Economic Project Appraisal Manual for Kenya

Case Primary Educational Infrastructure Project (CEA)

2021

Final version

July 2021

By ICON and PIM Consulting Group

ABBREVIATIONS/ ACRONYMS

ADSCR	Annual Debt Service Coverage Ratio
ANPC	Annualized Net Present Cost
ANPV	Annualized Net Present Value
AR	Accounts Receivable
AP	Accounts Payable
BAC	Budget at Completion
BAU	Business-As-Usual
BCR	Benefit–Cost Ratio
CAPEX	Capital Expenditures
CBA	Cost-Benefit Analysis
CEA	Cost Effectiveness Analysis
CPB	Cost Per Beneficiaries
CPM	Critical Path Method
CSCF	Commodity Specific Conversion Factor
EAC	East African Community
Ee	Economic Exchange Rate
EIA	Environmental Impact Assessment
Em	Market Exchange Rate
ENPV	Economic Net Present Value
EOCK	Economic Opportunity Cost of Capital
EXT	Externalities
FEL	Front End Loading
FEP	Foreign Exchange Premium
FF	Finish to Finish
FNPV	Financial Net Present Value
FS	Feasibility Studies
FtS	Finish to Start
GDP	Gross Domestic Product
GoK	Government of Kenya
IRR	Internal Rate of Return
KES	Kenyan Shillings
KPI	Key Performance Indicators
LFA	Logical Framework Approach

LFM	Logical Framework Matrix
LLCR	Loan Life Coverage Ratio
MCA	Multi-Criteria Analysis
MDA	Line Ministries, Departments and Agencies
M&E	Monitoring and Evaluation
NGOs	Non-Government Organizations
NPC	Net Present Costs
NPP	National Priority Programs
NPV	Net Present Value
NTP	Premium on Non-tradable Outlays
OER	Official Exchange Rate
OPEX	Operational Expenditures
O&M	Operating and Maintenance
PACM	Project Alternatives Comparison Matrix
PAT	Project Alternatives Table
PCN	Project Concept Note
PEP	Project Execution Plan
PFS	Pre-Feasibility Studies
PIM	Public Investment Management
PIP	Public Investment Plan
PPP	Public Private Partnership
PDM	Precedence Diagramming Method
PtW	Permits to Work
RBS	Resource Breakdown Structure
ROI	Return on Investment
SCF	Standard/Generic Conversion Factor
SDR	Social Discount Rate
SER	Shadow Exchange Rate
SERCF	Shadow Exchange Rate Conversion Factor
SF	Start to Finish
SIA	Social Impact Assessment
SMART	Specific, Measurable, Achievable, Relevant, Time-bound
SOCC	Social Opportunity Cost of Capital
SOE	State Owned Enterprises
SPE	Strategic Planning Exercise

SPNT	Shadow Price for Non-Tradable
SPNTO	Shadow Price for Non-Tradable Outlays
SRTP	Social Rate of Time Preference
StS	Start to Start
SWOT	Strengths, Weaknesses, Opportunities and Threats
SWR	Shadow Ware Rate
SWRCF	Shadow Wage Rate Conversion Factor
UDR	Utility Discount Rate
VAT	Value Added Taxes
WACC	Weighted Average Cost of Capital
WAM	Weighted Average Method
WBS	Work Breakdown Structure

TABLE OF CONTENTS

SOCIAL PROJECT CASE STUDY

Primary educational infrastructure + School-based nutrition intervention

1 INTRODUCTION

“Social Project” is a widely used term to refer to projects whose primary focus is to generate a positive impact on the population. It is also used to refer to projects that are specially formulated in order to serve a certain group of needs that a society has agreed on – either tacitly or explicitly- need not be quantified nor debated, because they represent the basis for human dignity and development (depending on the framework, these may be referred to as basic needs or basic rights). The majority of projects that fall into this category correspond to the health and education sectors, and they are more often than not related to policy goals that call for universal coverage.

Universal coverage of goods and services is rarely a matter of just providing the goods and services that the population may need, but also ensuring equitable access to all, which is normally more related to demand-side determinants (the population’s ability to make use of the goods and services provided) than the provision on its own (supply-side). It is therefore realized that, when a basic need’s satisfaction is at the core of the investment problem, an infrastructure project on its own may not be sufficient to ensure effective use of its installations (therefore, it doesn’t resolve the original problem detected).

For this reason, the formulation and evaluation of social projects is a great opportunity to apply an integrated approach to infrastructure-intervention project analysis, that looks at the demand and supply side of a public investment. The purpose of this case study is, in this context, to offer a method that will follow such approach.

In this case study, a simple yet effective method to formulate a primary school infrastructure project is proposed, in combination with a school-based nutrition program, following different methodologies that pay particular attention to the correct definition of the population’s problem and the chain of outcomes that the project is aimed to produce. It is also suggested that a 2-phase socio-economic evaluation approach is carried that i) Identifies the best possible intervention based on a cost-effectiveness analysis, and ii) Identifies the best possible infrastructure project based on a cost-efficiency analysis. Neither these types of analysis require for the quantification nor monetization of benefits or value created by the project. Instead, the focus is placed on the determination of adequate impact/effect measurements, and the proper estimation of alternatives' costs.

The case study presented in this document is built upon the combination of varied data and cases found in the literature for illustrative purposes only, and does not represent an actual investment plan. However, an effort was made to contextualize the exercise in the Kenyan experience as much as possible.

2 BACKGROUND

Education and health have long been recognized as essential pillars for national development. Health and education are the most effective investments in creating literate, self-reliant, skilled and healthy societies. This not only provides a country with the opportunity create a strong and competitive economy in their various sectors, but also determines the extent to which a nation is perceived to promote population welfare and long-term development.

These pillars are so critical that they sit highly in the international priority agenda: five Sustainable Development Goals are exclusively focused on health and educational concerns, as they advocate to:

- 1) Eradicate hunger and poverty
- 2) End hunger and achieve food security
- 3) Promote healthy lives
- 4) Ensure inclusive and equitable quality education
- 5) Ensure availability and sustainable management of water and sanitation for all

It is through quality education and healthcare that countries can become better equipped to effectively cope with the challenges of development, confidently adapt to changing markets and technologies. This is something that Kenya's authorities are well aware of. Multiple programs have been developed to improve the coverage and quality of education in the country, as well as interventions to improve the health status of the population. Indeed, the Kenyan Constitution has stipulated that (Article 53 b and c): "Every child has the right to Free and compulsory basic education; Basic nutrition, shelter and healthcare" (The Constitution of Kenya, 2010). In this sense, the country has adopted an explicit policy posture over what basic needs shall be guaranteed for the population.

Addressing primary education is a number one priority in Kenya, and it has made tremendous progress towards increasing access to it. In 2003 a Free Primary Education regime was adopted (FPE). After the introduction of FPE huge increases in enrolment were officially reported in Kenyan Schools. The Primary Net Enrolment Rate (NER) rose from less than 60% during the pre-2003 period to about 91.2% percent in 2017, and a clear policy target has been established in this matter: increasing the NER from current 91.2% to 93.1% in primary education by the year 2022 (Ministry of Education ,2018). Table shows key indicators in the Primary Sub-Sector for the period 2013-2018. Over this period, total enrolment in primary education rose by 5% from 9.8 million to 10.5 million children.

Table 1 - Trends in Primary Education

	2013	2014	2015	2016	2017	2018*
Males (thousands)	5,019.7	5,052.5	5,127.9	5,214.5	5,293.9	5,364.3
Females(thousands)	4,837.9	4,898.5	4,962.9	5,054.9	5,109.8	5,178.3
Total Primary (thousands)	9,857.6	9,950.8	10,090.9	10,280.1	10,403.7	10,542.6
GPI	0.96	0.97	0.97	0.97	0.97	0.97
Gross Enrolment Rate (GER), %	105	103.5	103.6	104.1	104.0	104.0
Net Enrolment Rate (NER), %	88.1	88.2	88.4	89.2	91.2	92.4
Primary Completion Rate, %	80	79.3	82.7	83.5	83.6	84.2
Primary secondary transition, %	74.1	76.1	81.9	81.3	81.8	83.3
Number of public primary schools	21,205	21,718	22,414	22,939	23,584	24,241
Number of private primary schools	6,821	7,742	8,919	10,263	11,858	13,669
Total number of schools	28,026	29,460	31,333	33,202	35,442	37,910
Average school size	352	338	322	310	294	278

Source: Ministry of Education (2018). National education sector strategic plan 2018-2022. Republic of Kenya

But, despite the overall progress this and other policies have created, there are still issues of access inequity, especially among marginalized groups. The average NER in primary grade stalled at 88% between 2011 and 2015, while are marginalized and hard to reach communities have much lower rates. Children from nomadic communities, for example face significant challenges in accessing quality education, a problem shared with children from urban informal settlements and children (specially girls) living in Arid and Semi-Arid Lands (ASAL). The has led to a rise in low-cost private schools that may not meet national quality standards. Addressing these inequities is one of the priorities of policies that aim to ensure education for all, following a universal access approach. It is critical for policy-makers, in order to do this, to not only look at the root educational problem at hand, but to also gain a deep understanding of the causes that lie behind it, as well as the “causes of the causes” (Marmot et al, 2008), which the Social determinants of Health approach so clearly organizes. From this perspective, it is equally important to address universal needs’ coverage from the perspective of goods and services provision, but also from the perspective of conditions that may limit or promote their usage.

For example, children may not enrol or drop out of school due to school-related issues such as lack of educational facilities, inadequate sanitary facilities at schools, forced repetition, or poor quality standards (supply-side determinants which should be constantly guarded and monitored by educational-sector authorities), but also due to non-school related issues, like poverty, gender-biased cultural practices, safety concerns (specially for girls that travel long distances to school), among others (demand-side determinants that may not need to be necessarily addressed by the education sector; instead, an integrative, multi-sector approach shall be used). In Kenya, the population living below the poverty line is still about 45.5%, out of which 80% live in rural areas, where their agricultural-based livelihood does not protect them from food insecurity. In fact, according to the Ministry of Agriculture, Livestock and Fisheries' Strategic Plan (2013– 2017), "it is estimated that about 47% of the country's population is food insecure. About 2 million Kenyans are in constant need of food relief, with the figure rising to almost 4 million during droughts and floods".

Provision of food through schools (Food For Education - FFE) is one of the most studied interventions to address this issue among children. School meals are considered an important safety net for vulnerable children from food-insecure households and communities, and have been found to have the highest education-related impacts on the population, at the lowest cost. Recent evaluations of FFE programs, including a Cochrane systematic review, have shown that FFE programs can lead to increased access to education, reduced dropout, particularly in the lower primary school grades, and improved student learning (Gelli, A., Al-Shaiba, N., & Espejo, F., 2009). This offers an unprecedented opportunity to take advantage of the synergies between health, nutrition, and education that naturally occur in school contexts: schools provide pre-existing systems that can be used as platforms for reaching vulnerable children with different health and nutrition interventions.

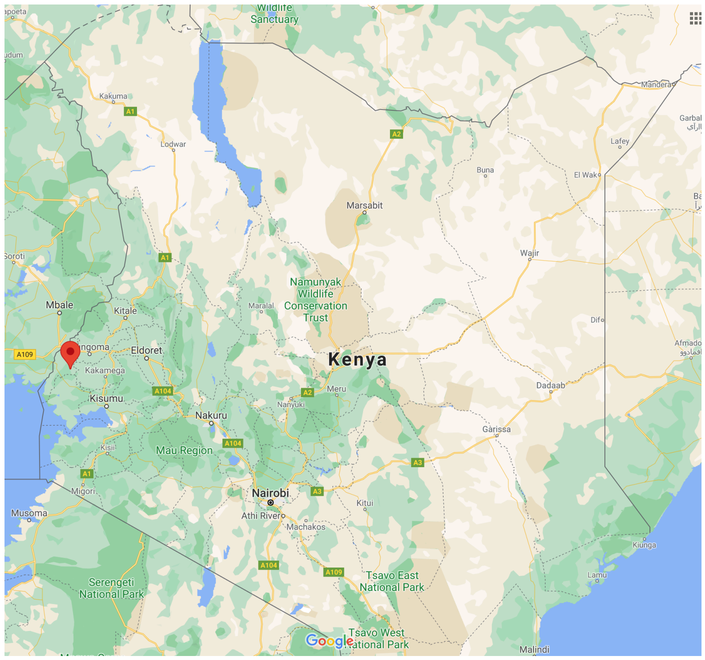
This education-health integration is not new to the government of Kenya. The national school meals and nutrition strategy 2017–2022, a policy developed by the Ministry of Education, Ministry of Health and Ministry of Agriculture, Livestock and Fisheries, has outlined "a strategy for the design and implementation of nutrition-sensitive school meals in Kenya. It is based on the commitment of the Government of Kenya to ensure that school children are well nourished and healthy and are able to learn and develop to their full potential"

In this context, this case study seeks to offer a method for integrating two distinct policy objectives which are closely interrelated -education and nutrition- in school settings. This integration recognizes that even though few policies, if any, are as universally accepted as that of raising primary school enrolment in developing countries, this objective can hardly be achieved by increasing infrastructure coverage on its own. Instead, it must be accompanied by measurements that ensure responsive enrolment rates to educational infrastructure. The novelty of this case study is to highlight the possibilities that lie within the integration of education and health interventions, which are commonly framed as separate sectors, but can certainly be evaluated together, following an integrated socio-economic evaluation approach.

The proposed project consists of building a Primary School which, from the beginning, integrates a school-based nutrition intervention. That is, the project has 2 components: a) Constructing simple yet effective educational infrastructure that can be easily (and cost-efficiently) be replicated in areas of Kenya where school shortages are found (particularly problematic in rural areas), and b) Defining a school-based intervention that will cost-effectively deliver food to every student enrolled. Upon completion, a project of this sort should help improve school participation through infrastructure and improved child nutrition.

This case study has been situated on Bwaliro, a village that lies in one of Kenya's poorest regions: 66.7% of Busia County's population (in Western Kenya) lives below the poverty line and 76% is food insecure. Subsistence farming is the main economic activity; most families rely on their farming land as a food and/or income source. Figure 1 presents a geographic reference of the studied area.

Figure 1 - Geographic reference of Study



According to Census data, the population of Busia County has experimented a growth of 20,13% in the last decade, half the growth observed in previous decades Table .

Table 2 - Population in Busia County

YEAR	POPULATION	GROWTH RATE
1979	297.841	
1989	401.658	34,86%
1999	552.099	37,45%
2009	743.946	34,75%
2019	893.681	20,13%

Source: Kenya Census Data

The census data, collected every 10 years, has been translated into a uniform yearly average growth of 1,85%. For the purposes of this case study, let us assume that most settlements in the county shared a similar growth pattern, except from the study area (Bwaliro) which went from representing the 0,5% of the county's population to the 0,8% in a period of just over 10 years, with an average growth of 5,57% per year Table .

Table 3 - Population in Busia County and study area

YEAR	BUSIA	STUDY AREA		
	Population	Population	Relative weight	Growth
2009	743.946	3.869	0,5%	
2010	757.709	4.016	0,5%	3,81%
2011	771.727	4.167	0,5%	3,77%
2012	786.004	4.323	0,6%	3,74%
2013	800.545	4.483	0,6%	3,70%
2014	815.355	4.648	0,6%	3,67%
2015	830.439	4.817	0,6%	3,64%
2016	845.802	4.990	0,6%	3,61%
2017	861.449	5.169	0,6%	3,58%
2018	877.386	5.440	0,6%	5,25%
2019	893.618	5.809	0,7%	6,78%
2020	910.150	6.371	0,7%	9,68%
2021	926.987	7.367	0,8%	15,63%

Source: Consultants' designated parameters

For a small village this would represent an explosive population expansion, that would create incredible pressure on public goods and basic services required by the expanded settlement. Busia County authorities are particularly challenged by the actual and projected deficit (quantity) of primary education facilities this phenomenon has created. Three alternative infrastructure projects are being appraised by the authorities, together with a number of complementary initiatives that shall help ensure the effective use of the educational facilities (alternatives described in following sections). Authorities have to determine which of the infrastructure alternatives is the best in terms of efficiency (cost-efficiency) and which interventions lead to highest effectiveness, for every dollar spend (cost-effectiveness).

3 PROJECT JUSTIFICATION

It is assumed that a survey carried by the Ministry of Education in the whole country revealed an important problem in the study area: It has one of the lowest school participations in the county (measured as enrolment and attendance rates), as shown in the following Table.

Table 4 - Enrolment rates in Bwaliro compared to the rest of the country

VARIABLE	BWALIRO	BUSIA COUNTY	COUNTRY
Pupils	930	137.380	10,1 million
Population (Children 6-11)	1.400	176.128	N/I
Gross enrolment rate	66%	78%	91%
Gross attendance rate	60%	N/I	N/I

Source: Author's designated parameters

Suppose it was estimated that Bwaliro village had an approximate population of children from 6 to 11 years old (primary education) of 1.400, and an enrolment rate of 66% (compared to 91% in the country), leaving 470 children unenrolled.

The other 930 children of this community are currently enrolled in the one primary school that serves the study area: Bwaliro Primary School. This school, originally designed for half the population it currently serves, is under a lot of pressure to accommodate the increasing population numbers. It has, to an extent, been able to carry on this task for 2 reasons: i) It has habilitated improvised classrooms outside the building, ii) A big proportion of children that are enrolled in the school don't always attend class: with a 60% attendance rate, 312 children don't attend school daily.

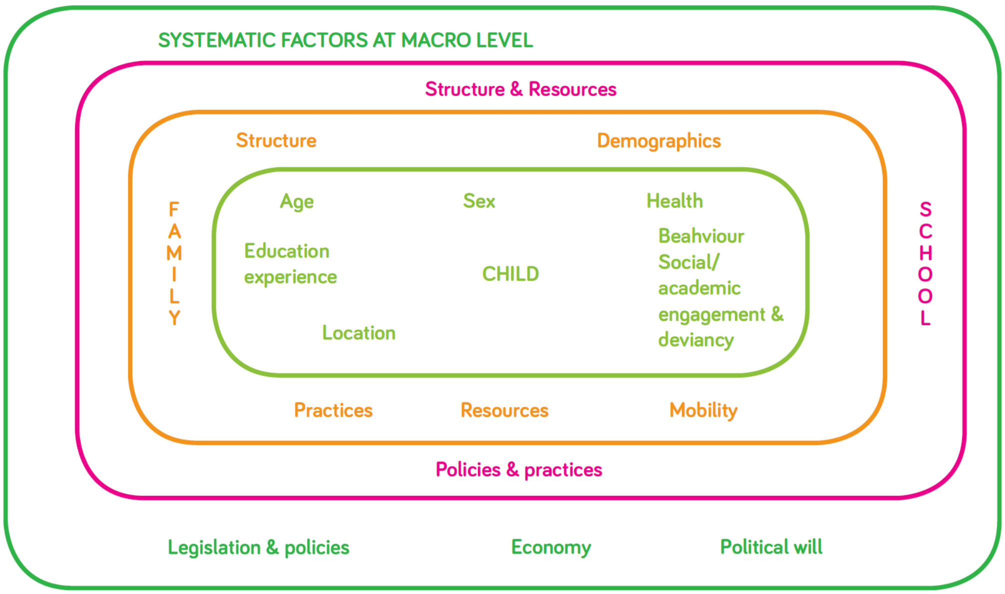
This data immediately points out a deficit of coverage or capacity to provide educational services to the area under study (or some portion of it). This means that even though there is a school in the study area, its capacity cannot satisfy the requirements of the population that reside in it. Primary school children do not have access to education according to the goals set for the national education sector and to the basic rights that the government is mandated to protect. On top of that, children failing to fully participate on primary education represent a significant source of inefficiency and resource-drain in the education system.

The identified shortage of educational facilities is, however, only one side of the problem. Effective educational coverage is indeed determined by the extent to which sufficient educational facilities (measured in terms of classrooms, seats or square meters available) are provided to ensure primary school for all, but it's also determined by the children's ability to make effective use of the installations (measured in terms of enrolment, attendance and other school-participation outcomes). Access to education is, in this context, a highly complex phenomenon, because it involves both supply and demand sides of the equation.

Suppose that the County's authorities, in order to clarify the extent and nature of the observed problem, carried a brief literature review about school participation and its social determinants.

This review showed that low school participation encompasses a wide range of determinants from the enabling environment, supply, demand and the quality of education and other related supported services (UNICEF, 2017). These dimensions are summarized in

Figure 2 - Non-enrolment, non-attendance and drop out factors



Source: UNICEF (2017)

As shown, there are a number of constraints hindering access to primary education. The most prominent ones identified in the literature are: cost of school, long distance to school, parent's or guardian's education level, culture, existence of early marriages, security, lack of food and water at home, and other health-related problems (like Malaria). Let's also assume, for illustrative purposes, that after gaining this theoretical understanding of the problem, local authorities, sent out a survey to parents/ caretakers of the children of the community, to assess the plausible and contextual explanations for this phenomenon. Questions were informed by the main literature review findings, and explicitly enquired about the causes for low attendance/ non-enrolment of 6-11 aged children.

Suppose that the survey's results pointed at 3 main reasons for which parents/ caretakers will not support school participation: the distance that children must travel to school is too large for 6–11-year old's, exposing them to risks along the way; children spend too many sick days at home due to undernourishment and lack of energy; parents perceive the existing school's conditions to be inappropriate for their child involvement. These results guided local authorities into gathering objective measurements in the territory, to complement the perceptual study:

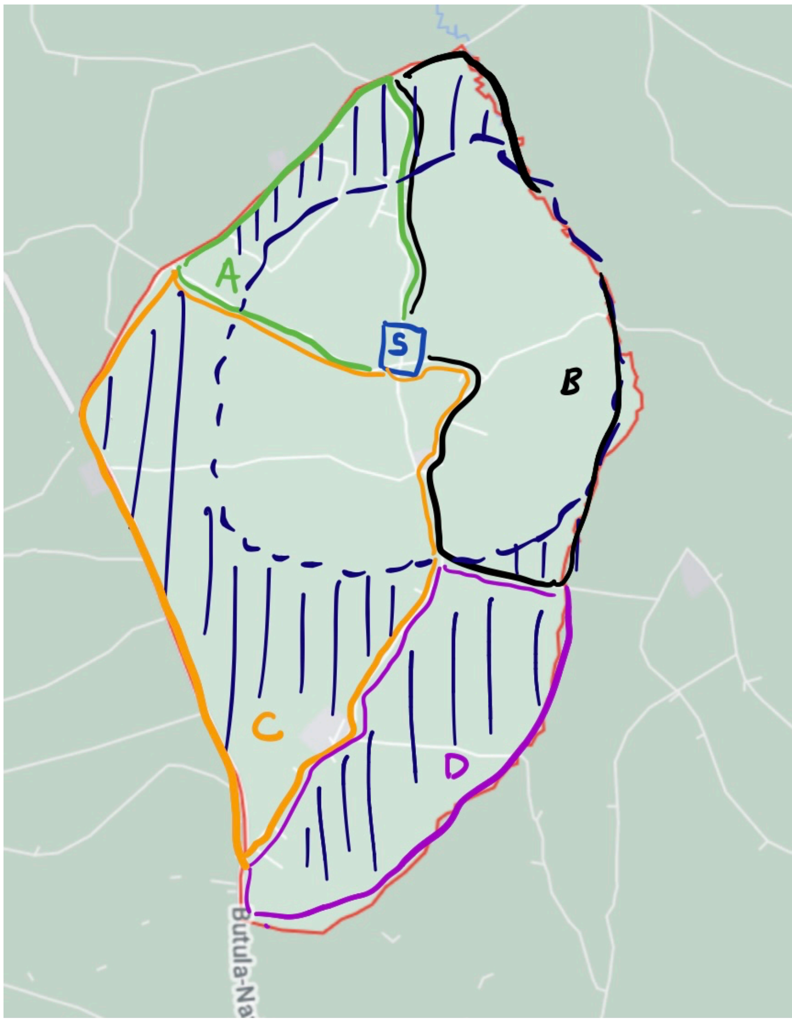
Distance to school

In order to confidently establish, beyond the survey's results, whether distance to school may be a cause of low school participation, it is necessary to evaluate the current situation under certain standards: Evidence from African countries suggests that enrolment and retention decline significantly beyond a distance of even 1 to 2 kilometres, or a 30-minute walk, particularly for younger children (Theunynck, S., 2009). All these elements advocate for a house-to-school distance well below 2 km or a 30-minute walk, which is significantly lower than the norm used in most African countries for planning purposes, which can be as high as 5 km. Therefore, a **2 km threshold may be utilized to define a school's effective influence area or, ideally, a location standard**: this is the distance that young children believed to be able to travel in order to attend school (children of this age cannot move easily from one place to another on their own and if they do so, it is to travel only very short distances by foot or bicycle). It is assumed that the study area has favourable access conditions.

Using a mapping tool and georeferenced household locations[1], an estimation of the population geographical distribution was carried in Bwaliro. It was estimated that 26,4% of the primary school-aged children live within Segment A (green), 25% in Segment B, 20% is segment C and 26,6% in segment D (Figure 3 and Table 5). It was also estimated that 54% of the children of Bwaliro lived more than 2 km from the existing primary school (shaded area in Figure). This population is therefore at risk of ceasing their school participation based on distance.

[1] A real application of these tools would normally include data on the educational buildings and facilities, number of children attending each school (enrolments), age of the children and of teaching staff. Results would be shown to appropriate scale maps, along with critical physical features of the territory. Ideally, poverty data overlays should also be presented

Figure 3 - Study area and influence area



Source: Own elaboration

Table 5 - Current Population Geographical Distribution

SEGMENT	%	NO.	LESS THAN 2KM		MORE THAN 2 KM	
			%	No.	%	No.
A	26,4%	370	40%	148	60%	222
B	25,0%	350	90%	315	10%	35
C	20,0%	280	65%	182	35%	98
D	28,6%	400	0%	0	100%	400
TOTAL	100,0%	1.400	46%	645	54%	755

Source: Own elaboration

Looking at this hypothetical map, it shall not be assumed that the large distance to school estimated in this area is necessarily due to poor planning. In fact, as previously mentioned, it was assumed that the original settlement of Bwaliro begun to increase exponentially towards the edges of town on recent years, with which the average distance to school was dramatically increased.

Overcrowding

Overcrowding is a second issue identified by the survey results that may explain low school participation of young children. The extent to which the existing school's classrooms are overcrowded is analysed on following sections (supply estimation). It is required, however, that a standard is also defined to establish an "objective" overcrowding measurement to which to compare the current situation with.

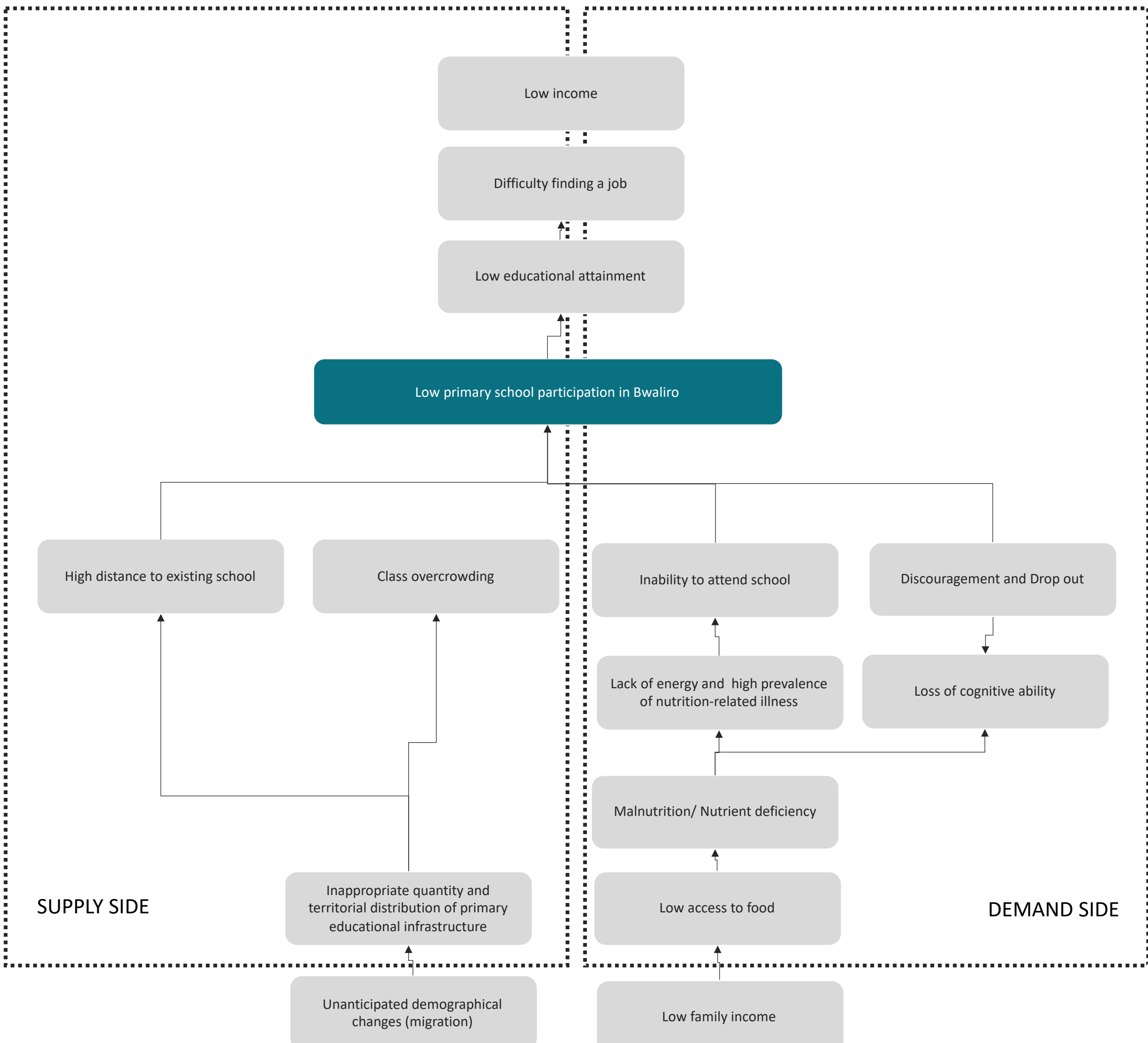
There are multiple ways of defining overcrowding. For example, and overcrowding indictor may be established in terms of student to teacher ratios. Numerous studies have shown that students in classes with high student to teacher ratios, up to a threshold of 60 students per class, perform just as well as students in smaller classes. However, beyond 60 students per class, learning outcomes deteriorate (Mingat 2003, as cited by Theunynck, S, 200). But this would be insufficient to establish an overcrowding measurement. It is obviously not the same to accommodate 60 students into an already minimal space (say, designed for only 45), even if the pupil to teacher ratio is considered. For this reason, it is also necessary to establish a minimum physical space (square meters) that a pupil requires to be able to attend school comfortably, engage in class adequately, and achieve expected educational outcomes. In this case study the **minimum standards have been set to 2,5 m2 of teaching areas per pupil, with a maximum of 60 pupils per classroom** (60 students to 1 teacher)

▶ Health-related issues/ Malnutrition

Nutritious – and ideally hot- meals are essential to help children develop properly, both at the physical and mental level. Adequate amounts of food (measured in either portions or kcal) and micronutrients support children's cognitive development and combat nutritional deficiencies in other age groups, that may lead to mid-term and long-term nutritional-related chronic diseases. Suppose that the nearest health centre to the study area's population kept records of periodic health controls of the children in the community. These reports show that 65% of the children are underweight, based on anthropometric measurements, while 49% are believed to be malnourished, based on the food daily consumption provided by adults, which is expected to provide no more than 300 kcal/meal to children, per day. Minimum standards could then be established based on kcal requirements of children of different age, and the opportunity to provide as many kcal per meal as possible. For this case study, it is assumed that planned meals meet those standards.

With all the information above, a better comprehension of the originally stated problem can be achieved and organized with the help of a problem tree (or causes and effects tree). This is tool that allows to easily visualize the different aspects that connect (and explain) a root problem, and anticipate consequences it's currently bringing (or will bring) to the affected population. The proposed problem tree for this exercise is presented in **Error! Reference source not found.**.

Figure 4 - Low school participation Problem Tree



Source: Own elaboration

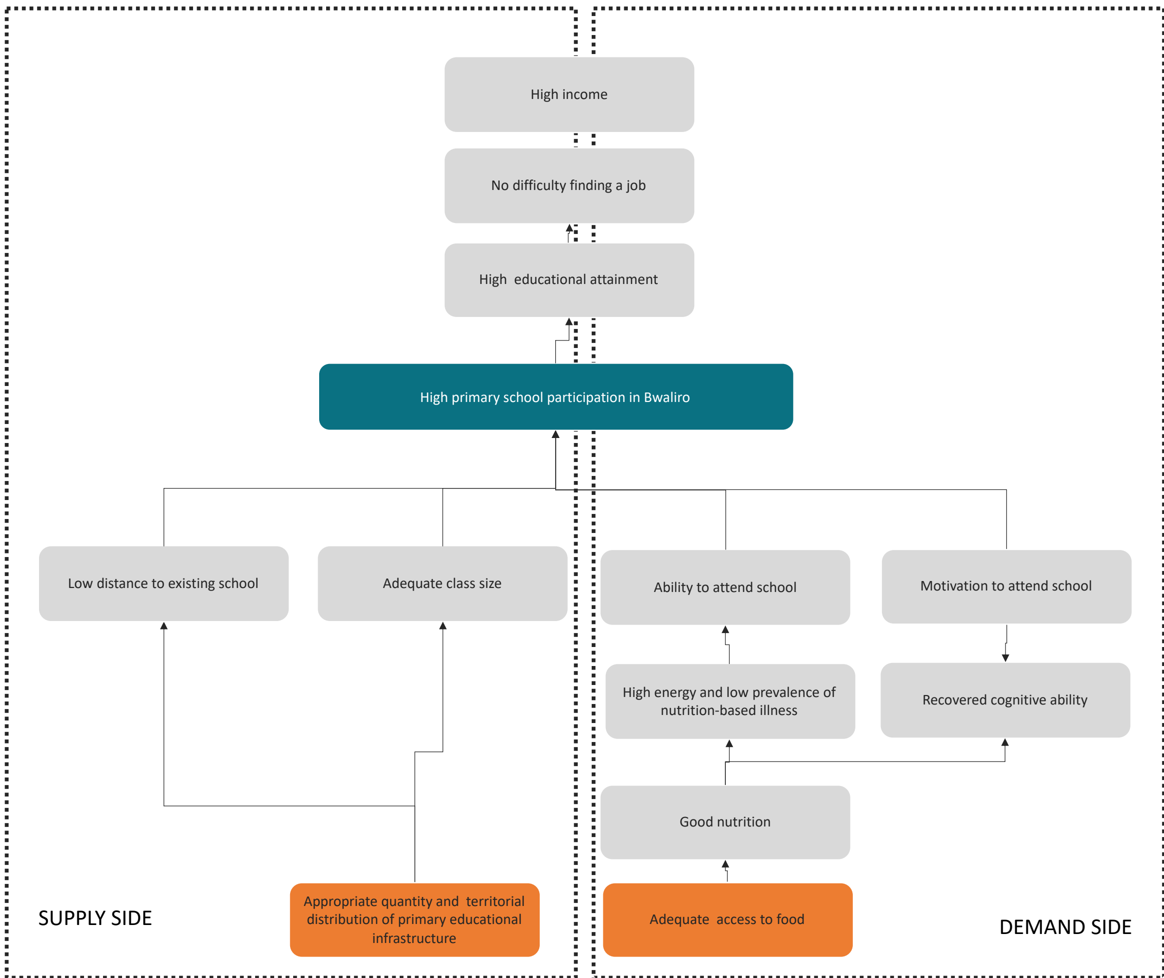
Constructing of a problem tree often requires – depending of the complexity of the problem under study- to carry an extensive literature review, and to bring into the analysis the experiences and perceptions of all involved stakeholders (sometimes in the form of "brainstorming" sessions). However, it is important in this phase to keep the problem analysis centred on the root problem and primary object of the project under study. For example, it could of course be argued that children malnutrition affects numerous aspects of a child's life, but as long as the root problem is stated in terms of school participation, efforts should be made to connect these two aspects, instead of displaying multiple tree's branches that don't connect back to the stated problem. Similarly, it is always possible to iterate infinite number of causes that represent the roots of the tree. Low income/poverty, for example, may be the "cause of the cause" – at the bottom of the tree, and provide a plausible explanation for the identified problems that follow. However, since poverty is not strictly related to the projects' purpose, it's left outside (included in the figure for illustrative purposes).

For the purposes of this case study, 2 particular tree branches are explored in more detail: one that addresses the supply side of the equation (educational infrastructure shortage) and one that addresses the demand side (children malnutrition). This double-sided problem anticipates that, even if the schooling coverage was addressed (through infrastructure), the issues presented at the demand side may hinder the expected results of the project. This is why the project is thought jointly to meet both needs. By improving nutrition, not only the health-related issues are solved but also the education-related.

Sometimes, a problem tree may help identify numerous and complex causes that may not all be able to be addressed by the formulator. When this happens, cost-effectiveness analysis may also be used to prioritize which intervention strategies or actions may be taken into account. This is the approach followed in the next sections to further argue for the implementation of a school-based nutrition intervention.

In the next figure, a Solution Tree is presented, which has turned all the negative conditions of the Problem Tree into positive conditions. Similarly, the causes of the Problem Tree were transformed into the Means/Resources of the Solution Tree, whereas the Effects/Consequences of the Problem Tree were transformed into Purposes and Ends of the Solution. What was defined as the root problem, now becomes the central objective or purpose that the project must accomplish: Increase primary school participation in Bwaliro.

Figure 5 - Low school participation Solution Tree



Source: Own elaboration

The orange-coloured boxes in

Figure , indicate what are the courses of action that the project should integrate, in order to achieve its expected results: Ensure appropriate quantity and territorial distribution of educational infrastructure, as well as adequate access to food to primary school children. Up to this point, and according to this Solution Tree, the implementation of an integral health-education project is justified based on the 2 primary causes that induce low school participation in the study area, both from the demand and supply side of the equation.

4 DEMAND FORECAST AND ANALYSIS

In this section, we present the estimations for primary educational facilities demand, supply and deficit.

4.1 DEMAND ANALYSIS

In order to estimate the current and future demand for education facilities in the study area, it is important to look for statistics and demographic information. This is particularly true in the case of a social project that aims to address a problem that is connected to a basic need (i.e primary education) that has been agreed all should have covered (universal access).

When this happens, demand estimations are determined by the total population that resides in the study area. That is, the primary school-aged population (children between 6 and 11) in Bwaliro is equal to the demand because it's policy statement that all children should have access to primary education (each kid represents an enrollment demand unit).

According to census data, in year 2018 the town had a population of 5.809 people. It's expected that, by year 2021, 7.367 people will live in the area, with 19% of the population represented by children between 6 and 11 years old (primary school age)

Table 6 - Study area population distribution by age, 2021

AGE	NO	WEIGHT
0 to 5	1.105	15%
6 to 11	1.400	19%
12 to 18	1.621	22%
Adults (19 years over)	3.242	44%
TOTAL POPULATION	7.367	100%

Source: Author's designated parameters, based on 2018 CENSUS data

Suppose that the population growth was estimated on the basis of a specialized study carried for these purposes, in consideration on the exponential and unanticipated growth experienced in the area over the last decade. According to the study, the annual growth rate shall be expected to smoothly decrease over the next 20 years, until it reaches a point (1,97%) that resembles the average growth rate that has been seen in Busia County over the last decade (1,85%). Also, and in order to estimate the distribution of the demand across the study area, it is assumed that the segment distribution shown previously, remains constant through the whole evaluation period (20 years). The actual and projected demand (measured as enrolments) is presented in **Error! Reference source not found.**.

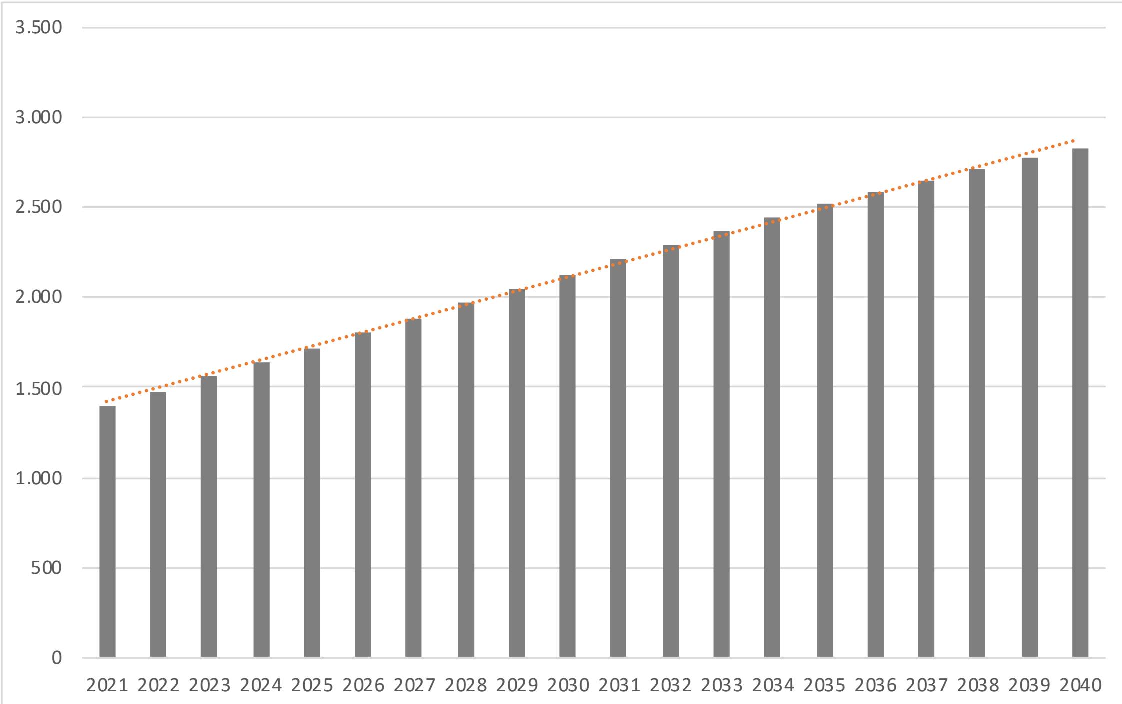
Table 7 - Study area enrolments demand from 2021 to 2040

YEAR	GROWTH RATE	TOTAL	SECTOR A	SECTOR B	SECTOR C	SECTOR D
2021		1.400	370	350	280	400
2022	5,57%	1.478	391	369	296	422
2023	5,37%	1.557	412	389	311	445
2024	5,17%	1.638	433	409	328	468
2025	4,97%	1.719	454	430	344	491
2026	4,77%	1.801	476	450	360	515
2027	4,57%	1.884	498	471	377	538
2028	4,37%	1.966	520	491	393	562
2029	4,17%	2.048	541	512	410	585
2030	3,97%	2.129	563	532	426	608
2031	3,77%	2.210	584	552	442	631
2032	3,57%	2.288	605	572	458	654
2033	3,37%	2.366	625	591	473	676
2034	3,17%	2.441	645	610	488	697
2035	2,97%	2.513	664	628	503	718
2036	2,77%	2.583	683	646	517	738
2037	2,57%	2.649	700	662	530	757
2038	2,37%	2.712	717	678	542	775
2039	2,17%	2.771	732	693	554	792
2040	1,97%	2.825	747	706	565	807

Source: Own elaboration

This table shows that, by year 2040, 2.825 children 6-11 are expected to live in the study area and demand primary education. Figure   displays the same data in a tendency graph.

Figure 6 - Projected demand for primary education



Source: Own elaboration

4.2 SUPPLY

For the purposes of this case study, it is assumed that there is only one primary school operating on the study area: Bwaliro Primary School. It has also been assumed that the public school is located in the upper sector of the Bwaliro village[2]. As Table 8 shows, the school has 8 classrooms, which serve 930 pupils in the area, with an average number of students per class of 116. This is an extremely high pupil-to-classroom ratio in the context of primary education. Suppose that the school was originally planned to serve a much smaller population, but due to the exceptionally high population growth experienced in the area, it was forced to accommodate extra children increasing the number of class size. This left the

[2] Bwaliro Primary School is an actual primary school in the area, but the location and other capacity indicators have been purposefully designated by the consultants for this exercise.

school functioning at sub-optimal conditions, serving the population in overcrowded classes, with a direct impact on participation and education quality.

Given a classroom size standard of 60 children class, the school operates with an excess of 56 pupils on average per class. This also implies that the school has no capacity to take new enrolments.

Table 8 - Existing school enrolments by age

CLASS	BOYS	GIRLS	TOTAL
1	69	58	127
2	57	64	121
3	68	61	129
4	60	62	122
5	56	59	115
6	59	58	117
7	63	56	119
8	42	38	80
TOTAL	474	456	930
%	51,0%	49,0%	

Source: Own elaboration

The school consists of a 1.865 m2 building, where the 64% is allocated to teaching areas, as shown in the next Table (1.199 m2). Even though this is a large building, the school is currently working at 1,3 m2 per pupil enrolled. Given a minimum standard of 2,5 square meters (m2) of teaching area per pupil, the school should be able to serve optimally no more than 480 students. This means that the school is currently serving an excess of 450 students in total.

Table 9 - Existing Primary School spatial distribution

BUILDING	CURRENT AREA (M2)
Administrative areas	133
Teaching areas	1.199
Service areas	266
Covered circulation areas	266
Open air areas	-
Total	1.865

Source: Authors' designated parameters

It is also assumed that the school currently has a feeding program poorly implemented, due to the excess of students currently served, which results in irregular and incomplete meal provision: only some students are served, with sub-optimal level of food quality, measured in terms of their kcal and micronutrient contribution (this would explain why nutritional deficits represent a problem in the study area, even when a feeding program is theoretically functioning).

As a summary, it is established that the existing primary school should operate at a maximum capacity of 480 primary students, considering 2 different criteria/ standards:

- Number of classrooms: maximum of 60 per classroom. Considering 8 classrooms, 60 each, 480 can be served.
- School area: considering a minimum of 2.5 m2 per student required to offer a sufficient educational environment for the students. With 1.199 m2 of teaching area available, 480 students can be served

This analysis shows that the effective supply is lower than the current usage of facilities, and any project that shall be evaluated in the area, should be able to absorb this excess usage/ class overcrowding in the school (as further discussed in the following section).

4.3 DEFICIT ESTIMATIONS

In order to address whether current infrastructure could cover the projected demand, deficit estimations are calculated, in consideration of the expected increase in children's population for the period of evaluation and the set of standards defined for the existing school.

The following table shows what the primary school deficit in the area looks like under current operation conditions (sub-optimal). That means, what would the deficit be if only we looked at new potential students:

Table 10 - Enrolment's deficit estimation under current (sub-optimal) operation conditions

YEAR	DEMAND	SUPPLY	DEFICIT
2021	1.400	930	470
2022	1.478	930	548
2023	1.557	930	627
2024	1.638	930	708
2025	1.719	930	789
2026	1.801	930	871
2027	1.884	930	954
2028	1.966	930	1.036
2029	2.048	930	1.118
2030	2.129	930	1.199
2031	2.210	930	1.280
2032	2.288	930	1.358
2033	2.366	930	1.436
2034	2.441	930	1.511
2035	2.513	930	1.583
2036	2.583	930	1.653

2037	2.649	930	1.719
2038	2.712	930	1.782
2039	2.771	930	1.841
2040	2.825	930	1.895

Source: Own elaboration

This shows that even if nothing was done about the current excess of students in the existing primary school, by year 2040, there would still be a capacity shortage of 1.895 that need to be absorbed.

If deficit estimates also take into account the definition of standards in the provision of educational infrastructure, the projected situation is even more worrying. These numbers show that, unless the schooling situation is solved, the infrastructure shortage would leave almost 2.345 children out of school by year 2040.

These 2 types of analysis are presented separately only to highlight the importance of not only paying attention to what portion of the population needs to be served, but also the status of the currently served. When minimum standards are defined, as already mentioned, the current supply becomes an overestimation of the effective supply because it's looked at from the demand point view (how many children require educational services) instead of the capacity of the facilities to deliver services in adequate conditions.

Table 11 - Enrolment's deficit estimation with standards compliance

YEAR	DEMAND	EFFECTIVE SUPPLY	EFFECTIVE DEFICIT
2021	1.400	480	920
2022	1.478	480	998
2023	1.557	480	1.077
2024	1.638	480	1.158
2025	1.719	480	1.239
2026	1.801	480	1.321
2027	1.884	480	1.404
2028	1.966	480	1.486
2029	2.048	480	1.568
2030	2.129	480	1.649
2031	2.210	480	1.730
2032	2.288	480	1.808
2033	2.366	480	1.886
2034	2.441	480	1.961
2035	2.513	480	2.033
2036	2.583	480	2.103
2037	2.649	480	2.169
2038	2.712	480	2.232
2039	2.771	480	2.291
2040	2.825	480	2.345

Source: Own elaboration

Deficit estimations can also be established in terms of the square meters required to serve the population optimally, based on standards definitions. Adopting a 2,5 mt2/ pupil standard would result in the following educational infrastructure deficit:

Table 12 - Educational infrastructure deficit (m2) with standards compliance

YEAR	DEMAND	SUPPLY	DEFICIT
2021	3.500	1.199	2.301
2022	3.695	1.199	2.496
2023	3.893	1.199	2.695
2024	4.095	1.199	2.896
2025	4.298	1.199	3.099
2026	4.503	1.199	3.304
2027	4.709	1.199	3.510
2028	4.915	1.199	3.716
2029	5.120	1.199	3.921
2030	5.323	1.199	4.124
2031	5.524	1.199	4.325
2032	5.721	1.199	4.522
2033	5.914	1.199	4.715
2034	6.101	1.199	4.902
2035	6.282	1.199	5.084
2036	6.457	1.199	5.258
2037	6.622	1.199	5.424
2038	6.779	1.199	5.581
2039	6.927	1.199	5.728
2040	7.063	1.199	5.864

Source: Own elaboration

This means that, by year 2040, an educational infrastructure shortage of 5.864 m2 would be faced.

Both enrolments and square meters' estimations reveal a clear and severe educational infrastructure deficit which this project seeks to deal with. This coverage problem, however, is not the only aspect that the project needs to address, since providing infrastructure on its own may not be sufficient to solve the school participation problem, given the population context and demand-side issues that was previously discussed.

The enrolments deficit is also used as a measure of the nutrition services required to complement the educational infrastructure. That is, by year 2040, the primary education facilities implemented in this area should also be capable of providing school meals to thousands of children (it is assumed for this exercise that the existing school is able to recover its ability to provide adequate meals to all the children enrolled, once the excess demand it diverted elsewhere. Otherwise, the proposed project would also have to deal with the meal provision shortage in the existing school facilities).

5 TECHNICAL ANALYSIS AND ALTERNATIVES FOR APPRAISAL

There are many different ways of approaching primary education participation. Depending on the projects' component that's been looked at, different criteria may be used to set out alternatives for appraisal. From the supply side, there's a clear identification of a coverage deficit that need to be addressed by providing educational facilities that eliminate the shortage. There is no question around whether or not educational facilities should be habilitated because there's a policy decision that supports universal access of primary education. For this reason, resolving the socio-economic problem on this side of the equation is done by asking the question: What is the minimum cost at which primary school coverage can be ensured?

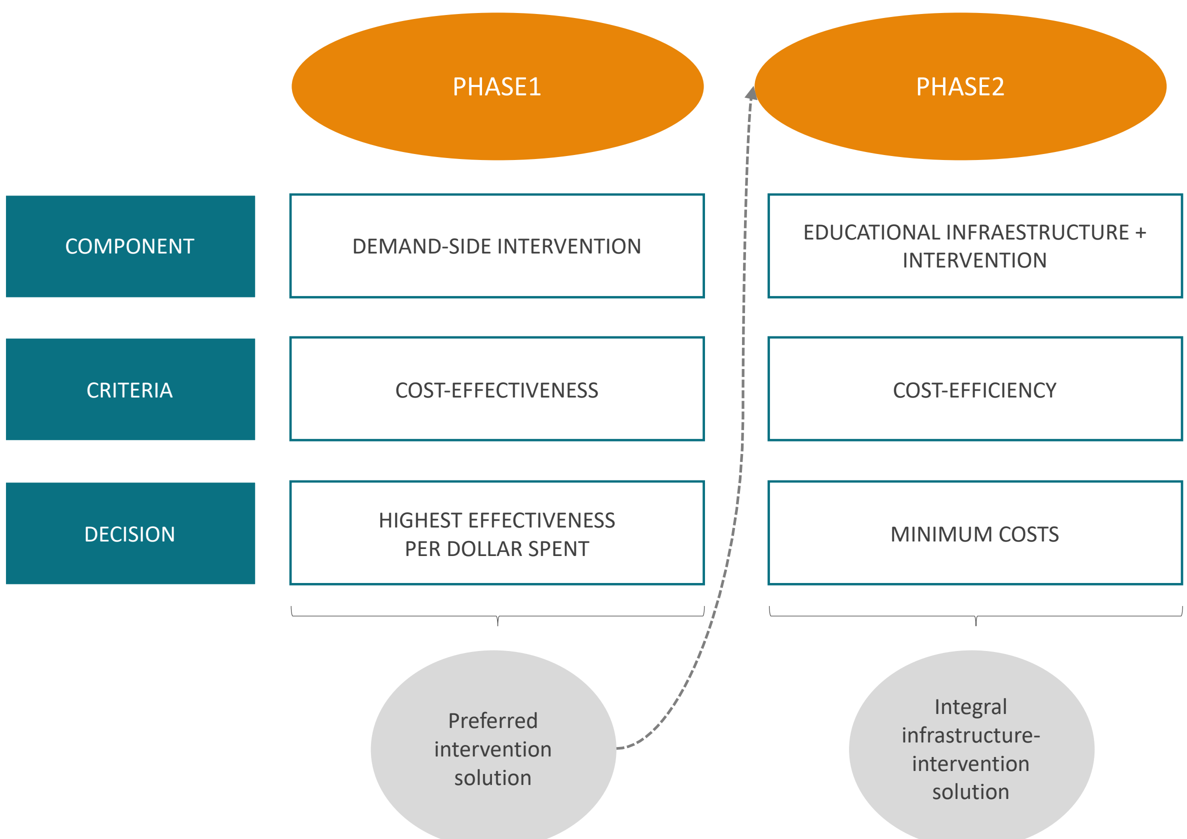
Alternative ways of providing primary school coverage may be thought of (e.g. building more classrooms or schools, expanding existing schools, habilitating mobile classrooms, etc.), but they all eventually lead to enrolling children in school. The formulator's challenge is to be able to define a set of variables that are known to determine (evidence-based) the impact that a particular solution will have in solving the population's problem (for example, school location and classroom size), or to propose alternatives based on pre-estimated measures of cost-efficiency of different solutions (for example, construction technology of a school).

But the demand-side of the equation (intervention component) must be solved differently. As mentioned in previous sections, school enrolment is determined, from the demand point of view, by multiple and varied determinants. Children's malnutrition is only one of them. And even though it is the only determinant represented in the problem tree (in order to simplify the analysis), it has been argued that many more aspects of a child's life affect their school participation. Each determinant leads a to a particular course of action, and not all of them can always be part of the intervention strategy. When this happens, it is crucial to establish a method that will allow to compare these options, and decide upon which will create the highest impact, at the minimum cost. For the intervention component, therefore, the criteria to define and select alternatives is based on a cost-effectiveness analysis. The question to be asked is: given that sufficient educational infrastructure is provided, what is the most cost-effective way to promote school participation of children?

In this section, it is presented a 2-phase method to decide over project alternatives. The first, looks at cost-effectiveness of different intervention strategies that aim to increase school participation and have already been studied in the literature. Based on the estimated cost-effectiveness ratios, a decision is made over which intervention should be part of the project.

On Phase 2, integrated infrastructure-intervention alternatives are assessed, considering the results from Phase 1 (most cost-effective way of increasing school participation, from the demand's point of view). This rationale is shown in the next Figure.

Figure 7 - Rationale behind alternatives selection



Source: Own elaboration

5.1 IDENTIFICATION OF INTERVENTION ALTERNATIVES

In pre-feasibility or feasibility studies, ex ante cost-effectiveness analysis must lie on pre-existing data than can be reliably applied to the context and population of a proposed intervention. At times, the formulator will only be able to access effectiveness data, and will face the challenge of estimating detailed costs for all the proposed intervention alternatives. Other times, the evidence will directly report cost-effectiveness ratios that compare precisely the intervention alternatives that the formulator was interested in. It is expected, therefore, that effectiveness data will always be taken from the literature, unless a good effectiveness studied was carried by the formulator (following all the standards for a high quality effectiveness evaluation, which encompasses impact evaluation methodologies). For the purpose of this case study, some evidence was directly taken from the literature, while some data was modified in order to satisfy the evidence requirements of this particular project. This section is organized around 3 main areas on analysis: Effectiveness, Costs, and Cost-effectiveness indicators.

> i Review: Cost-effectiveness analysis (CEA) is a way to examine both the costs and outcomes of one or more interventions. It compares an intervention to another intervention (or, sometimes, the status quo or current state) by estimating how much it costs to gain a unit of an outcome. Results are presented as a cost-effectiveness ratio. This cost-effectiveness ratio can be compared to another intervention to determine which is more cost-effective. This approach requires to estimate both the costs and effectiveness of the alternative interventions. This method is commonly used on the evaluation of interventions in sectors where the monetization of the benefits produced by a project is either too complex or undesirable (for example, for ethical reasons). Notably, the sectors considered in this study case, health and education, fall under this category.

5.1.1 Effectiveness

There exist a variety of techniques for ascertaining the effectiveness of an intervention. In an ideal scenario, a formulator will be able to decide on different intervention alternatives and then carry a cost-effectiveness analysis based on those preferred alternatives. In reality, as already mentioned, in ex ante socio-economic evaluations, that is rarely the case. The formulator has limited freedom to select which alternatives will be compared, and is therefore more often focused on choosing a particular outcome of interest for which effectiveness measures had already been established.

Outcome selection

One of the key tasks is, therefore, to establish clear dimensions and measures of effectiveness that are relevant to the project's objective/ context. In this sense, for cost-effectiveness analysis to be a useful alternative to cost-benefit analysis, it is necessary to agree on an outcome that represents the single "key objective" of the alternative interventions. This objective should be, as previous sections have shown, be informed by a needs assessment and clear problem identification. In this project, increasing school participation is the outcome of focus, which is described as a combination of student enrolment and attendance.

In the context of educational projects, many different outcomes may be relevant in a cost-effectiveness analysis, depending on what the intervention's primary goal is. **Error! Reference source not found.** details a set of some effectiveness measurements available for the education sector.

Table 13 - Effectiveness measures of School-based interventions

PROGRAM OBJECTIVE	MEASURE OF EFFECTIVENESS
Program completion	Number of students completing program
Reducing dropouts	Number of potential dropouts who graduate
Employment of graduates	Number of graduates placed in appropriate jobs
Student learning	Test scores in appropriate domains utilizing appropriate test instruments
Student satisfaction	Student assessment of program on appropriate instrument to measure satisfaction
Physical performance	Evaluation of student physical condition and physical skills
College placement	Number of students placed in colleges of particular types

Advance college placement	Number of courses and units received by students in advance placement, by subject
Student enrolment	Number of students enrolled in school
Student attendance	Percentage of student attendance

Source: Adapted from Levin, H. M. (1995)

As it can be seen, the definition of a clear project objective is crucial, since different effectiveness measures should be selected to respond to different educational programs objectives. In this example, only 2 effectiveness measures would be relevant for the context of a primary education intervention, and the particular problem and objectives identified by the program. In this case study it has been clearly stated that the problem to be tackled by the integrated infrastructure-intervention approach is student enrolment and attendance. Therefore, these are the effectiveness measures that should be looked at in the literature. If the problem had been poorly stated or the objective of the intervention expressed in too broaden terms, it would be very likely to get lost between all the available measures of effectiveness linked to the particular setting of interest (the school).

One weakness of the cost-effectiveness method is that it can only contrast alternatives for one particular outcome. It is known, however, that social projects usually achieve multiple outcomes at a time. For example, giving children free school meals increases attendance at preschools (the selected education-related outcome), but it also improves children's nutritional status (health-related outcome). When this is the case, the formulator may choose to present different effectiveness measures for each outcome of interest. However, only one effectiveness measure may be used to decide on the best intervention alternative.

This study is primarily focused on the education-related outcome (school participation) and it is understood that any additional impacts on the nutrition status of a child are "bought" with the same dollars as the increased participation.

▶ Chain of outcomes

Often, it will not be possible for a formulator to find evidence in the literature evidence for the exact outcome that a program may be looking at. When this happens, it's important to think about the interrelation of all possible outcomes that occur at different moments in time. The formulator, for example, may be capable of finding evidence for an intermediate outcome that is conductive to the final outcome of interest. Building a chain of outcomes is a clarifying exercise for this purpose because it helps interrelate and display all the causal measures together (method discussed in previous sections). Intermediate effects would be converted into final effects by assuming an unknown parameter or estimating it with further statistical modelling (often using a secondary data set). This can only be done when the outcomes relationship has been clearly stated in the literature.

Suppose that, in the literature, no evidence was found around the different strategies that may help increase primary school participation, but there was good evidence about the connection between self-reported motivation to attend school and effective school attendance. It has been stated that a child that is motivated to attend school is 30% more likely to go to school. If children's motivation data was collected in the study area, this parameter would be used to build a model that predicts school participation based on motivation.

5.1.2 Costs

The costs of an intervention, C, are the opportunity costs of resources used in the intervention versus the no-invention control. C only reflects the cost of additional resources used in the intervention. Indeed, CEA evaluations would normally refer to C as the incremental costs of an intervention. Second, costs include any resource with an opportunity cost, even "free" resources such as volunteer labour. Such resources have an opportunity cost because they require the worker to forgo another valuable opportunity, and are costly to society. Technically, then, the cost of a specific intervention will be defined as the value of all of the resources that it utilizes had they been assigned to their most valuable alternative uses. In most cases, the market price of a resource suffices, but for other resources, especially non-marketed ones like contributed facilities or labour, a shadow price must be estimated.

One of the preferred methods to estimate an intervention costs is the “ingredients method”. It relies on the identification of all resources or “ingredients” consumed in an intervention over a certain time frame (often 1 year). There are multiple ways to apply this method, but is normally useful to evaluate the ingredients of a program based on 5 categories. If a cost-effectiveness study was to compare a school-based intervention against other alternatives that are known to positively impact school enrolment, it would be expected that all the costs of the program would be detailed following there or more categories (**Error! Reference source not found.**).

Table 14 - “Ingredients” involved in a school-based nutrition intervention

CATEGORY	DESCRIPTION
Personnel	Meal-preparing staff Management of school kitchens
Facilities	Canteens and food storage rooms Dining rooms
Equipment and materials	Food ingredients Cooking ware Serving ware
Other program inputs	Training of cooks on safe food preparation
Beneficiaries inputs	-

Source: Own elaboration

Cost data are rarely collected simultaneously with effectiveness data and very few studies, if any, provide substantial details regarding the implementation of an intervention. As a result, it is usually necessary to collect data on resource requirements retrospectively. This requires reconstructing program implementation through historical documents and interviewing personnel involved in actual program implementation. The latter is only feasible when knowledgeable personnel can be identified and can accurately recall the necessary details. In conducting cost analyses, we the accuracy of recollection drops markedly beyond a few years and can be quite poor beyond ten years. To assure the greatest possible accuracy in retrospective collection of resource utilization, costs of program implementation must be based on fairly recent evaluation studies.

5.1.3 Cost-effectiveness indicators

Many times, cost-effectiveness indicators will be readily available for a set of interventions that the formulator is interested in contrasting. When this happens, the formulator can inform their decision-making based on the cost-effectiveness indicators found in the evidence. For this case study, these indicators would be built as follows:

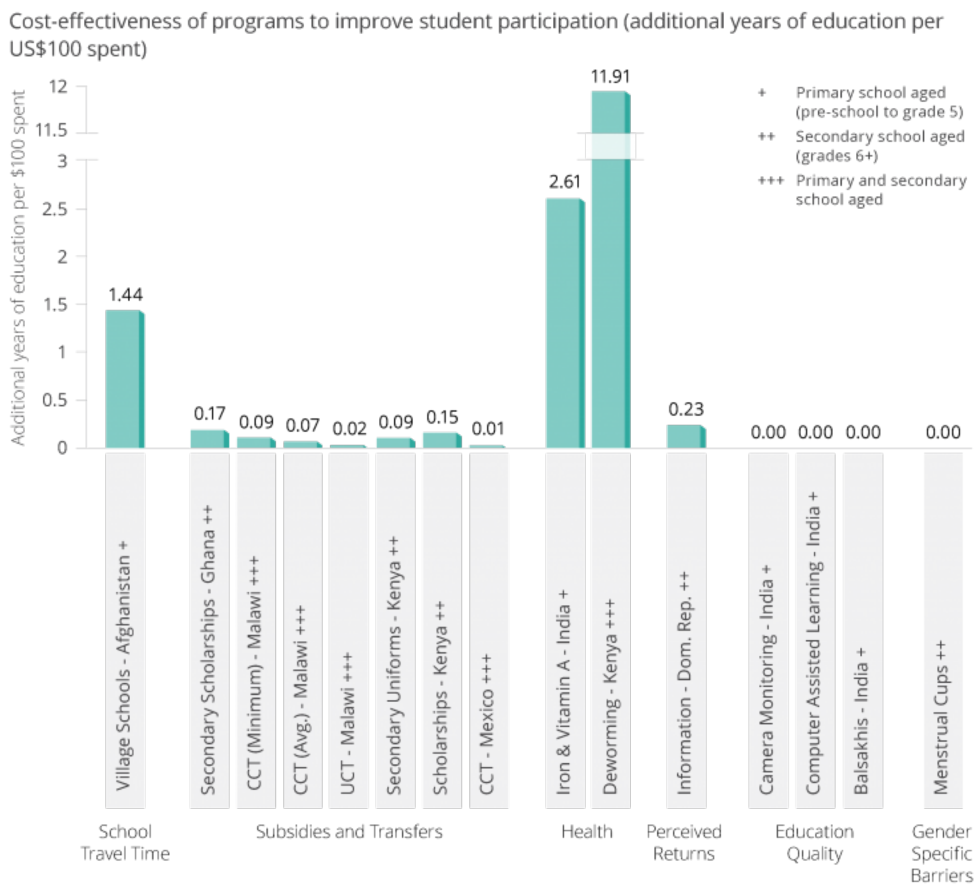
$$\mathbf{\mathit{Cost - efectiveness\ ratio}} = \frac{\mathbf{\mathit{Enrolment\ rate\ with\ Prgram - Enrolment\ rate\ without\ program}}}{\mathbf{\mathit{Costs\ with\ program - Costs\ without\ program}}}$$

These indicators would show which, of at least two interventions, say X or Y, improved a specific outcome at a least cost. This means that cost-effectiveness analyses is never about comparing the implementation of say, a school-based nutrition program to doing nothing at all; if that were the case then every single cost associated with running the intervention could be attributed to this program. The cost-effectiveness of a program is calculated as the marginal change in food access as a result of the program, divided by the marginal change in costs because the program was implemented.

For this case study, there is some evidence that supports, under a cost-effectiveness criterion, that school-based nutrition programs are implemented to help increase participation, over other demand-side alternatives.

For example, a study carried by the Poverty Action Lab, estimated the cost-effectiveness ratios of several programs in Asian and African countries to improve student participation.

Figure 8 -Cost-effectiveness of programs to improve student participation (additional years of education per US $100 spent)



Abdul Latif Jameel Poverty Action Lab (J-PAL) (2018).

Error! Reference source not found. shows that a deworming program in Kenya increased an average of 11,9 years of education in primary and secondary school aged children per US$ 100 spent, while a program in India that supplemented primary school kids with Iron & Vitamin A, increased 2,61 years of education on average, per dollar spent. These interventions offer the highest effect per US$100 spent, and shall be selected over every other option. As the Poverty Action Lab puts it: ""The most cost-effective programs to increase student participation are those that addressed child morbidity (such as intestinal worms and chronic anaemia) or reduce the distance to school through the creation of low-cost schools in areas where few schools exist".

Another study, found that RCTs that the cost per added day of school attendance associated to a school feeding program ranges from $4 to $8 (Kristjansson, E. et al, 2016) which seems like a low price to pay for increased school participation. However, these results need to be compared against other alternatives in other to properly assess its cost-effectiveness. Unlike the net present value in a CBA, the CER of a single intervention cannot be used to judge its absolute desirability, because there is no means of weighing pecuniary costs against non-pecuniary effects. For this reason, the CER can be compared to those of other interventions, presuming that effects are measured in the same units. In this case, the question to be asked would be: Among several effective interventions, which one incurs in the lowest costs to increase school attendance by a given amount?

This evidence, to an extent, strengthens the intervention strategy adopted by this project, based on the needs assessment and problem logic (ideally, more studies should be looked at in order to compare the most relevant intervention alternatives for the specific project's context).

Other studies have estimated cost-effectiveness ratios that are further down on the chain of outcomes, which could potentially be connected back to the outcome on interest. For example, a study carried by Kremer, Miguel, and Thornton (2009), as cited by McEwan, P. J. (2012) compared different program interventions against each other to evaluate which one was the most cost-effective in improving test scores at school (long term effect of increased school participation) in Kenya.

The authors found that the most cost-effective alternative was a girls's scholarship program which had an average treatment effect of 0.12 gains on test scores and an incremental cost per pupil of $1.69 (or a CER of $1.41 per 0.1 standard deviations).

Table 15 - Cost-Effectiveness Ratios of Education Interventions in Kenya

	Effect	Cost	CER	CER
Intervention	Average test score gain	Cost per pupil (excluding transfers)	Cost per pupil per 0.1 gain (excluding transfers)	Cost per pupil per 0.1 gain (including transfers)
Girls scholarship program				
Busia and Teso districts	0.12	$1.69	$1.41	$4.94
Busia district	0.19	$1.35	$0.71	$2.48
Teacher incentives	0.07	$0.95	$1.36	$4.77
Textbook provision	0.04	$2.24	$5.61	$5.61
Deworming project	≈0	$1.46	--	--
Flip chart provision	≈0	$1.25	--	--
Child sponsorship program	≈0	$7.94	--	--

Source: Kremer, Miguel, and Thornton (2009), as cited by McEwan, P. J. (2012)

5.2 INFRAESTRUCTURE ALTERNATIVES

5.2.1 Rationale

As previously mentioned, the selection of infrastructure alternatives is based on a set of variables that the consultant has identified as having the highest potential of changing the outcome of interest (location and size), as well as technological variants of a same solution (educational infrastructure):

- **Location:** As previously discussed, distance to school remains a problem for many children and is the single most important determinant of primary school enrolment primary age children (Theunynck, S, 2009). In the context of this study this anticipates that even if the existing school had the installed capacity to attend all primary schooling demands, chances are children wouldn't go to the school anyway, since a large part of the population settled far from the current school. This suggests that alternatives should aim to reduce the distance a child must travel to school as much as possible, either by planning the construction of educational facilities close to their homes or, eventually, by bringing children closer to the already built schools (e.g habilitating a transport system). Location is also an essential variable, in the context of this case study, because it helps determine what demand is a project effectively capable of capturing. Therefore, the **captured demand** of each alternative is defined in terms of the school-aged population that lives within a 2km radius from a school.

- **Size:** There is an obvious relationship between the size of schools and the distances that students have to travel to get there: larger schools often have a larger catchment area. Evidence suggests that beyond 200 – 250 pupils there is no economy of scale that can be generated by the increase in the size of the school and that, in general, it is preferable to have smaller schools (but closer), especially in rural areas (Theunynck, S. & Rabakoson, H, 2017). In this case study, no standards were adopted around size, but alternative dimensions were used for the sensitivity analysis.
- **Technology:** African countries have built classrooms with five main types of technologies: i) the classic classroom, ii) the shelter model, iii) the local materials and appropriate technology classroom, iv) the prefabricated classroom, and v) the modern construction model (Theunynck, S, 2009). The "classic classroom" accounts for the vast majority of today's stock of long-lasting classrooms in the continent and has been used, with slight adaptations, in almost all school construction programs implemented by governments, communities, contract management agencies, and development partners (91% of schools in the author's sample). Project alternatives consider that the selection of one technology over the other does not only impact the construction unitary costs, but also the time required for the infrastructure to be ready for use, and the ease at which a particular solution may be expanded or replicated elsewhere. For example, technologies that rely on modular solutions (prefabricated classrooms) can be easily increased with student´s size in a short period of time, allowing formulators to respond to an increasing demand for educational facilities over shorter planning periods.

5.2.2 Description of alternatives

This section presents 3 alternatives appraised in this project as possible capacity design alternatives. All alternatives are designed to expand the study areas capacity to enrol new students, both from the unattended segment of the population and the segment attended in sub-optimal conditions (overcrowded classes), but this does not necessarily imply the construction of a school (as previously mentioned, there are multiple ways of understanding educational facilities, including: number of seats, number classrooms, number of schools, number of shifts, mobile classrooms, among others).

The 3 project alternatives are:

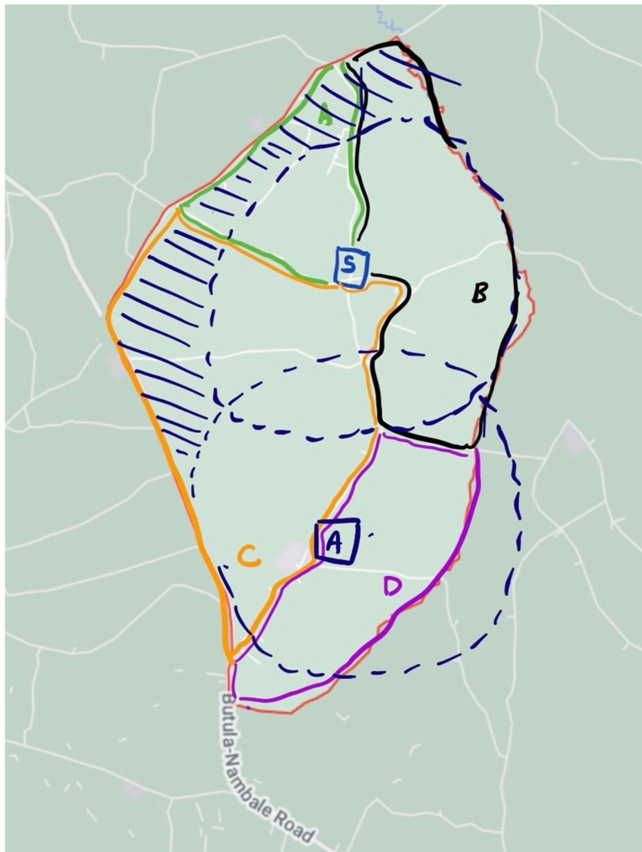
Alternative A	The first alternative consists of building 1 large new primary school in a location that will improve current travel times but leaves small segments of the population at a distance slightly larger than 2km.
Alternative B	The second alternative consists of building 2 medium-sized primary schools following a simpler design, but prioritizing location: optimal locations were located to minimize travel time for all students.
Alternative C	The last alternative expands the capacity of the existing primary school (construction of classrooms) and provides a reliable transport system for children that live out of the influence area.

Each alternative is presented in detail in the following paragraphs.

▶ Alternative A

This alternative is designed to reduce (though not minimize) the time travel of children to school, and maximize the quality of the educational infrastructure for a long-term investment that can capture the whole anticipated school-aged children population growth. A modern construction model is proposed, with relatively higher construction costs. This alternative would not only allow for new students to enrol (particularly from segments C and D), but also allowing segment B enrolments to decongest the existing school (Decongestion of the existing school is only as possible as long as it is **assumed that children can easily be relocated from one school to another, based on the minimum distance to school**).

Figure 9 - Proposed location for large Primary School, Alternative A



Source: Own elaboration

The specific demand capture of this alternative is established, however, not only based on the expected population growth but also on the school's location. Table 16 shows the captured demand for each segment (%), while Table 17 details the captured demand per year (number of pupils enrolled). As previously mentioned, it is assumed that **only the demand located within a 2 km radius of the school (influence area) is 100% captured**.

Table 16 - Percentage of captured demand per segment, Alternative A

DEMAND CAPTURE PER SEGMENT	%
A	50%
B	80%
C	70%
D	90%

Source: Author's designated parameters

Table 17 - Captured demand Alternative A

YEAR	CAPTURED DEMAND
2021	0
2022	0
2023	656
2024	714
2025	774
2026	834
2027	894
2028	954
2029	1.014
2030	1.073
2031	1.131
2032	1.189
2033	1.245
2034	1.300
2035	1.353
2036	1.403
2037	1.452
2038	1.498
2039	1.541
2040	1.580
2041	1.617

2042	1.649
2043	0

Source: Own elaboration

As it can be seen in Figure, this alternative fails to offer every child the opportunity to travel less than 2 km to attend school (households in shaded areas must still travel longer distances to school), but can offer the intra-school quality and quantity standards mentioned previously.

The spatial distribution of Alternative A (in square meters) is presented in Table 18. As shown, this alternative allocates 60% of the built capacity to teaching areas, distributed between 27 classrooms (2,5 m2 per classroom). The total size of the projects in square meters is 6.874 m2. This alternative represents the biggest primary school in the county.

Table 18 - Alternative A spatial distribution (square meters)

BUILDING	ALTERNATIVE A (M2)
Administrative areas	185
Teaching areas	4.124
Service areas	476
Covered circulation areas	264
Open air areas	132
Total	6.874

Source: Author's designated parameters

Since this is a major infrastructure project, it is estimated that the construction will take no less than 2 years. The investment is scheduled to start on late 2021 and finish on 2023.

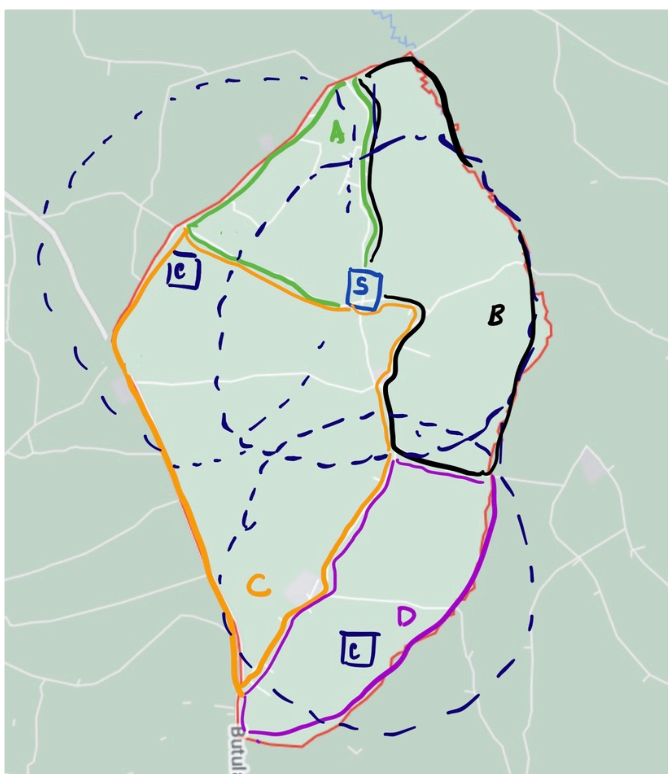
▶ Alternative B

This alternative proposes to build 2 new schools on different locations to minimize the travel distance of students. The construction solution follows a much simpler -yet effective- layout that can be easily extended or built elsewhere, thanks to its modular/prefabricated configuration.

This alternative is supposed to more easily replicated alternative for other parts of the territory, depending of the dynamics of migration and population growth in the area.

The proposed location for the schools is the following:

Figure 10 - Proposed location for 2 modular Primary Schools, Alternative B



Source: Own elaboration

As the figure shows, the influence area of each school (based on walking distance to school) is overlapped with the existing school, in order to help decongest its usage. Table 19 shows the captured demand for each segment (%).

Table 19 - Percentage of captured demand per segment, Alternative B

DEMAND CAPTURE PER SEGMENT	%
A	95%
B	85%
C	90%
D	95%

Source: Author's designated parameters

Table 20 - Captured demand Alternative B

YEAR	CAPTURED DEMAND
2021	0
2022	0
2023	945
2024	1019
2025	1093
2026	1168
2027	1244
2028	1319
2029	1394
2030	1468
2031	1542
2032	1614
2033	1649
2034	1649
2035	1649
2036	1649
2037	1649
2038	1649
2039	1649
2040	1649
2041	1649

2042	1649
2043	0

Source: Own elaboration

The spatial distribution of Alternative B (in square meters) is presented in Table 21. As shown, it offers 2 schools of different size, based on the segment of the population that they are designed to serve. The total coverage of this option, measured in m2 is 3.009 or 21 classrooms (9 in school 1, 22 in school 2)

Table 21 - Alternative B spatial distribution (square meters)

BUILDINGS	SCHOOL 1	SCHOOL 2	TOTAL
Administrative areas	65	152	217
Teaching areas	558	1.302	1.860
Service areas	167	391	558
Covered circulation areas	93	217	310
Open air areas	46	108	155
Total	930	2.170	3.099

Source: Author' designated parameters

Given the nature of the modular solution, this alternative should be able to start operating within 1 year.

Alternative C

The last alternative consists of an expansion plan for the existing Bwaliro school, which will add an extra 16 classrooms for primary education (990 enrolments) which can capture the demand detailed in Table .

In this alternative, 100% of the projected deficit is captured, given the provision of a transport system that cancels out the walking distance thresholds assumed for walking-only alternatives A and B. A transport system does not represent a feasible solution in all cases (for example, when road conditions are inappropriate), but it has been included in this exercise to purposefully show the variety of alternatives that a formulator may think about, that don't always involve the construction of new infrastructure.

Table 22 - Captured demand Alternative C

YEAR	CAPTURED DEMAND
2021	0
2022	0
2023	1077
2024	1158
2025	1239
2026	1321
2027	1404
2028	1486
2029	1568
2030	1649
2031	1649
2032	1649
2033	1649
2034	1649
2035	1649
2036	1649
2037	1649
2038	1649
2039	1649
2040	1649
2041	1649
2042	1649
2043	0

Source: Own elaboration

It has been established that, given its location, the school cannot be expanded further to this. As it is shown, most of the investment is spent on teaching areas construction (75%) and services area (20%) which should allow for proper daily meal preparation (current program quality and continuity). The selected technology for this alternative follows a “local materials and appropriate technology classroom” approach.

Table 23 - Alternative C incremental space distribution (square meters)

BUILDING	ALTERNATIVE C (M2)
Administrative areas	49
Teaching areas	1.856
Service areas	495
Covered circulation areas	49
Open air areas	25
Total	2.475

Source: Own elaboration

It also involves the implementation of a public transport system that will allow students that live far from the school (outside of its influence area, measured by the walking distance to the facilities) to travel safely and conveniently to the school.

This service would only be available to eligible families (living more than 2km away from the school) for which an application process would have to be designed. If there were spare seats available, children who are not eligible can be carried on school transport.

The scheme would not be a door-to-door service. Parents/guardians would be responsible for bringing their children to the nearest pick-up point to avail of the service. Generally, routes would have planned so pupils don't have to travel more than 2 km to their nearest pick-up point.

This transport system would operate daily with multiple buses and shifts per day, to be able to absorb the projected demand for this service (school-aged population that lives 2 km away from the nearest school or further, 2 trips per day – roundtrip, 198 days per year). Costs of alternatives

For the purposes of this exercise, it is assumed that all the costs, including investment, operation and maintenance will be financed with public funds allocated by the education sector.

> **i** Studies have shown that in Sub-Saharan Africa construction costs are sensitive to the procurement method. In Kenya the average construction costs per classroom is of US$14,700 (US$170/m2) for contractor-built schools using national or local competitive bidding, compared to US$7,400 (US$86/m2) for those constructed under the Ministry of Education's community managed School Infrastructure Improvement Grants Programme. Also, there is a bias towards focusing on classroom unit costs, which normally represent only approximately 60% of the capital costs required for provision of a basic minimum package of infrastructure facilities at a school, which includes water and sanitation facilities, administration space, furniture and external works such as drainage, paths and boundary fencing. More information about this topic can be found in Bonner, R. et al, (2012). For the purposes of this study, teaching facilities have been separated from other areas to account for this bias.

▶ Investment costs

Investment costs are composed of building construction materials, building construction and equipment, terrain acquisition and labour.

Construction materials and labour vary according to the solution, as shows. Equipment (as chairs, desks, blackboards, computes, etc.) and habilitation costs (of utilities like sanitary and electrical infrastructure) are valued at 3.420 and 3.800 Ksh. per square meter of infrastructure. It is also assumed that the opportunity costs of terrain acquisition do not vary across alternatives, and therefore are not included in the analysis.

Table 24 - Unitary investment costs of alternatives

COST ITEM	A	B	C
Const. Materials and labour	42.750	29.925	34.200
Equipment	3.420	3.420	3.420
Habilitation	3.800	3.800	3.800

Source: Own elaboration

Alternative C also involves the acquisition of buses for the transport system (at USD 50.000/bus), but alternative rental models could be established. The total investment costs on the transport system was then calculated by multiplying the required buses per year (Table 24), times USD 50.000.

Operation and maintenance costs

Operational costs are primarily determined by staff hiring, including teachers, administrative staff and auxiliary/ maintenance staff. Unitary costs for staff hiring are assumed to be equal for all alternatives, as well as the number of staff required at the base year. However, since staff requirements are calculated according to a standards-based approach that establishes a staff to pupil ratio, the number of staff required for each year is sensitive to the captured demand by each alternative.

Table 25 - Staff to pupil ratio standard and monthly salary

TYPE	SC/MONTH - PERSON	RATIO TO PUPIL
Teaching	15.200	60
Administrative	11.400	150
Auxiliary / maintenance	7.600	250

Source: Own elaboration

Alternative C also has costs associated with the transport system operation. The unitary costs used for the model are shown in Table 26.

Table 26 - Operation costs parameters for transport system, Alterative C

VARIABLE	VALUE	*UNIT*
Travel Speed	25,00	(Km/Hr)
Time Value per Hour	105,00	*KSc*
Bus Capacity	45,00	Pupils/ bus
Bus Cost	50.000	USD
Bus Driver Salary	7.600	Ksh/month
Bus unitary operation cost	0,6	USD/Km

Source: Own elaboration

To estimate the annual buses operation costs, the following formula was followed:

$$\boldsymbol{BUS_t = \sum_s d_s * BUSd_t * 2 * T * UC * V}$$

Where,

BUS_t is the buses system operation costs.

d_s is the average distance from segment s to school C (for non-walking distances).

$BUSd_t$ is the bus demand/ requirement per year.

T is the number of school days per year.

UC is the unitary operation cost.

V is the time value per hour.

The transport system operation costs also encompass the salary of the drivers that operate the buses. This annual cost is calculated by multiplying the number of yearly required buses times the bus driver salary parameter (KSh/ month), times 10 (10 months of school per year).

Maintenance costs were estimated as a proportion of building costs for each alternative, 5% annually. Operational Costs like electricity, internet, phone, water, and others utilities are estimated as 3% of the building costs. These costs represent a conservative approach towards cost estimation (that it, over estimation of probable costs). It has indeed been shown, that maintenance costs of schools in developing countries represent, on average, 1,8% of the total construction costs:

Table 27- Reference maintenance costs

Element and activity	Scope and interval	% of total cost	Annual maintenance cost as % of construction cost
Floor screed; repairs	20% of area, 5 years	4.00	0.16
Plaster, internal/external; repairs	10% of area, 5 years	4.00	0.08
Painting walls	50% of area, 2 years	2.00	0.50
Painting doors, windows, trusses	100%, 5 years	1.50	0.30
Painting blackboard	100%, every year	0.25	0.25
Locks, hinges, bolts; replace	100%, 5 years	1.50	0.30
Roofing screws, fix and replace	25%, 5 years	1.00	0.05
Doors; replace	50%, 10 years	3.00	0.15
Total annual maintenance cost as percentage of construction costs			**1.79**

Source: Group Consulting Engineers (2006) as cited in Theunynck, S. (2009)

▶ Travel time costs

First, **travel time costs for walking distances** (effective influence area, 2 km threshold) were calculated (for the 3 alternatives) by estimating the average walking distance between each segment to the nearest school (varies across alternatives), and the total amount of yearly trips carried by children by foot. In order to estimate the foot-travel time costs, the total number of yearly walking trips was calculated according to the following:

$$\boldsymbol{WalkTrips_s = \sum_s D_t * POP_s * W_s * T * 2}$$

$WalkTrips_t$ is the total number of walking trips from segment s, per year

D_t is the total estimated deficit for year t

POP_s is the percentage of school-aged population (6 to 11) living in segment s

W_s is the effectively captured demand by foot (walking distance, 2 km threshold)

T is the total number of school days (assumed to be 198)

Next, bus-travel time costs were calculated

Once the total number of walking trips is calculated, total foot-travel costs are estimated, assuming an average walking travel speed of 4 km/ hour, as follows:

$$\boldsymbol{TTCW_t = \frac{WalkTrips_s * d_s}{S_w} * V}$$

$TTCW_t$ is the walking time travel cost per year.

d_s is the average distance from segment s to each school (for walking distances).

S_w is the travel speed by foot.

V is the time value per hour.

The average distance from each segment to alternative schools is presented in Table 28.

Table 28 - Average distance from each segment to alternative schools (meters), by foot

SEGMENT	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
A	900	900	900
B	1.200	1.200	1.200
C	1.100	900	1.000
D	400	300	-

Source: Own elaboration

Second, **travel time costs for non-walking distances** (children located 2 km away from school or further) were calculated for Alternative C (that is, time travel costs generated for children that travel by bus). In order to do this, the number of bus yearly trips was estimated, using the following formula:

$$\boldsymbol{BusTrips_t = \sum_s D_t * POP_s * (1 - W_s) * T * 2}$$

$BusTrips_t$ is the total number of bus trips per year.

D_t is the total estimated deficit for year t.

POP_s is the percentage of school-aged population (6 to 11) living in segment s.

$1 - W_s$ is the by-foot demand that isn't captured (travel distance is over the 2 km threshold).

T is the total number of school days (assumed to be 198).

Next, bus-travel time costs were calculated, assuming an average bus travel speed of 25 km/hour, as follows:

$$\boldsymbol{TTCB_t = \frac{BusTrips_s * d_s}{S_b} * V}$$

$TTCB_t$ is the bus time travel cost per year.

d_s is the average distance from segment s to each school (for non-walking distances).

S_b is the travel speed by bus.

V is the time value per hour.

The average distance from each segment to Alternative C School is presented in the following table.

Table 29 - Average distance from each segment to School C (mts), for non-walking distance areas (transport system)

ALTERNATIVE	MTS
A	2.100
B	2.500
C	3.000
D	3.500

Source: Own elaboration

To estimate the required buses for the transport system, it was assumed that the capacity of each bus is **45 pupils/bus**. To estimate the requirement of buses for each year, following formula was applied:

$$\boldsymbol{BUSd = \sum_{s} D_t * POP_s * \frac{(1 - W_s)}{BusC}}$$

Where:

BUSd is the bus demand per year.

D_t is the total estimated deficit per year.

POP_s is the percentage of school-aged population (6 to 11) living in segment s.

W_s is the effectively captured demand (walking distance, 2 km threshold).

$BusC$ is the Bus capacity (seats per bus).

After summing up the requirement of buses for all segments, the total amount of buses per year was calculated (Table 30).

Table 30 - Total bused need, Alternative C

YEAR	REQUIRED BUSES
2021	0
2022	0
2023	14
2024	16
2025	16
2026	18
2027	18
2028	20
2029	20
2030	21
2031	21
2032	21
2033	21
2034	21
2035	21
2036	21
2037	21
2038	21
2039	21
2040	21
2041	21
2042	21
2043	0

Source: Own elaboration

Nutrition program costs

For the purposes of this case study, it is assumed that all alternatives incorporate similar standards around meal preparation and delivery, fixing an average yearly expenditure per child, over a 200-day on-site feeding period (and an average ration) of US$21.59. This cost is based on a study carried by Gelli, A., Al-Shaiba, N., & Espejo, F. (2009) which estimated the programmatic costs and cost-efficiency associated with providing food through schools in food-insecure, developing-country contexts, by analyzing global project data from the World Food Programme (WFP). It must be noted that nutrition program costs are sensitive to several factors, including the composition and size of the ration, the caloric intake per day, and the program modality (e.g fortified biscuits, on-site meals, take-home rations). Choice of modality of food delivery in school has considerable implications for both program objectives and costs but it has been assumed that none of these elements vary across alternatives (Espejo 2009). It is also assumed, for the purpose of this case study, that in this unitary cost includes all operational costs associated with the meal provision (preparing food, buying ingredients, etc.).

Construction schedules

ALTERNATIVE	2021	2022
A	35%	65%
B	100%	
C	50%	50%

Source: Authors' designated parameters

6 FISCAL AND FINANTIAL ANALYIS

For the purposes of this case study, it is assumed that the project is 100% covered with public funds and that project involves no co-payments from the benefited population (provided that the Free primary education scheme is hold in place). For this reason, and since the project alternatives are only described in terms of its costs (there is no monetization of benefits in a cost-effectiveness or cost-efficiency analysis), the fiscal and financial analysis is quite simple: from the project point of view, the funds required to implement the project are equal to the budget that the Treasury (or sponsor) would have to allocate.

The annual budgetary requirements of each alternative are presented as follows. These represent the full amount that the sponsor should consider in its budget process (not only capital expenditure, but also operational cost). Only in this way can the operation of the project be fully guaranteed.

Table 31 - Budgetary requirements of project alternatives: Total annual costs, MM Ksh.

AÑO	ALTERNATIVE A	ALTERNATIVE B	ALTERNATIVE C
2021	$ 120,219	$ 89,364	$ 99,649
2022	$ 223,264	$ 165,962	$ 185,063
2023	$ 32,070	$ 27,193	$ 106,144
2024	$ 32,434	$ 27,695	$ 44,051
2025	$ 33,029	$ 28,428	$ 34,123
2026	$ 33,398	$ 28,844	$ 45,648
2027	$ 33,766	$ 29,397	$ 35,723
2028	$ 34,272	$ 29,904	$ 46,953
2029	$ 34,732	$ 30,639	$ 37,300
2030	$ 35,235	$ 31,053	$ 43,149
2031	$ 35,599	$ 31,691	$ 37,899
2032	$ 35,960	$ 32,098	$ 37,899
2033	$ 36,454	$ 32,390	$ 37,899
2034	$ 36,898	$ 32,390	$ 37,899
2035	$ 37,381	$ 32,390	$ 37,899
2036	$ 37,722	$ 32,390	$ 37,899
2037	$ 38,054	$ 32,390	$ 37,899
2038	$ 38,197	$ 32,390	$ 37,899
2039	$ 38,740	$ 32,390	$ 37,899
2040	$ 39,046	$ 32,390	$ 37,899
2041	$ 39,160	$ 32,390	$ 37,899
2042	$ 39,443	$ 32,390	$ 37,899
2043	$ -333,035	$ -233,124	$ -376,678

Source: Own elaboration

The negative values at the end of the period denote the imputation of residual values for civil works, equipment and infrastructure habilitation.

7 ECONOMIC AND STAKEHOLDERS ANALYSIS

This section details the socio-economic analysis of the integrated infrastructure-intervention project, following a cost-efficiency approach.

> i Cost-efficiency is a method used in socio-economic evaluation which assumes that the benefits produced by different project alternatives are equivalent and are not estimated. Therefore, the decision around choosing one project alternative over the other is merely given by the comparison of the costs that each alternative incurs. The alternative with the lowest cost is the one to be picked (this is why this method is also referred to as "minimum cost". One primary indicator is used in this type on analysis: Net Present Cost (NPC) or Present Value of Costs.

7.1 ECONOMIC PARAMETERS AND ASSUMPTIONS

▶ Economic Cost of Capital

The SDR is set at 12,34%. This rate is used to discount future cash flows into the calculation of present values.

▶ Taxes

Value added taxes (VAT) is set at 12.5%, import taxes for imported goods at 15%, and a SERCF of 1,047.

Income taxes for skilled, semi-skilled and unskilled labour are 17.5%, 10.0% and 5%, respectively.

▶ Labour Assumptions

Labor market parameters are shown in the following table:

Table 32 - Labour assumptions

Type of labour	Project wage/month	Supply wage/month Alt. sources	Market wage/month	Income tax rate	Demand Prop. from taxed alt.
	(Wp)	(Wa)	(Ws)	(T)	(Hd)
Skilled	15.200	13.300	13.870	17.50%	90%
Semi-skilled	11.400	9.500	10.450	10.00%	75%
Unskilled	7.600	4.180	5.320	5.00%	50%

Source: Own elaboration

7.2 COSTS BREAKDOWN

Construction, Equipment and Habilitation costs are composed of labour, materials and equipment, which can be both domestically produced or imported. The following tables summarize the parameters used for this case study:

Const. Materials and labour

Labour

Skilled	5%
Semiskilled	10%
Unskilled	20%

Material

		Imported	Domestic
Cement	22%	70%	30%
Steel	20%	50%	50%
Glass	5%	100%	0%
Concrete	18%	40%	60%

Equipment

Materials and equipment

Domestically produced	75%
Imported	25%

Habilitation

Labour

Skilled	25%
Semiskilled	35%
Unskilled	10%

Materials and equipment

Domestically produced	5%
Imported	25%

Source: Own elaboration

7.3 SOCIO-ECONOMIC EVALUATION

In this section, the financial cash flows are detailed for each alternative, followed by a conversion of market to economic values. Finally, cost-efficiency indicators are calculated to decide upon the alternative with the minimum net present cost.

7.3.1 Financial cash flows

- **Investment costs**

Table 33 - Investment costs for Alternative A (MM KSh)

Civil Works			35,0%	65,0%
Labour				
Skilled	5%	*MM KSh*	$ 5,14	$ 9,55
Semiskilled	10%	*MM KSh*	$ 10,28	$ 19,10
Unskilled	20%	*MM KSh*	$ 20,57	$ 38,20
Total Labour		*MM KSh*	$ 36,00	$ 66,85
Material				
Cement	22%	*MM KSh*	$ 22,63	$ 42,02
Steel	20%	*MM KSh*	$ 20,57	$ 38,20
Glass	5%	*MM KSh*	$ 5,14	$ 9,55
Concrete	18%	*MM KSh*	$ 18,51	$ 34,38
Total Materials		*MM KSh*	$ 66,85	$ 124,15
Total Civil Works		*MM KSh*	$ 102,85	$ 191,01
Equipment				
Materials and equipment				
Domestically produced	75%	*MM KSh*	$ 6,17	$ 11,46
Imported	25%	*MM KSh*	$ 2,06	$ 3,82
Total Equipments		*MM KSh*	$ 8,23	$ 15,28
Habilitation				
Labour				
Skilled	25%	*MM KSh*	$ 2,29	$ 4,24
Semiskilled	35%	*MM KSh*	$ 3,20	$ 5,94
Unskilled	10%	*MM KSh*	$ 0,91	$ 1,70
Materials and equipment				
Domestically produced	5%	*MM KSh*	$ 0,46	$ 0,85
Imported	25%	*MM KSh*	$ 2,29	$ 4,24
Total Habilitation		*MM KSh*	$ 9,14	$ 16,98
TOTAL INVESTMENT COSTS		*MM KSh*	$ 120,22	$ 223,26

Source: Own elaboration

Table 34 - Investment costs for Alternative B (MM KSh)

Civil Works			100,0%
Labour			
Skilled	5%	*MM KSh*	$ 10,28
Semiskilled	10%	*MM KSh*	$ 20,57
Unskilled	20%	*MM KSh*	$ 41,14
Total Labour		*MM KSh*	$ 71,99
Material			
Cement	22%	*MM KSh*	$ 45,25
Steel	20%	*MM KSh*	$ 41,14
Glass	5%	*MM KSh*	$ 10,28
Concrete	18%	*MM KSh*	$ 37,03
Total Materials		*MM KSh*	$ 133,70
Total Civil Works		*MM KSh*	$ 205,70
Equipment			
Materials and equipment			
Domestically produced	75%	*MM KSh*	$ 17,63
Imported	25%	*MM KSh*	$ 5,88
Total Equipments		*MM KSh*	$ 23,51
Habilitation			
Labour			
Skilled	25%	*MM KSh*	$ 6,53
Semiskilled	35%	*MM KSh*	$ 9,14
Unskilled	10%	*MM KSh*	$ 2,61
Materials and equipment			
Domestically produced	5%	*MM KSh*	$ 1,31
Imported	25%	*MM KSh*	$ 6,53
Total Habilitation		*MM KSh*	$ 26,12
TOTAL INVESTMENT COSTS		*MM KSh*	$ 255,33

Source: Own elaboration

Table 35 - Investment costs for Alternative C (MM KSh)

Civil Works			50,0%	50,0%
Labour				
Skilled	5%	MM KSh	$ 5,88	$ 5,88
Semiskilled	10%	MM KSh	$ 11,75	$ 11,75
Unskilled	20%	MM KSh	$ 23,51	$ 23,51
Total Labour		MM KSh	$ 41,14	$ 41,14
Material				
Cement	22%	MM KSh	$ 25,86	$ 25,86
Steel	20%	MM KSh	$ 23,51	$ 23,51
Glass	5%	MM KSh	$ 5,88	$ 5,88
Concrete	18%	MM KSh	$ 21,16	$ 21,16
Total Materials		MM KSh	$ 76,40	$ 76,40
Total Civil Works		MM KSh	$ 117,54	$ 117,54
Equipment				
Materials and equipment				
Domestically produced	75%	MM KSh	$ 8,82	$ 8,82
Imported	25%	MM KSh	$ 2,94	$ 2,94
Total Equipments		MM KSh	$ 11,75	$ 11,75
Habilitation				
Labour				
Skilled	25%	MM KSh	$ 3,27	$ 3,27
Semiskilled	35%	MM KSh	$ 4,57	$ 4,57
Unskilled	10%	MM KSh	$ 1,31	$ 1,31
Materials and equipment				
Domestically produced	5%	MM KSh	$ 0,65	$ 0,65
Imported	25%	MM KSh	$ 3,27	$ 3,27
Total Habilitation		MM KSh	$ 13,06	$ 13,06
TOTAL INVESTMENT COSTS		MM KSh	$ 142,36	$ 142,36

Source: Own elaboration

Operational and maintenance costs

Table 36, Table 37, Table 38 and Table 39 detail the comparable operational and maintenance costs of project alternatives (including maintenance costs as % of CAPEX, operational costs as % of capex, staff expenditures and intervention costs). Costs associated to the transport system of Alternative C are presented separately, on

Table 36 - OPEX of Alternative A (MM KSh.)

YEAR	YEARLY MAINTENANCE COSTS (AS % OF CAPEX)	YEARLY OPERATIONAL COSTS (AS % OF CAPEX)	TOTAL STAFF EXPENSES	INTERVENTION COSTS (NUTRITION PROGRAM)	TOTAL OPEX
2021	$-	$-	$-	$-	$-
2022	$-	$-	$-	$-	$-
2023	$17,2	$10,3	$2,6	$2,0	$32,1
2024	$17,2	$10,3	$2,7	$2,2	$32,4
2025	$17,2	$10,3	$3,1	$2,4	$33,0
2026	$17,2	$10,3	$3,3	$2,6	$33,4
2027	$17,2	$10,3	$3,5	$2,8	$33,8
2028	$17,2	$10,3	$3,8	$3,0	$34,3
2029	$17,2	$10,3	$4,1	$3,1	$34,7
2030	$17,2	$10,3	$4,4	$3,3	$35,2
2031	$17,2	$10,3	$4,6	$3,5	$35,6
2032	$17,2	$10,3	$4,8	$3,7	$36,0
2033	$17,2	$10,3	$5,1	$3,9	$36,5
2034	$17,2	$10,3	$5,4	$4,0	$36,9
2035	$17,2	$10,3	$5,7	$4,2	$37,4
2036	$17,2	$10,3	$5,9	$4,4	$37,7
2037	$17,2	$10,3	$6,1	$4,5	$38,1
2038	$17,2	$10,3	$6,1	$4,7	$38,2
2039	$17,2	$10,3	$6,5	$4,8	$38,7
2040	$17,2	$10,3	$6,7	$4,9	$39,0
2041	$17,2	$10,3	$6,7	$5,0	$39,2
2042	$17,2	$10,3	$6,8	$5,1	$39,4
2043	$-	$-	$-	$-	$-

Source: Own elaboration

Table 37 - OPEX of Alternative B (MM KSh.)

YEAR	YEARLY MAINTENANCE COSTS (AS % OF CAPEX)	YEARLY OPERATIONAL COSTS (AS % OF CAPEX)	TOTAL STAFF EXPENSES	INTERVENTION COSTS (NUTRITION PROGRAM)	TOTAL, OPEX
2021	$-	$-	$-	$-	$-
2022	$-	$-	$-	$-	$-
2023	$12,8	$7,7	$3,8	$2,9	$27,2
2024	$12,8	$7,7	$4,1	$3,2	$27,7
2025	$12,8	$7,7	$4,6	$3,4	$28,4
2026	$12,8	$7,7	$4,8	$3,6	$28,8
2027	$12,8	$7,7	$5,1	$3,9	$29,4
2028	$12,8	$7,7	$5,4	$4,1	$29,9
2029	$12,8	$7,7	$5,9	$4,3	$30,6
2030	$12,8	$7,7	$6,1	$4,6	$31,1
2031	$12,8	$7,7	$6,5	$4,8	$31,7
2032	$12,8	$7,7	$6,7	$5,0	$32,1
2033	$12,8	$7,7	$6,8	$5,1	$32,4
2034	$12,8	$7,7	$6,8	$5,1	$32,4
2035	$12,8	$7,7	$6,8	$5,1	$32,4
2036	$12,8	$7,7	$6,8	$5,1	$32,4
2037	$12,8	$7,7	$6,8	$5,1	$32,4
2038	$12,8	$7,7	$6,8	$5,1	$32,4
2039	$12,8	$7,7	$6,8	$5,1	$32,4
2040	$12,8	$7,7	$6,8	$5,1	$32,4
2041	$12,8	$7,7	$6,8	$5,1	$32,4
2042	$12,8	$7,7	$6,8	$5,1	$32,4
2043	$-	$-	$-	$-	$-

Source: Own elaboration

Table 38 - OPEX of Alternative C (MM KSh.)

YEAR	YEARLY MAINTENANCE COSTS (AS % OF CAPEX)	YEARLY OPERATIONAL COSTS (AS % OF CAPEX)	TOTAL STAFF EXPENSES	INTERVENTION COSTS (NUTRITION PROGRAM)	TOTAL OPEX
2021	$-	$-	$-	$-	$-
2022	$-	$-	$-	$-	$-
2023	$14,2	$8,5	$4,4	$3,3	$30,5
2024	$14,2	$8,5	$4,8	$3,6	$31,2
2025	$14,2	$8,5	$5,1	$3,9	$31,7
2026	$14,2	$8,5	$5,6	$4,1	$32,4
2027	$14,2	$8,5	$5,9	$4,4	$33,0
2028	$14,2	$8,5	$6,1	$4,6	$33,5
2029	$14,2	$8,5	$6,7	$4,9	$34,3
2030	$14,2	$8,5	$6,8	$5,1	$34,7
2031	$14,2	$8,5	$6,8	$5,1	$34,7
2032	$14,2	$8,5	$6,8	$5,1	$34,7
2033	$14,2	$8,5	$6,8	$5,1	$34,7
2034	$14,2	$8,5	$6,8	$5,1	$34,7
2035	$14,2	$8,5	$6,8	$5,1	$34,7
2036	$14,2	$8,5	$6,8	$5,1	$34,7
2037	$14,2	$8,5	$6,8	$5,1	$34,7
2038	$14,2	$8,5	$6,8	$5,1	$34,7
2039	$14,2	$8,5	$6,8	$5,1	$34,7
2040	$14,2	$8,5	$6,8	$5,1	$34,7
2041	$14,2	$8,5	$6,8	$5,1	$34,7
2042	$14,2	$8,5	$6,8	$5,1	$34,7
2043	$-	$-	$-	$-	$-

Source: Own elaboration

Table 39 - Transport system operational costs, Alternative C

YEAR	BUS DRIVERS SALARY EXPENSES	BUS OPERATION COSTS
2021	$ -	$ -
2022	$ -	$ -
2023	$ 1,06	$ 1,03
2024	$ 1,22	$ 1,17
2025	$ 1,22	$ 1,17
2026	$ 1,37	$ 1,33
2027	$ 1,37	$ 1,33
2028	$ 1,52	$ 1,47
2029	$ 1,52	$ 1,47
2030	$ 1,60	$ 1,56
2031	$ 1,60	$ 1,56
2032	$ 1,60	$ 1,56
2033	$ 1,60	$ 1,56
2034	$ 1,60	$ 1,56
2035	$ 1,60	$ 1,56
2036	$ 1,60	$ 1,56
2037	$ 1,60	$ 1,56
2038	$ 1,60	$ 1,56
2039	$ 1,60	$ 1,56
2040	$ 1,60	$ 1,56
2041	$ 1,60	$ 1,56
2042	$ 1,60	$ 1,56
2043	$ -	$ -

Source: Own elaboration

Travel time costs

Table 40 – Walking and bus travel time costs, per alternative, MM KSh.

YEAR	A	B	C WALKING)	C (BUS)
2021	$-	$-	$-	$-
2022	$-	$-	$-	$-
2023	$5,95	$7,05	$5,55	$2,88
2024	$6,48	$7,60	$5,96	$3,09
2025	$7,02	$8,16	$6,38	$3,31
2026	$7,56	$8,72	$6,80	$3,53
2027	$8,10	$9,28	$7,22	$3,75
2028	$8,65	$9,84	$7,65	$3,97
2029	$9,19	$10,40	$8,07	$4,19
2030	$9,73	$10,96	$8,49	$4,40
2031	$10,26	$11,50	$8,49	$4,40
2032	$10,78	$12,04	$8,49	$4,40
2033	$11,29	$12,31	$8,49	$4,40
2034	$11,78	$12,31	$8,49	$4,40
2035	$12,26	$12,31	$8,49	$4,40
2036	$12,72	$12,31	$8,49	$4,40
2037	$13,16	$12,31	$8,49	$4,40
2038	$13,58	$12,31	$8,49	$4,40
2039	$13,97	$12,31	$8,49	$4,40
2040	$14,33	$12,31	$8,49	$4,40
2041	$14,66	$12,31	$8,49	$4,40
2042	$14,95	$12,31	$8,49	$4,40
2043	$-	$-	$-	$-

Source: Own elaboration

Conversion Factors: Market to Economic values

In order to complete the economic evaluation of alternative projects, it is necessary to transform the market values to economic values that reflect the real opportunity costs of resources. The following conversion factors were used for this case study:

Table 41 - Conversion factors: market to economic values

Total Labour	0,8235	*MM KSh*
Total Materials	0,9950	*MM KSh*
Materials and equipment		
Domestically produced	0,9950	*MM KSh*
Imported	1,4047	*MM KSh*
Habilitation		
Labour		
Skilled	0,8235	*MM KSh*
Semiskilled	0,8235	*MM KSh*
Unskilled	0,8235	*MM KSh*
Materials and equipment		
Domestically produced	0,9950	*MM KSh*
Imported	1,4047	*MM KSh*

Source: Own elaboration

Applying these conversion factors to the financial cash flows previously detailed result in the economic flows of the three project alternatives.

Table 42 – Socio-economic flows (costs) of project alternatives

YEAR	A	B	C
2021	$ 114,126	$ 243,650	$ 135,562
2022	$ 211,948	$ -	$ 135,562
2023	$ 36,171	$ 32,634	$ 142,674
2024	$ 37,036	$ 33,638	$ 55,680
2025	$ 38,097	$ 34,838	$ 42,082
2026	$ 38,975	$ 35,782	$ 58,456
2027	$ 39,856	$ 36,841	$ 44,869
2028	$ 40,850	$ 37,862	$ 60,989
2029	$ 41,803	$ 39,068	$ 47,624
2030	$ 42,788	$ 40,004	$ 56,222
2031	$ 43,651	$ 41,119	$ 48,847
2032	$ 44,501	$ 42,032	$ 48,847
2033	$ 45,449	$ 42,556	$ 48,847
2034	$ 46,340	$ 42,556	$ 48,847
2035	$ 47,246	$ 42,556	$ 48,847
2036	$ 48,014	$ 42,556	$ 48,847
2037	$ 48,754	$ 42,556	$ 48,847
2038	$ 49,311	$ 42,556	$ 48,847
2039	$ 50,172	$ 42,556	$ 48,847
2040	$ 50,806	$ 42,556	$ 48,847
2041	$ 51,250	$ 42,556	$ 48,847
2042	$ 51,795	$ 42,556	$ 48,847
2043	$ -316,156	$ -222,463	$ -408,581

Source: Own elaboration

7.4 COST-EFFICIENCY INDICATORS

For each alternative, the Net Present Costs (NPC) indicator was calculated, two measures of Cost Per Beneficiary (CPB). The NPC is an applicable criterion in cases where the benefits of the various alternative projects are equal. However, it often happens that different alternative projects generate unequal benefits, as in this case study, where different demands are captures over the years by project alternatives.

Table 43 - NPC and CPB calculations for each alternative

INDICATOR	A	B	C
Present Value of COSTS (NPC)	$ 549	$ 473	628,42169
Present Value of COSTS/ Seats (CPB)	$ 0,333	$ 0,287	0,38104013
Present Value of COSTS/ Pupil at Design (CPB)	$ 0,512	$ 0,322	0,38104013

Source: Own elaboration

Based on these results, the most cost-efficient alternative is B, with a cost per seat of MM Ksh 0,287 and a cost per pupil at design of MM Ksh 0,322, which follows the rationale of educational infrastructure designs found in the literature, where relatively smaller but close-to-home alternatives are preferred.

8 OBJECTIVES AND EXPECTED OUTPUTS

In this section, the reference project's rationale is presented. It is built upon the problem and solution trees developed in the previous section and is further informed by the use of alternative tools that are used in the formulation and evaluation of social projects, to organize its intervention strategy. In this case study this section is covered at the end to reflect the alternative's selection derived from the cost-effectiveness and cost-efficiency analysis. This allows the analysis to be focused on the selected infrastructure-intervention strategy, following a program evaluation approach.

In the following table, a recap of the primary inputs for this exercise is presented:

Table 44 - Intervention logic inputs

VARIABLE	DESCRIPTION
Identified problem	Low primary school participation in Bwaliro
Solution/ Objective	Increase school participation in Bwaliro
Primary cause	Supply side: Educational facilities shortage Demand side: Inability to attend school due to malnutrition
Needs	Supply side: Appropriate number and distribution of primary educational infrastructure Demand side: Good nutrition accessed
Courses of action/ Components of the project	Supply side: Educational infrastructure built Demand side: nutrition program implemented

Source: own elaboration

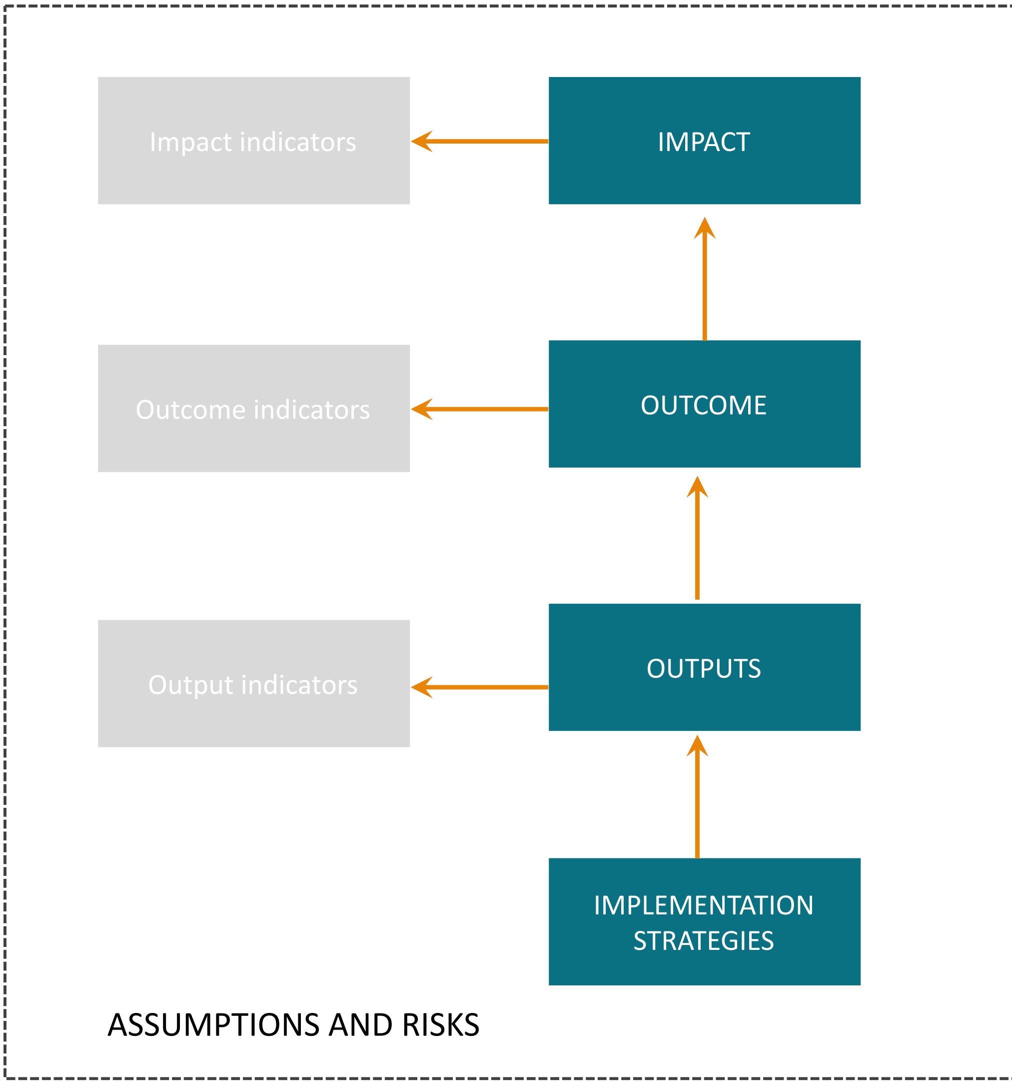
Based on these inputs, the goal of the project is defined as follows: increase school participation in Bwaliro by providing an appropriate number and distribution of primary educational infrastructure, and ensuring good nutrition access to students.

Suppose this goal was translated by the Busia County authorities into a concrete plan to build new primary school facilities with a capacity to serve, by year 2030, over 1.640 students under pre-defined standards, and to complement the infrastructure project with the implementation of a school-based nutrition program. This is expected to generate immediate effects/outcomes at the school participation level, but also long-term impacts in educational status and other variables not necessarily related to the education sector.

These impacts can be best summarized using a Theory of Change approach. A ‘theory of change’ (TC) explains how activities are understood to produce a series of results that contribute to achieving the final intended impact of an investment initiative. A TC clearly defines a causal hypothesis to anticipate the expected and unexpected impacts that a particular project may induce. It can be developed for any level of an intervention – an event, a project, a program, a policy, a strategy or an entire organization. Sometimes the term is used generally to refer to any version of this process, including a “results chain” or “outcomes chain”, which shows a series of boxes from inputs to outputs, outcomes and impacts, or a log frame, which represents the same information in a matrix.

A theory of change analysis may prove useful in ex-ante project evaluation to organize the current situation for all stakeholders involved in a project (and not the affected population only), and to revise what needs to be done to move from the current status to the intended situation through the project. This can help to design more realistic goals, clarify accountabilities and establish a common understanding of the strategies to be used to achieve the goals. It is also the basis for any impact evaluation.

Figure 11 - Schematic depiction of a theory of change



Source: Based on Brief theory of change. In United Nations Children's Fund, Supplementary Programme Note on the Theory of Change, Peer Review Group meeting, 11 March 2014, UNICEF, New York, 2014, p. 4.

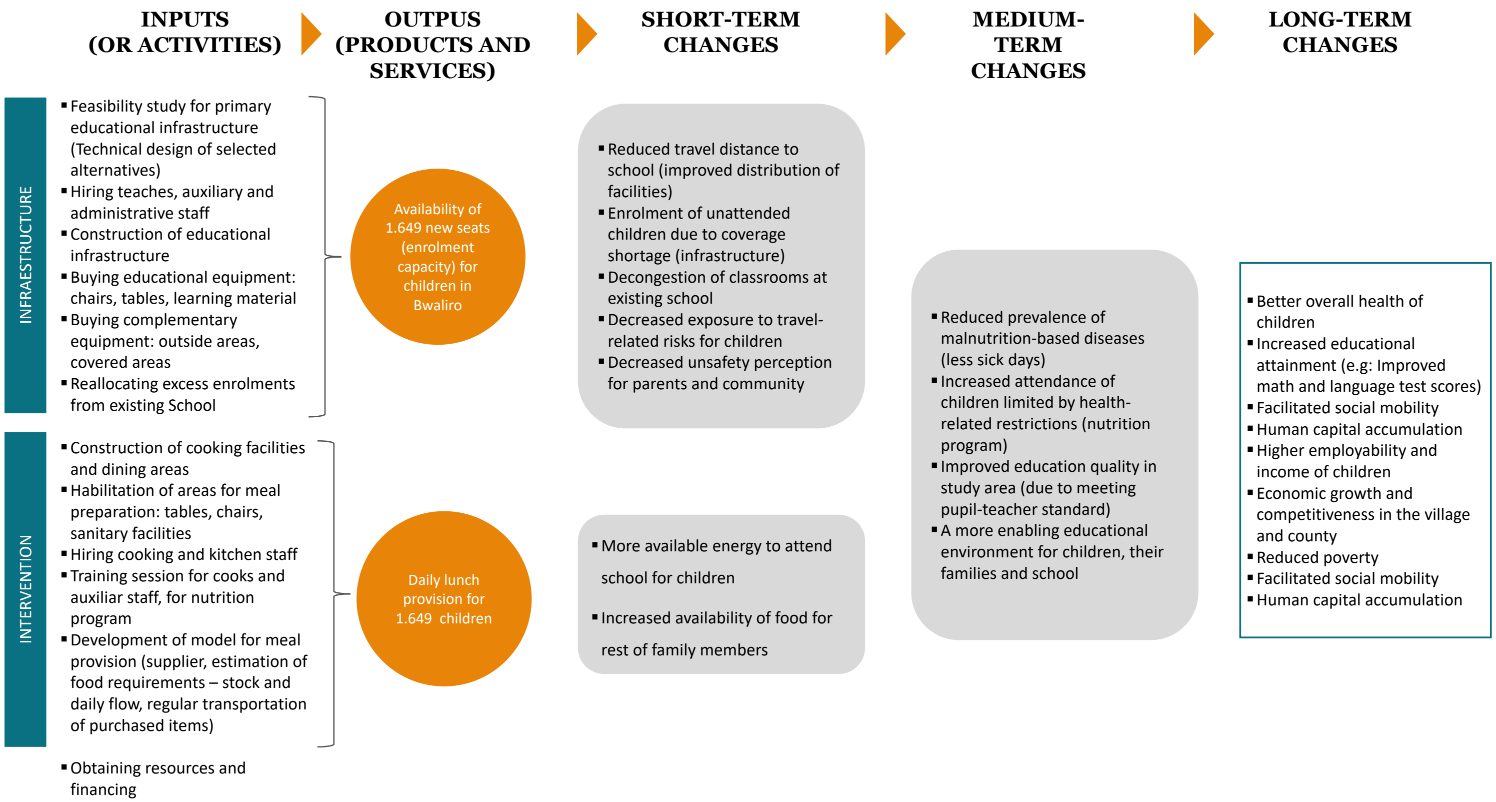
A theory of change may be established on the basis of a literature review, needs assessment and experience of the formulator, but is a good practice to always complement the analysis with the perceptions and expectations of the project's stakeholders. All this information sources will help reach a better understanding of how "change" shall be accomplished. One of the benefits of the theory of change analysis is that it allows to assess the project's impact in a wider context, to establish time frames for the expected impacts and to get relevant stakeholders involved.

There are different ways of developing and representing a theory of change, some simpler than others, but they should all consider at least 3 distinctive elements: Inputs, Outputs and Outcomes

- **Inputs:** They refer to the required recourses that all stakeholders must put in place in order to achieve the objectives of the program. These resources may be financial (e.g. direct cash transfers), human resources (e.g. hired staff), or intangible resources (e.g. non-monetized time spent on activities). Sometimes, inputs are grouped together with the "Activities" that these inputs involve (concrete actions, e.g.: hiring, developing, constructing, etc.)
- **Outputs:** These are the deliverables, products or services created by the project. They're measured in natural physical units (e.g. number of meals prepared)
- **Outcomes:** Correspond to the achievements created by the project, or changes (expected and unexpected) created by the services or facilities that the project offers. Can be immediate or short-term, medium term and long term (sometimes referred to as "impacts"). Outcomes that occur at different time frames or affect different scales of a person's life may be represented in a Chain of outcomes diagram, to summarize and display the known (or assumed) relationships between one outcome and the other. A clear identification of excepted and unexpected outcomes is required to later estimate effectiveness measures. In this case study, improved children nutrition is understood as an outcome that occurs before school participation. That is, children nutrition represents an intermediate outcome in the evaluation of an intervention whose primary purpose is to increase student's participation (final outcome). Relevant outcomes could defined be established for every step in the outcome chain, depending on the program's objective.

In the next figure, a detailed representation of the social project's theory of change is presented, focusing primarily on the outcomes generated for the children benefited by the infrastructure-intervention project and, to some extent, to their families. The analysis could be enriched by also taking other stakeholder into account, and by offering a quantification of the most relevant outcomes identified. These would usually be informed by a literature review (impact evaluations, effectiveness studies, etc.). For example, in this case study, the TOC could be enriched by pointing that school feeding interventions are known to lead to: i) An increase in attendance by 4-7 days a year, ii) Increase in enrolment by 16 percent, iii) A drop-out decline by 9 percent, iv) increased cognition (Kristjansson, E., 2016).

Figure 12 - Detailed theory of change



Source: Own elaboration

9 ENVIRONMENTAL AND SOCIAL ANALYSIS

It can be argued that all investment projects, of different types and scales, always create long-term outcomes or “impacts” that the project should account for. While this is true, it is also relevant to consider that these correspond to secondary effects generated by a project, that shall not be quantified and valued for the sake of justifying an intervention (even though the side effects they may influence a policy maker to implement a project, incorporating its estimated flows in the socio-economic analysis only to strengthen its viability is an undesirable practice). Instead, the focus should always be placed on the primary goal of the project which, if properly met, should be able to justify the intervention on its own. This is particularly true in the context of a small social project like the one discussed in this case study (compared to, for example, a regional transport project) where, from the socio-economic evaluation perspective, are not expected to generate significant impacts on the whole society. For these reasons, a more detailed environmental and social analysis is purposefully avoided in this case study.

10 RISKS ANALISYS

A simplified risk analysis is presented in this section, where project size is selected as the key variable for a sensitivity analysis (since this case study is only described in terms of costs, the probability of a negative NPV cannot be estimated, and there is no point of running a complex risk analysis).

Table 45 - Sensitivity analysis, Alternative A

DEFECIT DESIGN YEAR	PRESENT VALUE OF COSTS	PRESENT VALUE OF COSTS/ SEATS	PRESENT VALUE OF COSTS/ PUPIL AT DESIGN
	549	0,333	0,512
2025	433,199	0,350	0,560
2026	457,194	0,346	0,548
2027	480,775	0,343	0,538
2028	503,893	0,339	0,528
2029	526,745	0,336	0,520
2030	549,007	0,333	0,512
2031	570,816	0,330	0,505
2032	592,246	0,327	0,498
2033	613,198	0,325	0,492
2034	633,570	0,323	0,487
2035	653,263	0,321	0,483
2036	672,175	0,320	0,479
2037	690,207	0,318	0,475
2038	707,264	0,317	0,472
2039	723,252	0,316	0,469
2040	738,082	0,315	0,467

Source: Own elaboration

Table 46 - Sensitivity analysis, Alternative B

DEFECIT DESIGN YEAR	PRESENT VALUE OF COSTS	PRESENT VALUE OF COSTS/ SEATS	PRESENT VALUE OF COSTS/ PUPIL AT DESIGN
		$ 473	$ 0,287
2025	2025	370,858	0,299
2026	2026	392,503	0,297
2027	2027	413,363	0,294
2028	2028	433,469	0,292
2029	2029	453,794	0,289
2030	2030	472,908	0,287
2031	2031	491,706	0,284
2032	2032	510,136	0,282
2033	2033	527,528	0,280
2034	2034	544,296	0,278
2035	2035	560,326	0,276
2036	2036	575,622	0,274
2037	2037	589,965	0,272
2038	2038	603,435	0,270
2039	2039	616,040	0,269
2040	2040	627,732	0,268

Source: Own elaboration

Table 47 - Sensitivity analysis, Alternative C

DEFECIT DESIGN YEAR	PRESENT VALUE OF COSTS	PRESENT VALUE OF COSTS/ SEATS	PRESENT VALUE OF COSTS/ PUPIL AT DESIGN
		628	0,381
2025	2025	496,854	0,401
2026	2026	529,862	0,401
2027	2027	553,161	0,394
2028	2028	581,967	0,392
2029	2029	604,735	0,386
2030	2030	628,422	0,381
2031	2031	651,271	0,377
2032	2032	675,377	0,373
2033	2033	694,578	0,368
2034	2034	715,731	0,365
2035	2035	734,456	0,361
2036	2036	752,320	0,358
2037	2037	768,144	0,354
2038	2038	783,541	0,351
2039	2039	797,823	0,348
2040	2040	810,545	0,346

Source: Own elaboration