WHO, 2017).

Edejer et al., (2003), Drummond et al., (2015), and the WHO (2017) emphasized the importance of economic costs as well as evaluated and priced items donated by donors. For instance, a communications company may decide to donate TV time for health education and communication regarding IRS; or an NGO may decide to subsidize the price of protective clothes for IRS operators. Then, the value of these items will not reflect the market price; however, it needs to be accounted for, in the cost analysis through the process of equivalent value.

2.3 Review of Studies of Cost Analysis of Interventions to Control Malaria

Although the application of costs analysis received considerable attention in evaluating costs of implementing malaria interventions, it is important to recognize that, to date, few cases of single cost analysis for IRS have been drawn up. In fact, in 2011, a systematic review of EE of malaria control interventions identified 55 relevant costing studies of malaria interventions published between 2000 and 2010 (White et al., 2011). Of these 55 identified studies, only seven were purely focused on cost analysis of IRS (White et al., 2011).

Thus, a considerable proportion of the studies reviewed in the current study presented a combination of estimates of CEA that compares IRS and other tools to control malaria, and only one from the reviewed 5 studies identified presented a pure cost analysis, however of a school-based comprehensive malaria program in primary schools (Macarrio et al., 2017). It should be noted that the analysis of costs is common in all EE techniques, hence the studies reviewed in this chapter provided similar steps for conducting cost analyses, irrespective of the focus on interventions in order to control malaria and the EE technique.

Studies presented in this review were implemented from 2001 to 2017 and most of them were undertaken in SSA region, considering the influence of context specifics due to the heterogeneity of factors influencing the burden of malaria that is, in turn, likely to influence the transmission season and the costs of key resources.

Economic and financial costs were presented and were discussed separately in all studies. Most of the studies reported economic costs higher than financial costs and all stated a single difference between the two costs. However, the study of Conteh et al., (2004) done in Mozambique reported financial costs higher than economic costs.

In all studies, costs were collected from the provider's perspective. The base objective of the study was to provide information regarding the costs of the intervention to inform health care decision-makers. In this context, only direct costs were included in calculation of costs, and all studies

distinguished cost categories in personnel, overhead, capital and intervention or program costs, but cost categories had different components depending on the study objective (Goodman et al., 2001; Guyatt et al., 2002 and Conteh et al., 2004). For example, Conteh et al., (2004) included intervention costs of insecticide and supplies, monitoring and evaluation; personnel costs were for staff time, cost of training, and project management; and capital costs were for vehicles, equipment, buildings, and storage. Goodman et al., (2001) included the following components on the categories of costs: intervention costs for insecticide, spray pumps, and protective clothing for spray staff; personnel costs included time of personnel; and capital costs were for vehicles, water trailers, bicycles, storage, and equipment for spraying.

All studies reported the unit of analysis and most of the studies standardized it as cost per person protected per year (Goodman et al., 2001; Guyatt et al., 2002; Conteh et al., 2004). In the study where costs of IRS were not reported, unit of analysis was standardized as cost per child (Maccario et al., 2017).

Almost all studies clearly stated that capital costs were annualized over the useful life and using a discount rate that ranged from 1% to 10% to calculate the equivalent annual costs.

Costs were first converted from local currency to US\$ using the exchange rate at the year of analysis and then converted to US\$ using national inflation rates to allow comparison of the costs and benefits of several different interventions through various delivery channels, across different geographical regions and from varying costing perspectives. There were, however, variations on the resulting report regarding the currency used. For instance, even though the study of Goodman et al., (2001) and Guyatt et al., (2002) stated the conversion from local to US\$ currency, they reported their results in the national currency.

Results of the sensitivity analysis were reported in almost all studies and those studies included the DSA and used, in some cases, only “one-way” and others both “one-way” and “multiple- way” sensitivity analyses. In these studies, the limits of the sensitivity analyses were taken to be the highest and lowest estimates of costs or cost-effectiveness ratios or were chosen randomly depending on the cost of the study. National interest rates and discount rates provided by the literature were used in the sensitivity analysis. For instance, the studies of Goodman et al., (2001) and Conteh et al., (2004) state that the interest rate used to annualize capital resources was changed in the sensitivity analysis to standard discount rates of 3% as according to these studies recommended by Drummond et al., 2015. The main parameters included in the sensitivity analysis

were the price of insecticide, discount rate for costs, insecticide costs, population size, the number of structures sprayed daily, and treatment costs.

Conclusion

Overall, there was not much variation in the methodology of the studies reviewed, and all the studies followed the methodology recommended by EE experts such as Edejer et al., (2003) and Drummond et al., (2015) to conduct the cost analysis. Moreover, most of the studies were carried out in SSA regions, thus making their findings directly applicable to the Mozambican setting due to the context specificity of the malaria burden. Overall, the study quality was good, as most studies presented minor methodological limitations, only related to the validation of capital costs. However, these results showed that to date there has been a lack of full single cost analysis studies conducted in SSA region. In the case of Mozambique, the only available cost related study addresses the cost and cost effectiveness of IRS in order to compare two different sources of funds. This shows a gap in the literature regarding full and single cost analysis of IRS studies to inform decision makers regarding the costs of this important intervention to control malaria. This highlights the urgent need for research to address this shortfall. As such, the strength of the present study is that it will be the first single cost analysis of IRS operationalization in order to advise health care decision-makers in Mozambique and one of the few of this kind globally. This is useful in addressing the critical concerns caused by current government budget restrictions and their impact on the implementation of health interventions, particularly IRS in Mozambique, by estimating the resources required to sustain the intervention. Table 6 presents the systematized extracted information (methodology) reported in all studies to allow cross comparisons among the studies.

Table 6. Systematized Information from the Studies

Study's author and year	Country	Type of study	Costing approach	Perspective	Identification	Measurement	Validation of capital resources costs	Sensitive analysis
Goodman et al., (2001)	South Africa	Comparison of the cost and cost-effectiveness of ITNs and IRS in KwaZulu-Natal, South Africa	Economic	Provider	Direct costs	Cost per person protected	Real RSA interest rate on the year of analysis	5.3% interest rate was change to 3% discount rate. Extending the useful life of net from 4 to 6. Varying cost of cost drivers
Guyatt et al., (2002)	Kenya	Comparison of the effectiveness and cost-effectiveness IRS and ITNs for prevention in highland Kenya:	Economic	Provider	Direct costs	Cost per person protected	Unclear	Unclear
Conteh et al., (2004)	Mozambique	The cost and cost-effectiveness of malaria vector control by residual insecticide house-spraying in southern Mozambique: a rural and urban analysis	Economic	Provider	Direct costs	Cost per person covered	Real RSA interest rate on the year of analysis	5.3% interest rate was changed to 3% discount rate.

Study's author and year	Country	Type of study	Costing approach	Perspective	Identification	Measurement	Validation of capital resources costs	Sensitive analysis
Maccario et al., (2017)	Mali	Cost analysis of a school-based comprehensive malaria program in primary schools in Sikasso region, Mali	Economic	Provider	Direct costs	Total annual costs; Cost per child	Discount rate of 3% and expected useful lifespan	Discount rate of 1% and 3% were compared. Parameters variations ranging from -50% to +50%).
Howard et al., (2017)	Pakistan	Cost-effectiveness of adding indoor residual spraying to case management in Afghan refugee settlements in Northwest Pakistan during a prolonged malaria epidemic	Economic	Provider	Direct and indirect costs	Total annual case management costs; Total annual vector control costs; Annual per-capita case management costs; Annual per-capita vector control costs.	Discount rate of 10% and expected useful lifespan	3% 5% and 10% discount rate were compared. Parameters variation ranging from +30% to 50%.

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PART C: JOURNAL ARTICLE

Proposed Journal: Health Policy and Planning

Conducting a Cost Analysis to Address Issues of Budget Constraints on the Implementation of the Indoor Residual Spray Program. An Intervention to Control and Eliminate Malaria in Three Districts of Maputo Province, Mozambique

⁹ Instructions for authors appear in the appendix section

Abstract

Introduction: Over the past few years, the capacity of the government of Mozambique to sustain the cost of payment of salaries to operationalize the Indoor Residual Spray (IRS), a widely recommended tool to control and prevent malaria, is facing numerous challenges. This is due to recent restrictions of the Official Development Assistance (ODA), an external aid scheme and the main source of financing of the Mozambican government budget. The objective of this study was to estimate the cost of IRS operationalization activities in Matutuine and Namaacha districts health directorates, in Maputo Province, Mozambique. A cost analysis using an approach from the provider perspective was conducted in two district health directorates in the Maputo province, Matutuine and Namaacha. The institutions were purposely selected since in 2014, in both districts, the expenditure on salaries to operationalize IRS was funded by the government budget. Cost information was collected retrospectively and both economic and financial costs were calculated. Uncertainty of results was tested using “one-way” deterministic sensitivity analysis. The average total annual economic cost was 117,351.34 US\$. The average economic cost per household sprayed totaled 16.35 US\$. On average the economic cost per person protected totaled is 4.09 US\$. In the financial analysis, the average total annual financial costs totaled 69,174.83 US\$. The average financial cost per household sprayed and per person protected was 9.84 US\$ and 2.46 US\$ respectively. Vehicles, personnel salaries and IRS consumables were the major substantial cost components. Leaving aside the ODA restriction and focusing on the aim of implementing IRS within the existing resources, the study makes suggestions for improving efficiency by focusing on areas with higher need and pays attention to cost drivers in order to reduce the costs.

Keywords: Cost analysis, Economic evaluation, Interventions to control malaria, malaria, Indoor residual spray, Government budget, Official development assistance, External aid, Mozambique

Introduction

In Mozambique, the expenditure related to personnel salaries to operationalize Indoor Residual Spray (IRS), the primary tool to prevent and control malaria widely depend in the government budget (PNMCM, 2017).

However, the government of Mozambique has been facing budget difficulties due to restriction of Official Development Assistance (ODA), an external aid scheme and its main source of budget financing. This imposes a challenge on the government who have been facing difficulties to sustain the total expenditure related to personnel salaries for IRS operationalization, causing difficulties in achieving what is required to reach IRS procedures for application including delayed spraying for the scheduled period (DPSM, 2017).

The objective of this study is to provide information regarding how much IRS operationalization costs by applying cost analysis. This is useful in order to address the critical concerns caused by current government budget restrictions and their impact on the IRS operationalization in Mozambique. The other important contribution of this study is that it will be the first single cost analysis of IRS operationalization and that generates both total annual economic and financial costs, economic and financial costs per household

sprayed, and economic and financial costs per person protected by IRS to inform decision making in Mozambique and one of the few single cost analysis of IRS operationalization internationally.

Material and Methods

Setting of Analysis

Matutuine and Namaacha are two districts located in Maputo province, Mozambique. In both districts, IRS activities are provided by the respective District Health Directorates. In both districts, salaries for IRS operationalization including recruitment and selection, social mobilization, training and operationalization were funded by the government budget and are thus susceptible to shocks due to ODA funding restrictions. This informed the choice of districts as the study settings.

Together Matutuine and Namaacha are considered low risk areas for malaria transmission, however, in both districts, the disease is the leading cause of the demand for health care in health units, and the second cause of mortality after HIV/AIDS (DPSM, 2014).

According to the 2014 IRS report by the DPSM, in 2014 Matutuine had total estimated population of 17,501 aggregated into 7, 479 households and Namaacha 27,597

aggregated into 8, 839 households (DPSM, 2014). Additionally, according to the last

available census conducted in 2007 by the INE, both Matutuine and Namaacha had, on average, four people per household (INE, 2011). During the 2014 IRS operationalization campaign, 6,123 and 8,373 households were sprayed in Matutuine and Namaacha, reaching a total of 82% and 95% of the total population in Matutuine and Namaacha respectively.

Description of the Intervention Activities

According to DPSM report on IRS operationalization in 2014, IRS operationalization in both districts was initiated on 20 October 2014 and finalized on 21 of December 2014, reflecting a total of 45 days of work. A combined total of 14,496 households (6,123 in Matutuine and 8,373 in Namaacha) were sprayed, corresponding to coverage of 82% and 95% of the target reached respectively. Houses were sprayed using DDT insecticides (92 kg and 81.34 kg in Matutuine and Namaacha, respectively) if they were constructed using local materials, while deltamethrin (26 kg and 16 kg in Matutuine and Namaacha, respectively) was used in masonry houses and houses located near food factories (DPSM, 2014).

The following activities took place: (I) procurement and supply of commodities needed for IRS operationalization as guaranteed by the Global Fund; (II)

recruitment and selection of potential spray operators recruited from the communities by the district government; (III) training of the spray operators for 10 days; (IV) social mobilization with involvement of the local government director, and chief medical officer of the district health directorate, local school directors, religious congregations, civil society, and others; and (V) operationalization of IRS. Coordination was the responsibility of the director of the district health directorate, who is the IRS coordinator at the district level. The field staff involved in IRS operationalization included 26 and 41 spray operators (recruited from the communities) in Matutuine and Namaacha, respectively. Each district had one coordinator (district director of district health directorate), one medical chief, one hospital administrator, two supervisors, one mobilizer, one driver, community leaders, one communications technician and one warehouse manager (DPSM, 2014).

Cost Analysis

Identification, measurement and valuation of costs

The study followed the provider's perspective, and all economic and financial resources used in the intervention were identified, measured and valued. All costs were collected and handled in the local currency Meticals (MZM), but for the purpose

of publication, translated into United States dollar (US\$) using the official exchange rate of 2014 provided by the Central Bank of Mozambique (1 US\$ correspond to 30.57 MZN) (Banco de Moçambique, 2018).

A key feature of cost analysis from the provider's perspective is that only direct costs are covered in the analysis (Edejer et al., 2003 and Drummond et al. 2015). Thus, only direct costs involved in the IRS operationalization were included in the study and were decomposed in the following categories: (I) recurrent, which included personnel, intervention and overhead costs and (II) capital costs. Details of the data that made these costs in both settings were gathered retrospectively using both micro and gross costing approaches from sources including records of expenditure, purchase inventories, official reports and, national and international market prices. This data was complemented by data on the number of households sprayed and average population size obtained from the last available National Census carried out in 2007 as produced by the National Institute of Statistics of Mozambique (INE, 2011).

The unit costs of these resources were calculated as total annual economic and financial costs. All recurrent and capital costs were summed and presented as a total amount across both district settings, and for

each district separately. Total economic and financial costs per household sprayed were estimated by dividing the total costs by the number of households sprayed. The total economic and financial costs per person protected were estimated by multiplying the average number of people per household by the number of households sprayed, with the numerator remaining as the total costs.

To estimate (I) personnel costs, daily wages were multiplied by number of days worked and the percentage of staff time spent on IRS operationalization; (II) costs of IRS consumables and stationery were estimated by multiplying the quantities of units consumed in IRS by the price for each unit resource; (III) total annual cost of transport was divided in two categories: rent of vehicle for staff transport and fuel costs. These costs were estimated on the basis of the number of days the resource was allocated to IRS multiplied by the estimated daily costs of rent or fuel. (IV) Maintenance costs were estimated based on the total annual cost of maintenance multiplied by the proportion of days the vehicle was allocated to IRS operationalization. Finally, (V) overhead costs were estimated based on the total annual costs multiplied by the percentage of staff time devoted to IRS operationalization.

To allow for the calculation of opportunity cost and depreciation aspects, the cost of

capital resources used by IRS were valued based on equivalent annual costs approach by annualizing the present value of the resources on the year of analysis over the annualized factor. The resulting annualized costs were extracted from standardized tables (Drummond et al. 2015) and were based on data such as the useful life of the capital resource, following WHO-CHOICE (WHO, 2018): 40 years for building, 5, 7 and 8 for various furniture and equipment, and 7 years for vehicles. The national interest rate (8%) was given by the Central Bank of Mozambique (Banco de Moçambique, 2018).

The purchase price of the resource in the year of analysis was extracted from the national and international market based on data from the national suppliers and standardized international prices available on WHO-CHOICE (WHO, 2018).

Sensitivity analysis

The last part of cost calculation involves the sensitivity analysis. The variables chosen were subject to several assumptions that could affect the results of the study hence, an extended “one way” sensitivity analysis was performed on the key variables in the model. Thus, (I) an increase or decrease of 25% was applied to the most significant costs drivers in order to identify the impact on the total

cost, following the practice in the literature (Maccario et al., 2017 and Howard et al., 2017). (II) The interest rate used in the calculation of equivalent annual costs of capital resources was varied from 8% (Banco de Moçambique, 2018) to 5.3% (Goodman et al., 2001 and Conteh et al., 2004). The results are presented as a tornado diagram.

Results

Total annual economic and financial costs

Tables 7 and 8 present the four identified cost categories and summarize the estimates of the total economic and financial costs. Total annual economic costs for providing IRS operationalization in 2014 was higher in Namaacha at 128,480.33 US\$ versus Matutuine at 106,222.36 US\$. With respect to the financial analysis, the results show total annual financial cost of 71,781.95 US\$ in Matutuine and 66,567.70 US\$ in Namaacha. Across both settings, the average annual economic cost was 117,351.34 US\$ while the average annual financial cost was 69,174.83 US\$.

Economic and Financial Cost per Household Sprayed

The results of the cost per household sprayed are illustrated in table 7 and 8. The average annual economic cost per household was estimated to be at 16.35 US\$, ranging from

17.35 US\$ in Matutuine to 15.34 US\$ in Namaacha. The average annual financial cost per household sprayed was estimated at 9.84 US\$ accounting for 11.72 US\$ in Matutuine and 7.95 US\$ in Namaacha.

Economic and Financial Cost per Person Protected

Economic cost per person protected was 4.34 US\$ and 3.84 US\$ in Matutuine and in Namaacha respectively. Financial costs per person protected was a little more in Matutine, at 2.93 US\$ compared to Namaacha, at 1.99 US\$. Average costs were estimated to be 2.46 US\$. Results are provided in Tables 7 and 8.

Table 7: Economic costs (Total Annual Costs, Cost Per Household (per HH) Sprayed and Cost Per Person (PP) Protected)

Economic costs												
Categories	Matutuine				Namaacha				Average (Matutuine + Namaacha / 2)			
	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)
Intervention	20,628.12	3.37	0.84	19	22,724.40	2.7	0.68	18	21,676.26	3.04	0.76	18
Personnel	29,445.16	4.81	1.20	28	23,849.30	2.8	0.71	19	26,647.23	3.83	0.96	23
Overhead	5,865.18	0.96	0.24	6	6,031.98	0.7	0.18	5	5,948.08	0.84	0.21	5
Capital	50,284.89	8.21	2.05	47	75,876.64	9.1	2.27	59	63,079.77	8.64	2.16	54
Total	106,222.36	17.35	4.34	100	128,480.33	15.3	3.84	100	117,351.34	16.35	4.09	100

Table 8: Financial costs (Total Annual Costs, Cost Per Household (per HH) Sprayed and Cost Per Person (PP) Protected)

Financial costs												
Categories	Matutuine				Namaacha				Average (Matutuine +Namaacha/2)			
	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)	Total US\$	Per HH Sprayed US\$	Per PP US\$	Total (%)
Intervention	20,628.12	3.37	0.84	29	22,724.40	2.71	0.68	34	21,676	3.04	0.76	31
Personnel	29,445.16	4.81	1.20	41	23,849.30	2.85	0.71	36	26,647	3.83	0.96	38
Overhead	5,865.18	0.96	0.24	8	6,030.98	0.72	0.18	9	5,948	0.84	0.21	9
Capital	15,843.49	2.59	0.65	22	13,963.01	1.67	0.42	21	14,903	2.13	0.53	22
Total	71,781.95	11.72	2.93	100	66,567.70	8.0	2.0	100	69,175	9.8	2.46	100

In the economic analysis, capital was the most expensive cost category in both settings, accounting for 53% on average. Personnel costs involved in the intervention operationalization were the second highest category in this analysis comprising on average 23%. Intervention and overhead costs were the lowest costs, sharing on average 19% and 5% respectively of the total costs in the economic analysis. Regarding the financial analysis, personnel costs were the most expensive category at 38%. Intervention costs were the second highest category, at 31%. Capital and overhead costs accounted for 22% and 9% of the financial cost. This is illustrated in Figure 3. In Figure 4, the costs are split into their components. This figure shows that vehicle, personnel salaries and IRS consumables were the costliest, accounting for 52%, 17% and 13% of the total economic costs and 16%, 28% and 23% in the financial analysis.

Figure 3. Distribution of the Average Costs Categories (%)

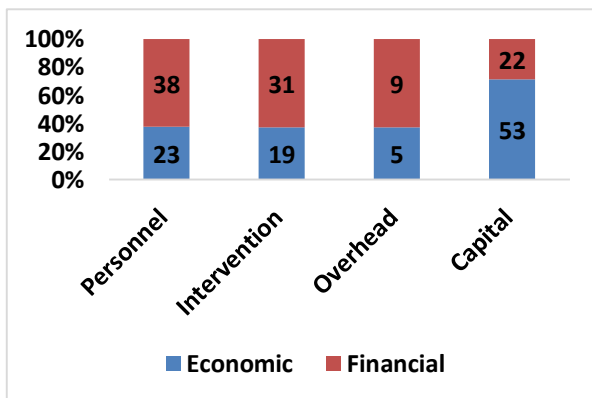
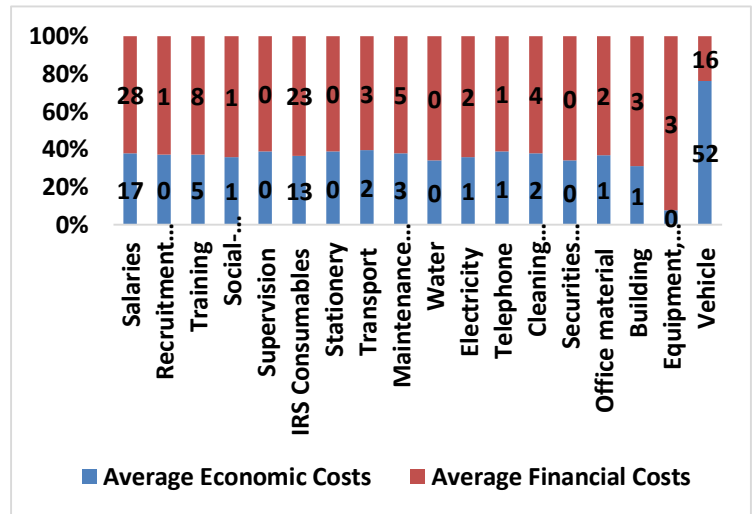


Figure 4. Distribution of the Average Costs

Components (%)



Sensitivity analysis

Figures 5 and 6 summarize the findings from “one-way” sensitivity analysis. The key primary parameters included were costs of vehicles, personnel salaries, IRS consumables and the interest rate. In the economic analysis, sensitivity analysis on the vehicles and interest rate had the largest impact on the total average economic costs. To illustrate, there was an approximate change of 13% in the average economic cost when vehicle cost was decreased by 25%. In addition, the average economic cost rose by 11% when the same cost was increased by 25%. In contradiction, in the financial analysis vehicle costs were the least sensitive. To illustrate, when the cost of this good was decrease by 25%, the average financial cost decrease only approximately 4%, and when the cost was increase by 25% the average financial

cost increased by only approximately 4%. Furthermore, in the financial analysis, personnel salaries and IRS consumables had the most relevant impact. To illustrate, when personnel salaries were changed by 25%, average financial costs changed by approximately 7%. On the other hand, when consumable costs changed by 25%, the average financial cost changed by approximately 6%.

Figure 5. A Tornado diagram summarizing the impact of the “one-way” sensitivity analysis on the annual average economic cost.

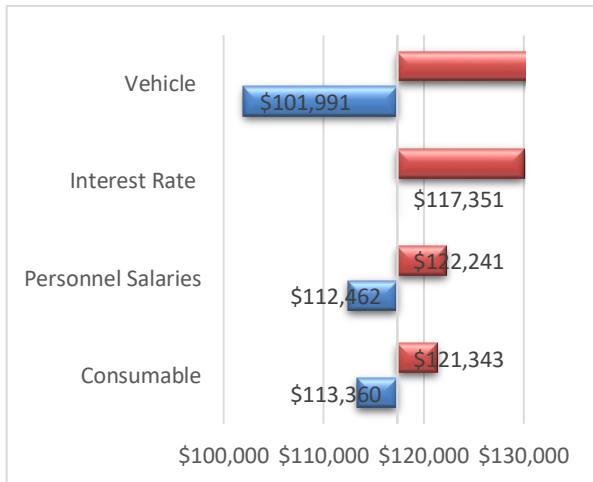
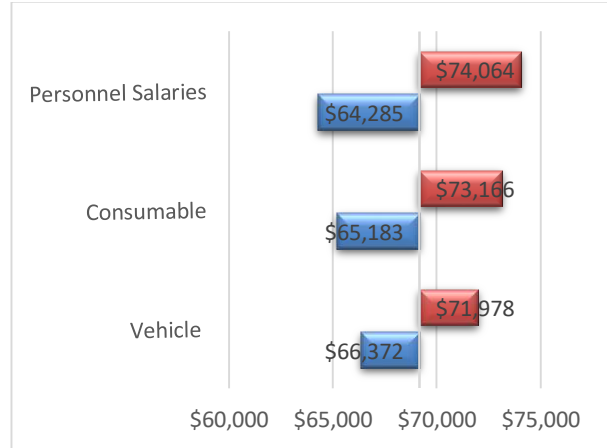


Figure 6. A Tornado diagram summarizing the impact of the “one-way” sensitivity analysis on the annual average financial cost



Discussion

The ODA is an international aid scheme used to overcome financial barriers of poor countries. However, in Mozambique it has been restricted, thus affecting government budget and consequently the IRS operationalization. While research into cost analysis of interventions to control malaria has been attracting interest in African settings, to the best of our knowledge this is the first economic and financial single cost analysis to address concerns of budget restriction in Mozambique. Thus, this study aims to offer an important contribution to the government of Mozambique on the evidence of how much IRS operationalization costs to inform concerns to the government due to the budget constraints. Total economic costs estimates show that, per year, IRS operationalization cost is 117,351.34 US\$ on

average. In the financial analysis, the average costs totalled 69,174.83 US\$.

This is in line with previous studies that commonly report financial costs that are lower than economic costs (Goodman et al., 2001; Guyatt et al., 2002). In this current study, one category that made up this wide differential gap was the exclusion of annualized vehicle-related costs in the financial analysis. Instead, in the financial analysis vehicle costs were calculated using the costs of renting and maintenance during IRS campaign.

Furthermore, this study revealed that the main cost drivers of the cost of IRS in both settings are the vehicle, personnel salaries and IRS. To illustrate, vehicle costs accounted for 52% and 16% of the average economic and financial costs respectively.

For salaries, the cost was 17% and 28% of the average economic and financial costs respectively while IRS consumables accounted for 13% and 23%. This is in line with the findings of Goodman et al., (2001), Guyatt et al., (2002) and Conteh et al., (2004) who document in their studies that vehicles, personnel salaries and IRS consumables comprise the largest proportion of the total costs of IRS operationalization.

In the sensitivity analysis, decreasing vehicle costs by 25% reduces the average economic cost by 13%, from 117,351.34 US\$ to 101,990.66 US\$. On the other hand, in relation to the average financial costs, when vehicle costs decrease by 25% the average financial cost decrease from 69,174.83 US\$ to approximately 66,371.71 US\$, showing a change of approximately 5%. These results show that vehicle costs do not influence the financial analysis of IRS operationalization much. In fact, one observation of this study is that district health directorates have traditionally operationalized IRS using donated vehicles to reach the targeted households, meaning that no cash expenditure or financing from the national government budget was used to purchase these items. Taking this into consideration, one element worth considering is local private partners to donate these goods to support IRS campaigns.

Costs could be reduced further if there were savings in the cost of personnel salaries. The sensitivity analysis shows that after reducing this cost by 25% the average economic cost decreased by approximately 4%, from 117,351.34 US\$ to 112,461.68 US\$ and the average financial cost decreased by approximately 7%, from 69,174.83 US\$ to 64,285.17 US\$. While determination of the reasons behind the allocation of personnel

salaries is beyond the scope of this study, the cost data revealed some type of inefficiency in the allocation of budget to pay personnel salaries. For instance, Namaacha that had less spray operators and achieved less coverage of the target households had bigger budget to support salaries of spray operators. Therefore, the distribution of budget would most likely drop if the application of efficiency was taken into account when establishing priorities in relation to budget allocation.

Previous studies in African settings estimated the financial and economic cost per person protected to range between 0.86 US\$ and 3.48 US\$. To illustrate, the study of Guyatt et al., (2002) done in the highlands of Kenya, found the financial cost for protecting one person by IRS was 0.86 US\$ while the economic cost was 0.88 US\$. The study in southern Mozambique by Conteh et al., (2004) found that the economic cost per person protected per year using IRS in rural areas was 3.48 US\$ and 2.16 US\$ in peri-urban areas, while the financial cost for rural areas was 3.86 US\$ and for peri-urban areas was 2.41 US\$. A review of literature in 2011 showed that the average financial cost of protecting one person for one year was 2.20 US\$ (White et al., 2011). In this study the economic cost per person protected was estimated to be 4.34 US\$ in Matutuine

and 3.84 US\$ in Namaacha and the financial cost per person protected was estimated to be 2.93 US\$ and 1.99 US\$ in Matutuine and Namaacha respectively in 2014 prices.

Nonetheless, the estimates of this current study stand out from the study of Guyatt et al., (2002), but are similar to those of Conteh et al., (2004) done also in Mozambique.

Despite its higher financial costs, but in light of restricted government budgets, the government of Mozambique may prefer distribution of ITNs through sales supported by social marketing, as this delivery strategy shifts the financial burden away from government, and spray only in areas considered strictly necessary. The problem, however, is that costs of ITNs will fall directly on the population, further worsening issues of financial affordability for a population already struggling to pay for Malaria treatment. Therefore, a study that estimates the impact of the financial burden of IRS and its acceptability and affordability by the population is suggested. In addition, further – Budget Impact Analysis studies that assess the affordability by the government of Mozambique by estimating the impact of the IRS operationalization on the fixed government budget are also suggested.

Study Limitation

The collection of cost data was the most likely source of information bias in this study since the data was collected retrospectively. For instance, some information and data regarding intervention costs (specifically material and supplies) were not found in the setting of analysis, thus it was exported from the Provincial Directorate of Health in Maputo province. Therefore, data was assumed to be correct and the information was used for both settings of analysis. However, our estimates may be conservative as this information may therefore be subject to biases that may have influenced the study estimates. To minimize this bias, source documentation for key data, namely accounting spreadsheets, was reviewed for quality. The other limitation that this study faced was the lack of EE of IRS studies in Mozambique, including single cost analysis studies. Thus, based on the results and conclusions of this study, suggestions for future work in the line of this study to compare the results is suggested.

Conclusion

This study has assessed the costs of IRS in two poor Mozambican settings, where recent data suggests that a reduction in IRS spraying in the past four years may have led to an increase in Malaria incidences. While the study found some

potential inefficiencies in the allocation of personnel expenditure in one setting, the overall cost per person protected is low and is in line with other studies. Despite this relatively low cost, IRS is currently unaffordable to the Mozambican government in these settings due to the ODA restriction.

Ethical Approval

Ethical approval was obtained from the Human Research Ethics Committee of the University of Cape Town (approval ID: HREC REF: 821/2017). Permission was also sought from the Provincial Health Directorate in Maputo province.

Author's Contributions

CG, Neide, conceived the topic for the study, performed the analysis and drafted the manuscript. C, Susan reviewed the manuscript.

Authors' Information

CG, Neide, is a Master's in Public Health student, specializing in Health Economics at the University of Cape Town, South Africa. C, Susan is a lecturer at the Health Economics Unit at the University of Cape Town, South Africa and PhD coordinator in the School of Public Health and Family of Medicine at the University of Cape Town, South Africa.

Competing Interest

The authors declare that there is no competing interest regarding the publication of this paper.

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PART D: POLICY BRIEF

POLICY BRIEF



Conducting a Cost Analysis to Address Issues of Budget Constraints on the Implementation of the Indoor Residual Spray Program. An Intervention to Control and Eliminate Malaria in Two Districts of Maputo Province, Mozambique

Introduction

To respond to the epidemic of malaria, the main cause of death and one of the major challenges to economic development, the government of Mozambique adopted Indoor Residual Spray (IRS) as the main tool to control and prevent the disease (PNCM, 2017). In several areas of Mozambique, IRS is funded through the government budget, which in turn is substantially supported by Official Development Assistance (ODA) (MEF, 2015).

However, since 2015, levels of ODA have been

restricted, with serious implications regarding whether the government of Mozambique can continue to fund IRS. This brief summarizes the findings of a cost analysis conducted on IRS intervention operationalization in Matutuine and Namaacha, two districts of Maputo province, Mozambique, where IRS operationalization activities were fully financed by the government budget in 2014.

Indoor Residual Spray

The WHO defines IRS as the application of a long-lasting residual insecticide in internal walls, eaves and ceilings of all houses or structures (including domestic animal shelters) to a potential malaria vector (WHO, 2015). In Mozambique there are two inter-related objectives of IRS application, namely to control and reduce malaria-related morbidity, mortality and to contribute to the Mozambican plan to reduce poverty (PNCM, 2017)

Key Messages

- The government of Mozambique's budget is the primary source of financing salaries for IRS operationalization.
- ODA is the largest overall contributor towards this budget.
- Since the level of ODA has been restricted, the affordability of IRS in certain areas has been compromised.
- This study aims to contribute towards an understanding of the cost of IRS from the perspective of the government, and to make recommendations about how efficiencies in the implementation of IRS might be increased.

Study Methods and Results

Methods: A cost analysis using the provider’s perspective was conducted in two district health directorates in the Maputo province, Matutuine and Namaacha. The institutions were purposely selected since in 2014, in both districts, the expenditure on IRS salaries was funded by the government budget. Cost information was collected retrospectively based on micro and gross approaches to derive both economic and financial costs. Uncertainty of results was tested using “one-way” deterministic sensitivity analysis.

Results: The average total annual economic cost was 117,351.34 US\$. The average economic cost per household sprayed totalled 16.35 US\$. On average economic cost per person protected totalled 4.09 US\$. In the financial analysis, the average total annual financial costs totalled 69,175.83 US\$. The average financial cost per household sprayed and per person protected was 9.84 US\$ and 2.46 US\$ respectively. Capital and personnel costs were the most expensive costs in the economic analysis. In the financial analysis, personnel and IRS consumables were the most expensive. In terms of cost components, vehicles, personnel salaries and IRS consumable were the costliest. The breakdown of average cost categories and cost components is shown in figure 7 and 8.

Figure 7. Distribution of the average cost categories of IRS operationalization

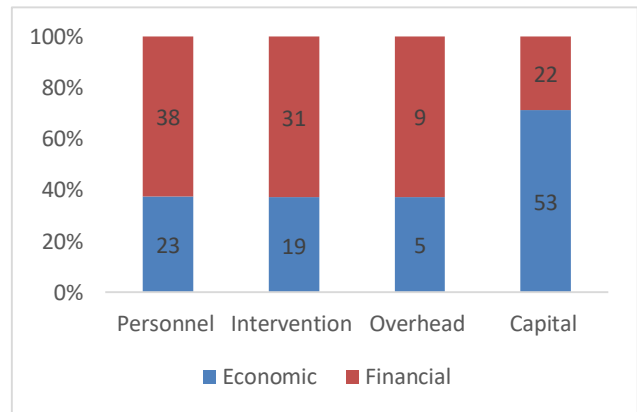
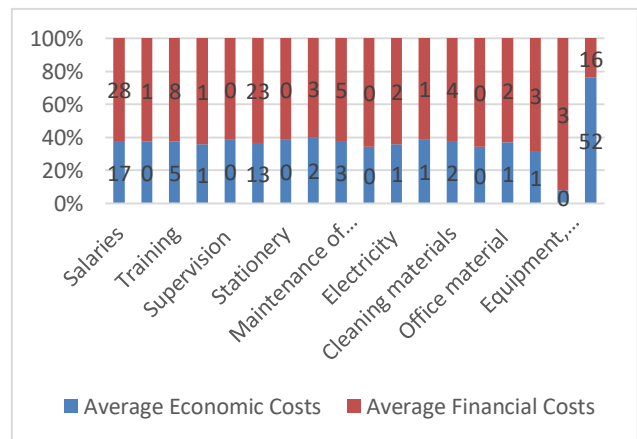


Figure 8. Distribution of the average cost components of IRS operationalization



Policy Implications and Recommendations

To overcome the implication on IRS operationalization due to ODA restriction on the government budget, this brief recommends the following points to reduce costs and improve efficiency:

Recommendation 1: Develop strategies to deal with the cost drivers by enhancing local private sector co-operation to reduce capital costs

One observation of this study is that district health directorates have traditionally operationalized IRS using at least two donated vehicles to reach the targets households, meaning that no cash expenditure or financing from the national government budget was used to purchase these items. Thus, for potential cost savings, this study suggests exploring the feasibility of vehicle donations from local partners and/or private sector as well as local partners and private sector to subsidize the cost of transport.

Recommendation 2: Develop strategies to increase efficiency

Evidence from several studies demonstrates that IRS is less costly when campaign teams achieve economies of scale. In fact, in 2014, Namaacha district compared to Matutuine district had a higher number of households sprayed, at a lower economic cost per household sprayed. Thus, it can be considered that the main reason for the cheaper cost per household sprayed and cost per person protected in Namaacha is the larger number of target households.

Recommendation 3: Expand ITNs for other groups

Even though IRS is the core strategy for malaria control in the country, the use of IRS, ITNs, and environmental management are emphasized in the latest Mozambican Malaria Strategy Plan (PNCM 2012). ITNs are the second core strategy to control and prevent malaria in the country. However, this approach has been focused on distributing ITNs to vulnerable groups, mainly pregnant women, children under 5 years of age and the elderly population, and/ or providing ITNs at the lowest possible price for other population groups in areas where IRS coverage is limited.

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PART E: APPENDICES

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Appendix 2: Journal Manuscript Instructions

Health Policy and Planning



Manuscript Preparation

Page 1: Title Page

Page 2: Abstract. The abstract should be prepared in one paragraph; no headings are required. It should describe the purpose, materials and methods, results, and conclusion in a single paragraph no longer than 300 words without line feeds.

Page 3: Introduction. The Introduction should state the purpose of the investigation and give a short review of the pertinent literature and be followed by:

Materials and methods. The Materials and methods section should follow the Introduction and should provide enough information to permit repetition of the experimental work. For particular chemicals or equipment, the name and location of the supplier should be given in parentheses. Results. The Results section should describe the outcome of the study. Data should be presented as concisely as possible, if appropriate in the form of tables or figures, although very large tables should be avoided.

Discussion. The Discussion should be an interpretation of the results and their significance with reference to work by other authors.

Abbreviations. Non-standard abbreviations should be defined at the first occurrence and introduced only where multiple use is made. Authors should not use abbreviations in headings.

All measures should be reported in SI units, followed (where necessary) by the traditional units in parentheses. There are two exceptions: blood pressure should be expressed in mmHg and

hemoglobin in g/dl. For general guidance on the International System of Units, and some useful conversion factors, see 'The SI for the Health Professions' (WHO 1977).

References. References must follow the Harvard system and must be cited as follows: Baker and Watts (1993) found...

In an earlier study (Baker and Watts 1993), it...

Where works by more than two authors are cited, only the first author is named followed by 'et al.' and the year. The reference list must be typed double-spaced in alphabetical order and include the full title of both paper (or chapter) and journal (or book), thus:

Baker S, Watts P. 1993. Paper/chapter title in normal script. Journal/book title in italics Volume number in bold: page numbers.

Baker S, Watts P. 1993. Chapter title in normal script. In: Smith B (ed). Book title in italics. 2nd edn. Place of publication: Publisher's name, page numbers.

Tables All tables should be on separate pages and accompanied by a title - and footnotes where necessary. The tables should be numbered consecutively using Arabic numerals. Units in which results are expressed should be given in parentheses at the top of each column and not repeated in each line of the table. Ditto signs are not used. Avoid overcrowding the tables and the excessive use of words. The format of tables should be in keeping with that normally used by the journal; in particular, vertical lines, colored text and shading should not be used. Please be certain that the data given in tables are correct. Tables should be provided as Word or Excel files.

Conflict of Interest

Authors must declare any conflicts of interest during the online submissions process. The lead author is responsible for confirming with the co-authors whether they also have any conflicts to declare.

Ethical Approval

A requirement of publication is that research involving human subjects was conducted with the ethical approval of the appropriate bodies in the country where the research was conducted and of the ethical approval committees of affiliated research institutions elsewhere. Furthermore,

subjects' consent must have been obtained according to the Declaration of Helsinki. A clear statement addressing all these points must be made in any submitted manuscript presenting such research. In original articles, this information must also be included in the methods section of the submitted manuscript. Please note that it is the responsibility of the corresponding author to ensure that the relevant ethical approval described above is provided. The Editors-in-Chief reserve the right to refuse publication where the required ethical approval/patient consent is lacking, or where the approval/consent provided is deemed incomplete or ambiguous.

Funding

The following rules should be followed:

The sentence should begin: 'This work was supported by ...'

The full official funding agency name should be given, i.e. 'the National Cancer Institute at the National Institutes of Health' or simply 'National Institutes of Health' not 'NCI' (one of the 27 sub institutions) or 'NCI at NIH' - [see the full RIN-approved list of UK funding agencies](#) for details

Grant numbers should be complete and accurate and provided in brackets as follows: '[grant number ABX CDXXXXXXX]'

Multiple grant numbers should be separated by a comma as follows: '[grant numbers ABX CDXXXXXX, EFX GHXXXXXX]'

Agencies should be separated by a semi-colon (plus 'and' before the last funding agency)

Where individuals need to be specified for certain sources of funding the following text should be added after the relevant agency or grant number 'to [author initials]'

An example is given here: 'This work was supported by the National Institutes of Health [P50 CA098252 and CA118790 to R.B.S.R.] and the Alcohol & Education Research Council [HFY GR667789].

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Appendix 3: UCT Ethical Approval Letter



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room ES3-46 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6625
Email: shuretta.chomas@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

29 November 2017

HREC REF: 821/2017

A/Prof S Cleary
Health Economics Unit
Public Health & Family Medicine
Falmouth Building

Dear A/Prof Cleary

PROJECT TITLE: CONDUCTING A COST ANALYSIS TO ADDRESS ISSUES OF BUDGET CONSTRAINTS ON THE IMPLEMENTATION OF THE RESIDUAL SPRAY PROGRAM. AN INTERVENTION TO CONTROL AND ELIMINATE MALARIA IN THREE DISTRICTS OF MAPUTO PROVINCE, MOZAMBIQUE (Master's candidate- Ms N Guilherme)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study subject to approval from the Mozambique Ethics Committee.

Approval is granted for one year until the 30 November 2018.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

The HREC acknowledge that the student, Neide Mercia Canana Guilherme will also be involved in this study.

Yours sincerely

signature removed to avoid exposure online

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

90

HREC 821/2017

Appendix 4: Costing Interventions template (Abbreviated)



WHO/HSS/HSF/CEP¹

CostIt (Costing Interventions template)©

CostIt for programme costs

* Indicates sheets where no or minimal data entry is required

1 [Intervention Information](#)

Programme costs:

2 [Programme Costs: At the National-Level](#)

3 [Programme Costs: At the Provincial-Level](#)

4 [Programme Costs: At the District-Level](#)

5 [Programme Costs: At the Household-Level](#)

* 6 [Programme Costs Summary \(All levels\)](#)

N. B.: Sheets 2-6 includes programme costs incurred at central, provincial and/or district levels and household level. They do not include facility (patient) related costs.

Intervention Costs Summary, including patient (beneficiary) costs:

* 6 [Intervention Costs Summary, Economic Perspective](#)

* 7 [Intervention Costs Summary, Financial Perspective](#) (function not implemented)

Footnote:

1.HSS: Health Systems and Services

HSF : Health Systems Financing

CEP: Costs, Effectiveness, Expenditure and Priority Setting

CostIt for Programme Costs

Name of Intervention	
Intervention id number	
Description	

Basic Information Sheet

a) Background information:	
Country name:	
Base year of cost data:	
Local currency:	
Exchange rate to US \$:	
Discount rate	3%

Mandatory!

The year(s) for which cost data was collected, and the GDP deflator of the respective years, should be entered beforehand in order to automatically adjust costs to the base year

insert base year here

GDP Deflators:					
Year:					
Deflators:					

Useful Life of Programme Start-Up:

b) Demographic data

Target population	Description of the target population (eg. age, sex, risk group)	Total no. of target population (regardless of coverage levels)	Country population	Year

[Go to Intervention Costs Summary Sheet \(Economic Perspective\)](#)

c) Capacity utilisation

[Go to Programme Costs Summary Sheet](#)

1)	Average capacity utilisation at higher (administrative) levels	Actual	Standardised
		Percentage	Percentage
i)	At National-level		
	Personnel		
	Means of transport		
ii)	At Provincial-Level		
	Personnel		
	Means of transport		
iii)	At District-level		
	Personnel		
	Means of transport		

2) Capacity utilization in facilities

i) Small facilities (e.g. primary health care)									
Type of providers	Government/Public		Non-Government		Private		Other		
Capacity utilisation (visits/provider/day)	Actual	Norm	Actual	Norm	Actual	Norm	Actual	Norm	
ii) Large facilities (e.g. hospitals)									
Type of providers	Government/Public	Non-Government	Private	Other					
Capacity utilisation (occupancy rate)									

CostIt for Programme Costs

Name of Intervention	
Intervention id number	
Description	

Basic Information Sheet

a) Background information:	
Country name:	
Base year of cost data:	
Local currency:	
Exchange rate to US \$:	
Discount rate	3%

Mandatory!

The year(s) for which cost data was collected, and the GDP deflator of the respective years, should be entered beforehand in order to automatically adjust costs to the base year

insert base year here

GDP Deflators:						
Year:						
Deflators:						

Useful Life of Programme Start-Up:

b) Demographic data

Target population	Description of the target population (e.g. age, sex, risk group)	Total no. of target population (regardless of coverage levels)	Country population	Year

[Go to Intervention Costs Summary Sheet \(Economic Perspective\)](#) [Go](#)

[to Programme Costs Summary Sheet](#)

c) Capacity utilisation

1)	Average capacity utilisation at higher (administrative) levels	Actual	Standardised
		Percentage	Percentage
i)	At National-level		
	Personnel		
	Means of transport		
ii)	At Provincial-Level		
	Personnel		
	Means of transport		
iii)	At District-level		
	Personnel		
	Means of transport		

2) **Capacity utilization in facilities**

i) Small facilities (e.g. primary health care)								
Type of providers	Government/Public		Non-Government		Private		Other	
Capacity utilisation (visits/provider/day)	Actual	Norm	Actual	Norm	Actual	Norm	Actual	Norm
ii) Large facilities (e.g. hospitals)								
Type of providers	Government/Public	Non-Government	Private	Other				
Capacity utilisation (occupancy rate)								

CostIt for Programme Costs

Provider Programme Costs at the District Level

[Go to Programme Costs Summary](#)

Name of intervention	0
Intervention id number	0
Programme coverage (%)	0%

Programme activities	
Number of activities	Name of intervention activities (examples are: training, planning, media, administration etc. See description in the user guide)
Activity 1:	0
Activity 2:	0
Activity 3:	0
Activity 4:	0
Activity 5:	0
Activity 6:	0

Names of the activities undertaken for the intervention should be inserted in this column.

Note names of activities are the same as at the national level by default but can be changed here.

Duration of start-up period (months)	
--------------------------------------	--

[Go to Programme Start Up Capital costs](#)

[I] PROVIDER PROGRAMME 'START UP' COSTS	Discount rate	3%
---	---------------	----

[Go to Programme Post Start Up Recurrent Costs](#)

A. RECURRENT COSTS

[Go to Programme Post Start Up Capital Costs](#)

A.1. PERSONNEL COST Base Year GDP Deflator:

Sr. No.	Type of personnel (job title)	Contributors	Number of person months	Gross salary per month		Benefits/allowances per month		Total salary per month	
				Financial	Economic	Financial	Economic	Financial	Economic
				(b)	(c)	(d)	(e)	(f)=(b+d)	(g)=(c+e)
a) Administration									
1								0.00	0.00
2								0.00	0.00
3								0.00	0.00
4								0.00	0.00
5								0.00	0.00
6								0.00	0.00
7								0.00	0.00
8								0.00	0.00