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DIPARTIMENTO SCIENZE DELLA VITA

DOTTORATO DI RICERCA IN SCIENZE DELLA VITA

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COORDINATORE: **Prof. Massimo Valoti**

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Exploring Barriers to Immunization Coverage within a Sub-Saharan African Setting

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Doctor of Philosophy in Life Sciences
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Title Page

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Exploring Barriers to Immunization Coverage within a Sub-Saharan African Setting

THESIS SUBMITTED BY

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List of Abbreviations

Abbreviation	Meaning
BCG	Bacillus Calmette–Guérin vaccine
BeSD	Behavioral and social drivers
CDC	Centre for Disease Control and Prevention
ICC	Inter-Agency Coordinating Committee
MR	Measles-Rubella Vaccine
ACLED	Armed Conflict Location and Event Dataset
AD	Adamawa Region
AEFI	Adverse Event Following Immunization
BEAC	Bank of Central African States;
bOPV.	Bivalent Oral Polio Vaccine
C4D	Communication for Development
CAA	Autonomous Sinking Fund
CBOs	Community-Based Organization
CCE	Cold Chain Equipment
CCI	Cold Chain Inventory
CE	Center
CH	Central Hospital
CHAI	Clinton Health Access Initiative
CMA	Sub-Divisional Hospital
COVID-19	Coronavirus disease 2019
CSO	Civil Society Organizations
CTD	Decentralized Territorial Collectivities
CTG	Central Technical Group
cVDPV2	Circulating Vaccine Derived Polio Virus Type 2
DH	District Hospital
DHIS2	District Health Information System 2
DMO	District Medical Officer
DRFP	Directorate of Finance and State Property
DTP-3	Third Dose of Diphtheria-Tetanus and Pertussis, containing vaccine or (PENTA)
EN	Far North Region

EPI	Expanded Program on Immunization
EPI DAF	EPI Department of Administration & Finance;
ES	East Region
Gavi	Gavi, The Vaccine Alliance
GDP	Gross Domestic Product
GESP	Growth and Employment Strategy Paper
GH	General Hospital
GIZ	German cooperation Agency
GPEI	Global Poliomyelitis Eradication Initiative
GRID3	Geo-Referenced Infrastructure and Demography Data for Development
HBsAg	Hepatitis B Surface Antigen
HCD	Human Centered Design
HCW	Healthcare worker
HDI	Human Development Index
HPV	Human Papilloma Virus
HR	Human Resource
HSS	Health Sector Strategy
IDHI	Human Development Index Inequalities
IHC	Integrated Health Center
IPV	Inactivated Polio Vaccine
KI	Key Informant
KII	Key Informant Interview
LT	Littoral Region
MC	Missed Communities
MINEPAT	Ministry of Economy, Planning and Land Planning
MINFI	Ministry of Finance
MINSANTE	Ministère de la Sante Publique
MoH	Ministry of Health
MR	Measles-Rubella Vaccine
NA	Not Applicable
NEO	Network Extension optimization
NHDP	National Health development Plan
NHSS	National Health Sector Strategy

NIDs	National Immunization Days
NITAG	National Immunization Technical Advisory Groups
NO	North Region
NW	Northwest Region
OU	West Region
PCA	Complementary Package of Activities
PCV13	Pneumococcal Conjugate vaccine- 13 valent
PENTA	DTP containing vaccine (Pentavalent)
PHC	Primary Health Care
PIRI	Periodic intensification of Routine Immunization activities
PM MOH	Paymaster of the Ministry of Public Health
PMA	Minimum Package of Activities
PROVARESSC	Promotion of Vaccination and Health System Strengthening in Cameroon
PSDRHS	Strategic Plan for Human Resource Development for Health
QGIS	Quantum Geographic Information system
RH	Regional Hospital
RHC	Regional Hospital Center
RI	Routine Immunization
SAF-PEV	Section Administrative et financières du Programme Elargi de Vaccination
SDG	Sustainable Development Goal
SMT	Stock Management Tool
SOP	Standard Operating Procedures
SSA	sub-Saharan Africa
SU	South Region
SW	Southwest Region
Td	Tetanus & Diphtheria vaccine
TWG	Technical Working Group
UHC	Universal Health Coverage
UIC	Under-immunized Children
Ultra-Cold Chain	UCC
UN	United Nations
Unicef SD	Unicef Supply Division
USAID,	United States Aid Agency

VPD	Vaccine Preventable Disease
WHO	World Health Organization
WICR	Walk-In-Cold Room
WIFR	Walk-in Freezer Room
WPV1	Wild Polio Virus Type 1
WUENIC	World Health Organization and Unicef Estimation of National Immunization Coverage
YF	Yellow Fever
ZDC	Zero Dose Children

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Abstract/ Summary

Background

In 2015, world leaders adopted 17 global goals (Sustainable Development Goal, SDG), committing their nations to eliminate poverty and human sufferings, protect the planet and enable all people, "irrespective of who they are and where they live", to enjoy peace and prosperity by 2030. The third goal (Goal #3) was designed to promote "good health and wellbeing" and the same leaders committed their nations to prioritize those who are further behind, including those residing in communities that are beyond the reach of conventional healthcare systems. Under the third goal, they pledged to put an end to preventable deaths among newborns and children, by committing to reduce neonatal and under-5 deaths to below 12 per 1,000 and 25 per 1,00 live births, respectively. To date, vaccines are undisputable tools that world leaders can leverage to help their countries reduce child mortality. While many countries have made great progress toward global immunization targets, others, particularly those in sub-Saharan African, are largely off-tract to achieving the targets defined by the global health community.

Indeed, each year, many Expanded Program on immunization (EPI) fail to fully immunize 20 million children with basic pediatric vaccines. The systems also fail to reach 13 million children with a single immunization shot. This failure has led to an uneven distribution of the benefits of vaccination across and within many countries. In Cameroon, for instance, progress to reach these global targets have not only stalled but is slipping backwards. Indeed, coverage for the third dose of diphtheria, pertussis and tetanus containing vaccine (DTP-3) has progressively declined, falling from 89% in 2013 to 79% in 2019. Similarly, the proportion of districts with a DTP-3 coverage of at least 80% has plummeted, declining from 88,69% in 2013 to 50,53% in 20193. This negative trend extends to all other antigens in the country's immunization schedule, including BGC, Rotavirus, Pneumococcal and Measles combined vaccines.

Recognizing this challenge, the government of Cameroon has engaged several efforts to stop and reserve the negative trend. These including upgrading the country's vaccine cold chain infrastructure, developing and executing capacity building plans for EPI personnel; putting in place policies and strategies to improve immunization service delivery at facility level; improving data systems and programmatic and financial management capacities at central and regional levels- amongst others; however, despite these colossal investments from the state and its development partners, immunization coverage and equity continue to decline, suggesting that they may be other factors accounting for the declining performance. In this thesis project, the author hypothesizes that four key factors, which have not been previously studied may represent the underlying reasons for the declining performance. These include:

1. The inability of Cameroon's EPI to equitably reach all eligible vaccination targets.
2. Disruption of immunization by the COVID-19 pandemic.
3. The ongoing armed conflict in two of the country's regions, which has disrupted supply chains, caused facilities to be shot down and personnel to flee from their duty stations.
4. Frequent stockouts of vaccines, resulting from unknown financing and procurement bottlenecks:

Aims and objectives

The overall goal of my thesis project is to explore barriers to optimal immunization coverage and equity in Cameroon and to leverage the findings to develop scalable strategies and interventions that can be used to improve coverage not only in Cameroon but also in similar settings in Sub-Saharan Africa. To attain this goal, I defined five specific objectives for the project namely:

1. To identify and characterize "hard-to-reach" populations or Zero-Dose Children (ZDC), Under-immunized children (UIC) and missed communities (MC) in Cameroon.
2. To assess the impact of the COVID-19 pandemic on vaccination coverage in Cameroon.

3. To assess the effect of the ongoing armed conflict in the Northwest (NW) and Southwest (SW) regions on key immunization indicators, including the Bacillus Calmette–Guérin vaccine (BCG), the third dose of Diphtheria-Tetanus and Pertussis, containing vaccine (DPT-3) and Measles-Rubella combined vaccine (MR).
4. To assess the procurement and financing processes for EPI vaccines in Cameroon
5. To develop and test a package of scalable interventions for each of the above specific objectives for addressing barriers to optimal immunization coverage and equity in Cameroon and other SSA settings.

Methods

To accomplish the above objectives, I conducted a cross sectional study operational research study, which utilized both quantitative and qualitative approaches. For specific objective #1, I used a quantitative approach, which involved data triangulation of 8 principal data sources, as well as QGIS technology to produce maps of underserved communities in Cameroon. In addition, I use a qualitative approach to explore supply and demand side barriers to reach ZDC, UIC and missed communities (MC) with immunization services. To accomplish objectives #2, #3, I used a quantitative approach to assess the effect of COVID-19 and civile strife on key Routine Immunization (RI) indicators in two target regions. For specific objective #4, I used both qualitative and quantitative approaches to explore bottlenecks impacting sustainable procurement and financing of vaccines in Cameroon. To accomplish specific objective #5, we implemented three pilots, with baseline and an endline assessments. The approach we used to accomplish these objectives is described in the section below.

Results and conclusions

In this thesis project, I sought out to assess barriers to optimal immunization coverage and equity in Cameroon and to leverage the findings to develop scalable strategies and interventions that can be used to improve coverage not only in Cameroon but also in similar settings in SSA. The first identified

barrier is the inability of the current healthcare system to reach ZDC, residing in MC with immunization services. Currently, there are several of these MC in Cameroon, with high numbers of ZDC and UIC. These MC are heavily concentrated in the EN, LT, SW, and OU regions; however, there are several pockets of such communities across the entire country. Overall, Cameroon seemingly has nearly 130,000 ZDC and over 180,000 under immunized children, representing 14% and 19% of the 2021 birth cohort (943,116), respectively. This finding lends supported to that reported by Chard and collaborators that Cameroon is amongst the top 10 countries, accounting for 86% of the 7.3 million ZDC in the world[1]. Guided by this finding, and in the context of limited resources, Cameroon and her development partners should prioritize reaching ZDC and UIC in 42 districts across the country. This prioritization may enable the country to immunize over 50% of these ZDC and UIC. I also went further to propose a model that could be leveraged to deliver immunization services to the identified MC. This model This model was leveraged to immunized over 8,500 ZDC in 20 missed communities[2]. In future, I plan to guide other researchers and students to evaluate the cost-effectiveness of the model.

The second important factor is the unparallel effect of COVID-19 pandemic on key immunization indicators in Cameroon. The pandemic caused the number of ZDC to rise by roughly 10% between 2020 and 2021. Furthermore, the pandemic disrupted key immunization indicators in 3,669 surveyed facilities. Indeed, access in these facilities dropped by 42%, utilization by 40%, total number of fixed sessions by 33% and outreaches by 19%. Similar trends were observed at health area and district levels. The findings also suggested that nearly half of all districts and health areas witnessed an increase in the number ZDC.

Next, the ongoing armed conflict in the NW and SW regions of the country has also impacted key immunization indicators in the regions. Findings from the project suggest that coverage rates plummeted considerably during the study period, with declines for almost all antigens ranging between 20 and 41% during the study period (2016 and 2019). Further, about 3 in 4 districts registered

coverage rates below 40%, with almost two-fifth (39%) of them having a coverage of below 20%. The project also noted a dramatic decline in the number of facilities offering immunization services in both regions during the study period, which had a profound impact on coverage at national level. Indeed, national coverage for DPT-3 dropped by 9%, falling from 84% in 2016 to 75% in 2019. In the same vein, the percentage of districts with a DPT-3 coverage of at least 80% dropped by 15%, falling from 60% in 2016 to 45% in 2019. To protect vulnerable populations from VPD in these two regions of Cameroon, proven strategies for delivering RI services would need to be implemented. This later assumption was piloted during this project.

Finally, the not so obvious procurement and financing bottlenecks are important barriers, with a far-reaching consequence on vaccine availability and adequacy. The process appears to be complex, lengthy and involves several stakeholders, who do not necessarily talk to each other. This disconnect ultimately affects funding allocation and mobilization for the procurement of vaccines. Indeed, funding allocated for vaccine procurement during the study period ranged from US$2.6M to US$6.2M, which is grossly insufficient to meet the evolving vaccine needs, that must cater for an ever-expanding birth cohort and new vaccine introductions. Mobilization of allocated funds was also an uphill task, taking an average of 11 months. This lengthy time made the country to fail to meet its vaccine funding requirements. Indeed, the government failed to purchase all the vaccines required between 2016 and 2019 due to inadequate funding and delayed disbursement. During the same period, a US$4-million funding deficit prevented the government from purchasing vaccines on time, leading to stockouts at service delivery points. During this period, Cameroon spent US$4M less than the forecasted need, impeding the procurement of 20 million doses of vaccines, causing spikes of stockouts for both traditional and co-financed vaccines, which in turn contributed to a decline in vaccination coverage and equity. Three systemic factors accounted for these observations, namely: 1) weaknesses in forecasting, 2) inefficient processes in allocating funds, and 3) delays in mobilizing the allocated funds. Suggested actions to redress these included:

- **Establish a technical working group for vaccine financing & procurement** to ensure regular, rapid, adequate & sustainable supply of vaccines. The group should be composed of members drawn from the bodies, involved in the vaccine procurement function of the government, including a representative from the Ministries of Finance, Health, Economy, Central Treasure, WHO, Unicef, Gavi and CHAI. The group reports to the minister of Health and meets biannually. The meetings are currently funded by CHAI and will eventually be funded by Gavi and transitioned to the state. The group has already registered remarkable progress including ensuring timely mobilization disbursement of funds for vaccine procurement 2022 and in 2023, the country is on track to meeting all is co-financing requirements.
- Appointment of a **Focal Point at the EPI to monitor government commitments** & lead advocacy for more efficient processes and timely disbursement of funds.
- Set-up a disbursement plan to **split the amounts requested by the EPI** into five installments for easier approval and disbursement.

Finally, three set of interventions can be deployed to improve RI coverage and equity in Cameroon. These include leveraging on existing data sources to identify and characterize hard-to-reach communities and harnessing the information to design context specific strategies that can be used to deliver immunization services to identified MC. Second, leverage periodic intensified routine immunization strategy **(PIRIs)** to raise coverage in crises zones. Third, establish a TWG to improve the procurement and financing processes for vaccines.

Recommendations

Basing on our objectives and findings, we recommend governments and other stakeholders that aim at improving immunization coverage and equity in any facility, administrative, health area, district, regional and national level to considered implementing the following recommendations.

1. **To reach ZDC, UIC and missed communities, we recommend the target audience to:**
   - 1.1. Use data analytics, leveraging various existing data sources to identify the distribution of ZDC, UIC and missed communities at health area, district, regional and national levels.
   - 1.2. Leverage Human Centered, qualitative and systematic or document reviews to explored both demand and supply barriers on why these children miss out on basic primary healthcare services, including vaccination.
   - 1.3. Leverage the information emanating from 1.1 and 1.2 to develop- context specific strategies to reach these children in their respective settings be it in crisis zone, remote enclaved zones, urban slums, or fluvial communities.
   - 1.4. Mobilize resources through targeted advocacy
   - 1.5. Pilot interventions in selected settings, document successes and failures and leverage these to prepare scaleup plans. This recommendation has been used by the EPI to apply for funding from the Gavi Equity Accelerator fund to improve vaccination coverage and equity in MC. Outcome of the application is expected in September 2023.
   - 1.6. Engage the government to develop a national policy on reaching the unreached coordinate with them to create a budget line for this as well as engage their development partners, multilateral and bilateral donors to support them in the implementation of the policy.
2. **To mitigate impact of a public health emergency on key health indicator we recommend interested stakeholders to:**
   - 2.1. Use basic resources to develop analytical tools that could be used to measure and track impact of the emergency on key health indicators.
   - 2.2. Leverage the tool to capture data from existing data sources to create analytics that could be used for quick decision making, guide actions and monitor progress.

2.3. Support governments to develop recovery plans, highlighting areas that should be targeted for catch ups and well as the strategies to use.

3. To improve RI coverage in conflict zones, we recommend governments to:

3.1. Leverage existing data to study trends to establish impact of the crises on key health indicators, including immunization.

3.2. Develop context specific strategies on how to reach target populations in these areas with health interventions Leverage existing local resources (including trusted people in the community, local transportation means etc.) to get the necessary logistics to the target sites.

3.3. Collaborate with the local stakeholders to rollout campaigns, such as PIRIs and target reaching the maximum of the target population, including internally displaced persons and refugees.

3.4. Set up data systems to capture and transmit data, emanating from the campaigns.

4. To mitigate the impact of sub-funding fund allocation and mobilization for the procurement of vaccines or other health commodities, we recommend the state to:

4.1. Map its current procurement and financing processes to gain insights into the various pain points and bottlenecks.

4.2. Assess impact of key bottlenecks on key health indicators, such as vaccine stockouts and their association of coverage and disease outbreaks

4.3. Establish a multi-sectorial technical working group with clear terms of reference and provide them with the necessary resources to perform their duties.

4.4. Use data to conduct accurate forecasting of vaccine needs and translate that into dollar amount.

4.5. Establish a disbursement plan, which splits the amounts to paid into small installments for easy approvals, mobilization, and disbursements.

4.6. Establish a monitoring and evaluation system, which will enable the tracking of key performance indicators, document lessons-be them positive or negative-, put in place plans to mitigate risks and implement corrective actions when problems arise.

1. Introduction

1.1. Background

In 2015, world leaders adopted 17 global goals (Sustainable Development Goal, SDG), committing their nations to eliminate poverty and human sufferings, protect the planet and enable all people irrespective of who they are and where they live to enjoy peace and prosperity by 2030[3]. The third goal (Goal #3) was designed to promote "good health and wellbeing" and the same leaders committed their nations to prioritize those who are further behind, including those residing in communities that are beyond the reach of conventional health systems. They pledged to put an end to preventable deaths among newborns and children, by committing to reduce neonatal and under-5 deaths to below 12 per 1,000 and 25 per 1,00 live births respectively[4].

Vaccines are key tools that world leaders can leverage to help their countries reach these ambitious targets. They can also help countries achieve certain targets of 13 other SDGs[5]. This is, partly, because vaccines have been critical in eradicating, eliminating, controlling, and preventing numerous communicable diseases over the last century- an achievement that have rendered them to be a success story for global health and development. Indeed, rationale deployment and use of vaccines have led to the eradication of smallpox, the elimination of poliomyelitis and the control of over 20 life-threatening diseases, including meningococcal meningitis, pneumonia, typhoid, cholera, pneumococcal pneumonia, Japanese encephalitis, viral hepatitis, and cervical cancer, amongst others[6]. More recently, vaccines have been critical in containing or limiting outbreaks of deadly emerging infectious diseases, such as Ebola viral disease and the COVID-19 pandemic.

While many countries have made great progress, others, particularly those in sub-Saharan African, are largely off-track to achieving immunization the targets (Table 1) defined by the global health community[5]

Table 1: Global Immunization Targets

Disease	Targets
Poliomyelitis	▪ Interrupt transmission of all wild poliovirus by 2020 ▪ Certify Polio eradication by 2023
Cholera	▪ Reduce Cholera deaths by 90% by 2030
Viral Hepatitis	▪ Reduce new cases of chronic viral hepatitis B infections by 95% by 2030 (equivalent to 0.1% prevalence for HBsAg among children). ▪ Reduce viral hepatitis B deaths by 65% by 2030.
Vector-borne diseases	▪ Reduce mortality due to vector-borne diseases by at least 75% by 2030. ▪ Reduce case incidence due to vector-borne diseases by at least 60% by 2030. ▪ Prevent epidemics of vector-borne diseases in all countries by 2030.
Yellow Fever	▪ Reduce yellow fever outbreaks to zero by 2026
Meningitis	▪ Eliminate meningitis epidemics by 2030 ▪ Reduce the numbers of cases and deaths from vaccine preventable bacterial meningitis by 2030.
Rabies	▪ Reduce the number of deaths from dog-mediated rabies to zero by 2030

Table 1: Global Immunization Targets 1

Source: Adapted from Immunization Agenda 2030[5]

Indeed, each year, many EPIs fail to fully immunize 20 million children with basic pediatric vaccines. The systems also fail to reach 13 million children with a single immunization shot[5]. This failure has led to an uneven distribution of the benefits of vaccination across and within many countries. In Cameroon, for instance, progress to reach these global targets have not only stalled but is slipping backwards. Indeed, coverage for the third dose of diphtheria, pertussis and tetanus containing vaccine (DTP-3) has progressively declined, falling from 89% in 2013 to 79% in 2019[7]. Similarly, the proportion of districts with a DTP-3 coverage of at least 80% has plummeted, declining from 88,69% in 2013 to 50,53% in 2019. This negative trend extends to all other antigens in the country's immunization schedule, including BGC, Rotavirus, Pneumococcal and Measles-Rubella combined vaccines (MR)[7].

1.2. Established barriers to optimal performance

Until now, current debates have attributed the declining performance of Cameroon's immunization program to six major factors, all of which have been extensively investigated by the author of this thesis[8–11]. These factors are briefly summarized below:

1. **Weak vaccine logistic capacity at central level that hampers vaccine stock availability at facility level.** In 2015 for instance, a dysfunctional cold room at central level damaged nearly 500,000 doses (worth ~US$250,000) of inactivated polio vaccine (IPV) two months prior to the introduction of IPV into Cameroon's routine immunization system. This unfortunate incident delayed the introduction of IPV by three months because the country needed to obtain additional stock to replace the damaged ones[12]. The dysfunctional cold room also destroyed millions of doses of other vaccines[13], which in turn resulted into a prolonged and generalized stockouts of vaccines at facility level, disrupting immunization service delivery, and by extension negatively impacting the national immunization coverage for all antigens[14].
2. **Inadequate and obsolete cold chain infrastructure at district and facility levels:** This weakness also impacts the adequacy, availability, and quality of vaccines at facility level. Indeed, in a survey involving 4,379 health facilities, Yauba and collaborators showed that over 50% of the surveyed facilities in Cameroon lacked a functional vaccine refrigerator[15]. They also found that in facilities with a functional vaccine refrigerator, vaccine stocks are often exposed to extra-ordinary temperature excursions, which can compromise their quality[16]. Vaccines whose quality have been compromised may not elicit the desired immune response and as such, administering this category of vaccines may not result into the intended benefits of immunization for the country. The above finding that over 50% of facilities in Cameroon did not have a vaccine refrigerator was a clarion call for urgent action to remedy the situation-a situation which if unaddressed will result to several missed opportunities for

vaccination, thereby contributing to the declining coverage and the rising number of children who are unprotected from VPDs.

3. **Inadequate number and capacity of immunization staff.** Indeed, in one of our assessments, we enumerated a total of 9,661 vaccinators in nearly 5,000 facilities in the country[10]. Over half of these vaccinators were found in just three of the country's ten regions, signifying a gross inequity in the distribution of the workforce for vaccination. Similarly, there was median of just 2 (range 1-13) vaccinators per facility, irrespective of the size of the facility. Furthermore, nearly 90% of these staff have not received a single training on vaccination at the time of the assessment, with remarkable variations across the country's ten regions. Indeed, in some regions up to 98% of the people involve in vaccination have not receive a single training on immunization-be it in-service or pre-service training. In another survey, involving central, regional and district EPI staff, we found a very high attrition rate amongst staff where over 50% of the people surveyed were just under two years in their current post[11]. In addition, there weren't any system in place to guarantee a successful onboarding of newcomers, highlighting that a lot of efficiency and knowledge might be lost in the process of transitioning staff between positions or when staff leaves.
4. **Challenges with immunization service delivery.** In one survey involving 265 health facilities in 68 districts in the 10 regions, we found that about 20% of health facilities were unaware of the monthly vaccination targets, 74% lack systems for tracking newborns while 32% lack systems for tracking defaulters or dropouts[8]. In addition, over 50% of the surveyed facilities lack a micro plan for immunization. Furthermore, 57% of the surveyed facilities organized just one fixed-post immunization[1] per month, while 75% of facilities offering

[1] Fixed-Post Immunization denotes delivery of immunization services at a health facility. According to Cameroon's EPI's Norms and standards, facilities offering immunization services are expected to vaccinate children on a daily basis.

outreaches organized just one outreach session[2] per month. The leading reasons for low execution rate of fixed-post immunization and outreaches included low turnout for vaccination (31%) and staff availability, either due to insufficient number of staff (28%) or competing priorities (14%). Caregivers also complained about long waiting times, with many spending over four hours before being attended to by immunization staff. Similarly, about a quarter of surveyed caregivers (24%) reported that they went to a health facility for immunization services and were turned away without achieving the purpose for which they came for. Often, this experience was linked to the fact that many health facilities did not offer immunization services daily, absence of personnel or stock out of vaccines and consumables amongst others. Clearly, these negative experiences can negatively impact caregiver's decision to return for future immunization visits, and by extension contributing to high dropout rates.

5. **Weak system for capturing and transmitting immunization data at facility.** According to the findings from one of our surveys, this weakness was driven by a lack of immunization data collection tools, including registers, tally sheets and vaccination cards[17]. In the survey, we found that in facilities where tools were available, recorded data were often incomplete. For instance, immunization registers were incomplete in 37% of facilities, tally sheets were incomplete in 81% of facilities and the monthly report forms in 87% of health facilities. In addition, for tools with data, there were discrepancies for the same data across different tools. For instance, the Penta 3 value from tally sheets, vaccination registers and monthly reporting forms was different in over 50% of surveyed facilities. To address these data challenges, the EPI may need to implement three actions, namely: 1) provide health facilities with enough

[2] Outreaches is a vaccination strategy that denotes the delivery of immunization services to eligible targets in a community within a catchment areas covered by a facility. In a typical outreach, health workers transport vaccines and consummables in a vaccine carrier to an agreed point (e.g. church, market, chief's palace). At this point, they collaborate with the community to deliver vaccines to a defined target. The norms is to organize at least one session per week and a total of at least 4 sessions per month.

data collection tools, 2) train staff on effective use of these tools and 3) implement regular audits of immunization data.

6. **Weak program and financial management capacity at central and regional levels.** In 2017, Gavi commissioned an independent audit firm to assess the causes of the declining performance of Cameroon's EPI[18]. The assessment revealed several human resources, structural and financial management gaps. Key positions were staffed with personnel without the requisite education, training, and experience. In addition, the auditors found that Gavi's investments up till the time of the audit were being managed without written procedures, which led to significant deviation of resources to other activities other than those necessary to achieve the EPI's goals. Furthermore, disbursement of funds was essentially cash-based, a practice that increased the likelihood of fraud. Moreover, the programmed lacked an accounting software and bookkeeping and other financial tasks were not in line with any accounting standards. This resulted into a huge misappropriation of funds at central level, which severely affected the financing of core EPI activities, including vaccine procurement and distribution, outreaches or even payment of staff allowances.

1.3. Government's effort to redress identified barriers

On the positive side, Cameroon's ministry of health viewed the findings from assessments as key obstacles that must be redressed if the country is to achieve the vaccination targets it subscribed to when the country ratified the SDGs. Under the leadership of the author of this thesis, the EPI leveraged the findings to develop several strategic plans, including the Cold Chain Expansion and Rehabilitation plan[19], a capacity building plan for EPI staff[20] and a data improvement plan[21] amongst others. In addition, the author also led the development of the Norms and Standards for the Expanded Program of Immunization in 2018, which provides clear directives on all aspects that should govern vaccination in Cameroon[22]. The ministry of public also took urgent actions regarding the audit recommendations from the Gavi program capacity assessment. The implementation of these targeted

strategies brought several transformational improvements in Cameroon's immunization system, including:

- Strengthening the leadership, human resource, and financial management capacity by designing a new organigram, appointing new and qualified staff to key positions, establishing a procedure manual, and acquiring, installing, and using an accounting software.
- A radical transformation of Cameroon's cold chain system via the acquisition, installation, and commissioning of five walk-in cold rooms, four freezers, 1,700 ice-line refrigerators and 1,383 solar direct drive refrigerators. These investments, worth ~US$13M, that were acquired from Gavi via a grant proposal, whose development was led by the author of this thesis in 2017, enabled the EPI to expand the proportion of health facilities with optimal cold chain equipment from just 3% in 2016 to 83% by 2020 as illustrated in Figure 1[23]. These investments closed cold chain capacity gaps at the Central Vaccine Stores, the ten regional vaccine depots, the 189 district vaccine stores and 3,082 health facilities.

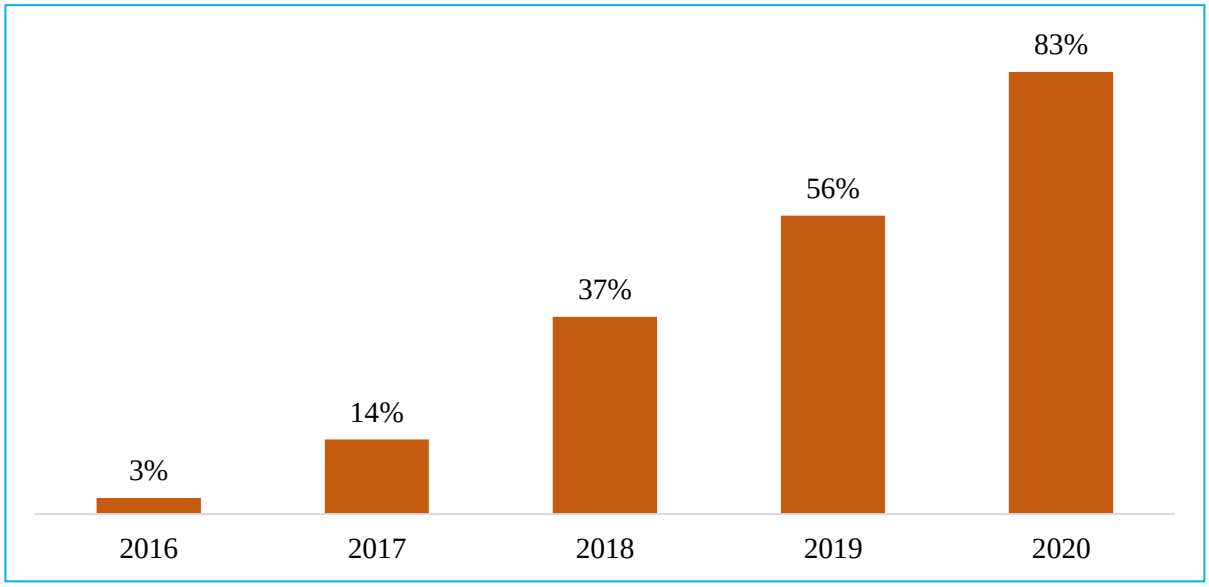


Figure 1: Evolution of Health Facilities with optimal vaccine refrigerators[23]. The X-axis denotes the proportion of health facilities with optimal vaccine refrigerators[3]. As shown, the proportion of health facilities with optimal vaccine refrigerators, rose dramatically as the cold chain expansion and rehabilitation plan was implemented, with funding from Gavi.

[3] Optimal vaccine refrigerators are new generation devices with features that do not expose vaccines to freezing temperatures. They also have extended hold-over time, meaning that they can conserved the temperatures of the fridge for about 48-72 hours in the event of a power outage.

Despite this remarkable progress nearly 2,000 facilities need a functional optimal vaccine refrigerator. This number is likely to increase over the years to cater for the need of an expanding population and birth cohort, new vaccines introductions as well as those needed to replace faulty equipment.

- A radical transformation of the EPI data management system, via the printing and distribution of vaccination registers, tally sheets and monthly progress report forms as well as rolling out of the District Health Information System 2 (DHIS2) for data capture, transmission, analyses and use for decision-making[21].
- Rolling out capacity building activities for over 1,000 frontline immunization workers, including trainings on all the modules on immunization in practice (creating a micro-plan, organizing and executing immunization sessions, management of immunization at the district level, effective vaccines management, community engagement for vaccination, basic maintenance of vaccine cold chain equipment, and temperature monitoring in the vaccine cold chain amongst others).[24–26]
- Preparing and distributing numerous policy circulars to address challenges link to:
    - Reluctance to open multi-dose vials until a given number of children are present,
    - Accidental freezing during immunization sessions,
    - Clarifying roles and responsibilities for immunization staff at each level
    - Accountability for results through regular conduct of annual microplanning at districts and health facilities and quarterly review meetings at district level
    - Irregular conduct of supportive supervisions
    - Absence of functional health committees in some health areas
    - Erratic organization of fixed and outreach immunization sessions
    - bundling of vaccines
    - Conduct of regular refresher trainings on immunizations

- Lack of standardization on defaulter tracking

Despite this massive and concerted investments, coverage for DPT-3 (and that for other antigens) increased marginally between 2015 and 2016 as shown in Figure 2; however, the coverage

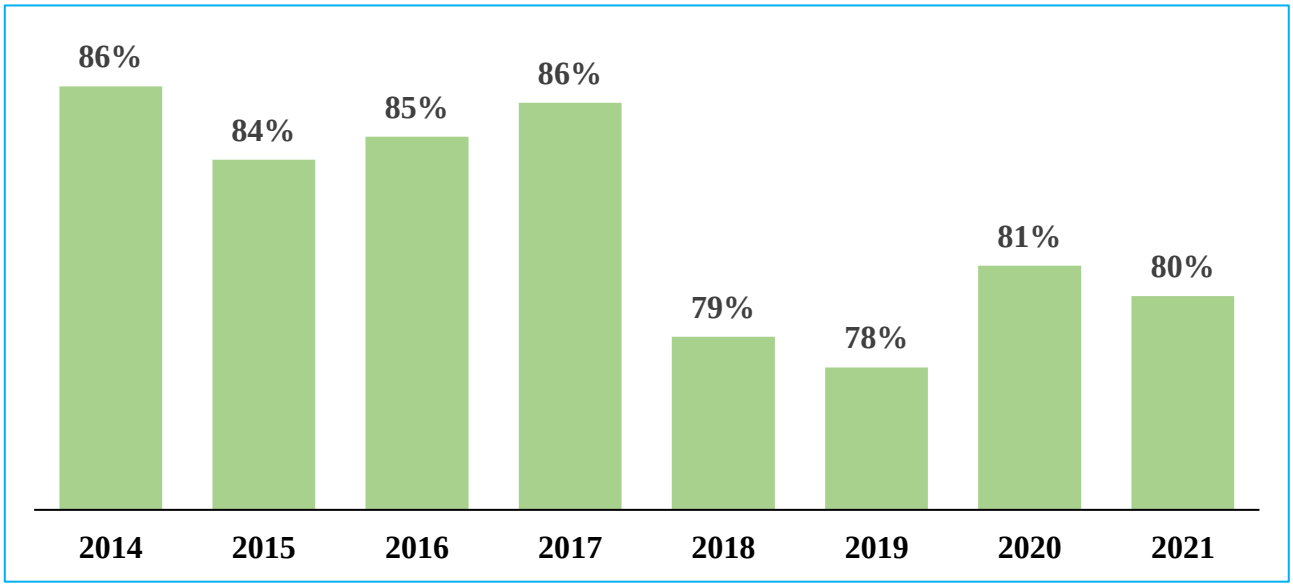


Figure 2: Evolution of DPT-3 Coverage in Cameroon from 2014-2021

plummeted by 8% point between 2017 and 2019, before starting to recover in 2020. This observation seems to suggest that may be other factors, other than those cited above, that are hindering the progress of Cameroon's EPI towards its coverage targets. The following section outlines the thinking of the author about the potential contributing factors to this declining performance.

1.4. Potential additional barriers to optimal performance- Working Hypothesis for the thesis project.

During the past three years, the author has explored additional factors that might account for the declining EPI's performance despite the significant efforts and resources that have invested to improve progress towards the program's goals. Discussions with key stakeholders and trend analysis enabled the identification of other potential factors that have not been previously explored. These are briefly summarized below:

1. **Cameroon's EPI is unable to equitably reach all eligible vaccination targets:** Like in many other countries, Cameroon's EPI faces an uphill challenge to reach children residing in

communities that are traditionally missed by the conventional healthcare system[27]. In 2019, Cameroon featured among the top 10 nations that accounted for 86% of the estimated 7.3 million ZDC globally[28]. Indeed, in one study, we showed that over 90% of children residing in one remote fishing Island have not received a single dose of any vaccine[29]. This experience suggests that there may be many more of such communities in Cameroon, with hundreds, if not thousands, of children who go unvaccinated each year. These are often the children of slum dwellers, nomads, pygmies, islanders, and mountain-people amongst others[4]. Generally, these communities are the most marginalized in Cameroon and over two-thirds of their inhabitants live below the poverty line. The communities also lack regular health services, are more likely to have outbreaks and least likely to respond. Indeed, these missed communities have been important epicenters for some outbreak of VPDs and are therefore critical for global health security. As these communities often lack access to regular health services, routine immunization can be a first step towards a comprehensive primary healthcare for their inhabitants. However, limited efforts have been invested to reach ZDC residing in these communities in Cameroon. Reaching them will first require a detailed understanding of their communities and leveraging this understanding, alongside existing systems, to develop and roll-out innovative and targeted interventions to address immunization coverage and equity gaps in these missed communities. This is one of the central themes of this thesis.

2. **Outbreak of vaccine preventable diseases:** In 2013, two cases of Wild Polio Virus Type 1 (WPV1) and four cases of cVDPV2 were detected in the West and Far North Regions of Cameroon, respectively, after the country was declared WPV1 in 2009[30]. These outbreaks triggered a massive emergency response, consisting of 14 rounds of national immunization days (NIDs) and several subnational immunization days in 2014. Many healthcare workers and

[4] Urban poor are slum dwellers mainly found in the cities of Yaoundé, Douala, Bafoussam, Bamenda and Buea; Fishing communities in the coastal regions of Littoral, South and South West; Nomads in the grass fields of the Northwest, Adamawa, North and Far North; Mountain-people that reside mainly in the North and Far North regions; Pygmies mostly residing in the South and East regions of the country.

resources were repurposed for these campaigns, which left few workers to run routine immunization services. By the end of 2014, national coverage for DTP-3 dropped by 3%, falling from 88% in 2013 to 85% in 2014. The negative trend continued during the first semester of 2015 as the coverage rate saw a much further decline, from 83% to 69%[31]. Since then, Cameroon's EPI has been grappling with several deadly epidemics, including outbreaks of measles, yellow fever, Cholera and more recently COVID-19 and monkey pox. Indeed, by November of 2022, 25% of the Cameroon's 189 health districts were grappling with a full blown measle epidemic, with over 2,300 confirmed cases across the country's ten regions. Interestingly, 73.8% of all the confirmed cases have not received a single dose of the combined measles-rubella (MR) vaccine. In all the affected districts, MR coverage was less than 80% for first dose and less than 50% for the second dose[31]. In the same vein, the EPI is also grappling with a Yellow Fever epidemic, with 1,363 confirmed cases across 13% of the country's 189 health districts. Similarly, the country has also been experiencing its worst Cholera outbreak in decades, which has been ongoing since 2018 and has affected over 3,000 people in six of the countries ten regions[32,33]. The country has also not been spared from the havoc of COVID-19 and Monkeypox pandemics. As of December 12th, 2022, Cameroon has registered a total of 123,993 confirmed cases of COVID-19 and 1,965 deaths[34]. Similarly, as of December 12th, 2022, nearly a hundred suspected cases of Monkeypox have been reported in six of the ten regions of the country[35]. A common feature of all these outbreaks is that they disrupt immunization supply chains and service delivery in various ways. They also instill fear of contagion and anxiety among the general population, which in turn affect their care seeking behavior for vaccination. The outbreaks also prompt governments to the repurpose their limited health workforce, material, and financial resources to contain the outbreaks at the expense of routine immunization (RI). However, limited to no efforts have been invested to explore the effect of outbreaks on RI services. In the past, data have not been systematically collected to explore the impact of disease outbreak on RI performance. For this

reason, COVID-19 pandemic was leveraged to develop a tool and methodology that can be used to explore the impact of outbreaks on EPI's performance. This constituted one of the key specific objectives of this thesis.

3. **Armed conflict in two of the country's regions.** Cameroon has been facing a protracted and deadly armed conflict in two of its regions- the Northwest (NW) and the Southwest (SW)[36]. This conflict began as s civil unrest in late 2016 and transformed into a full-blown armed conflict between government forces and separatist movements, leading to the death of thousands of people, massive displacement of the population, destruction of health facilities and targeted killing of health workers, which triggered the fleeing of several of them for their safety. These factors, and several others, led to a severe disruption of immunization services, causing children to miss out on basic vaccines, and creating vulnerability pockets for outbreaks of vaccine preventable diseases. The effect of the conflict on key immunization indicators was also a key specific objective of this thesis.
4. **Stockouts resulting from financing procurement bottle necks:** Each year, Cameroon's EPI faces multiple stockouts of vaccines and consumables at every tier of the vaccine supply chain. These supply chain disruptions, which can last for several months, severely disrupt service delivery-both fixed and outreach sessions. Between September 2017 and March 2018, the country experienced prolonged stockouts of several vaccines as shown in Figure 2[37]. Similarly, the country failed to attain its target for **stock adequacy**[5] between 2015 and 2019, attaining stock adequacy in only 1 out of 60 months of observation.

[5] Stock adequacy is defined as the country having all (9 out of 9) vaccines above minimum levels. The recommended minimum level is 3 months of stock per vaccine at central level.

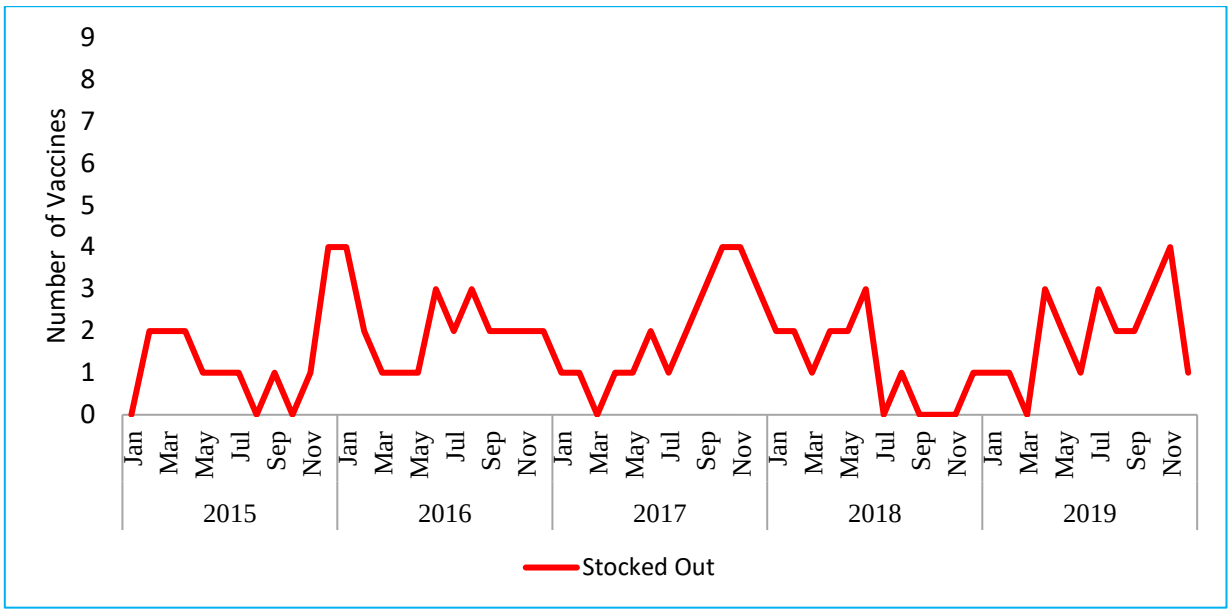


Figure 3: Stock outs of Vaccines at Central Vaccine Store from 2015 to 2019

Cameroon's EPI has taken several important steps to prevent stockouts. These include assessing stock management practices at central and regional vaccines stores[11]. Then leveraging the findings to develop and institute the use of standard operating procedures (SOP) and other key stock management tools (e.g., order forms, inventory forms, ledgers) that were grossly lacking during the assessment. And finally, training the logisticians and storekeepers on effective vaccine management practices, which helped to improve knowledge, accountability, and stock reporting rates among storekeepers[11]. Despite these actions, significant stock outs were still observed at central level, highlighting the need for further investigations. One hypothesis that I raised for this observation was weaknesses in the procurement and funding process for vaccines in Cameroon. Until now, there hasn't been any documentation on the procurement process, practices, and pain points. As such, filling this gap emerged as a key specific objective to be investigated in this thesis.

2. Aims and Objectives of the project.

The overall goal of my thesis project is to explore barriers to optimal immunization coverage and equity in Cameroon and to leverage the findings to develop scalable strategies and interventions that can be used to improve coverage not only in Cameroon but also in similar settings in Sub-Saharan Africa. To attain this goal, I defined five specific objectives for the project namely:

1. To identify and characterize[6] "hard-to-reach" populations or Zero-Dose Children, Under-immunized and missed communities in Cameroon.
2. To assess the impact of COVID-19 on vaccination coverage in Cameroon
3. To assess the effect of the ongoing armed conflict in the Northwest (NW) and Southwest (SW) regions on key immunization indicators, including the Bacillus Calmette–Guérin vaccine (BCG), the third dose of Diphtheria-Tetanus and Pertussis, containing vaccine (DPT-3) and Measles-Rubella combined vaccine (MR).
4. To assess the procurement and financing processes for EPI vaccines in Cameroon in a bid to identify bottlenecks to timely vaccine procurement and leverage the findings to develop a remedial plan.
5. To develop and test a package of scalable interventions for each of the above specific objectives for addressing barriers to optimal immunization coverage and equity in Cameroon and other SSA settings.

[6] Characterize is used here to Who are these children, how many of there, where are they and why are they not immunized.

3. Immunization performance in Cameroon

3.1. Overview of Cameroon

3.1.1. Geography

Cameroon is located in Central Africa and stretches from the Gulf of Guinea to Lake Chad. It lies between latitude 2º and 13º North and longitude 9º and 16 º degree West. As illustrated in Figure 4, the country has a triangular shape with a total surface area of about half a million square kilometers. Cameroon shares borders with Nigeria to the west, Chad to the Northeast, Central African Republic to the east and Congo, Equatorial Guinea, and Gabon to the South and the Atlantic Ocean to the southwest[38].

Figure 4:Map of Africa, showing Cameroon, in the Gulf of Guinea

This geographical location explains the observed biodiversity of its climate (both equatorial and tropical) and its natural landscape. The country is generally divided into four main ecological zones, namely:

i. **The coastal zone,** which covers the Littoral, South and Southwest regions and is characterized by continuous and heavy rainfall.

ii. **The Sudano-Sahelian zone**, which covers the Adamawa, North and the Far North regions with a Sahelian climate.

iii. **The forest zone**, which covers the Centre, South and East Regions, with a rainy and humid climate.

iv. **The high plateau or grass field zone**, covering the West and North-West Regions, characterized by mountains ranges and plateau with abundant savannah.

The country is a presidential republic and has had just two presidents since it gained independence in 1960. Administratively, the country is divided into 10 regions, 58 divisions, 306 sub-divisions, 54 administrative districts and 339 councils and 14 urban communities[39].

3.1.2. Demography

Weak information systems and lack of periodic population censuses makes it difficult to have accurate information regarding Cameroon's demography. Despite this challenge, development partners and the government work on an annual basis to develop estimates and projections for priority targets for various public health programs and interventions. In 2019, figures of the population in 2018 population, which stood at approximately 24,863,337 inhabitants, was used to project target population for 2020 to 2023 as shown in Table 2[39].

Table 2: Demographic projection for Cameroon

Year	Urban and Peri-urban zones	Rural Areas	Total
2020	**14,840,352**	**12,236,329**	**27,076,681**
2021	**14,460,031**	**13,347,721**	**27,807,751**
2022	**14,850,452**	**13,708,109**	**28,558,561**
2023	**15,251,414**	**14,078,228**	**29,329,642**

Cameroon's population is predominantly young. In 2021, roughly 42% of the total population were aged 0 to 14 years, a percentage that has remained relatively constant since 2011[40]. As shown in Figure 5, the population is projected to reach over 50 million inhabitants by 2050 and 74% of these people will in urban areas[41].

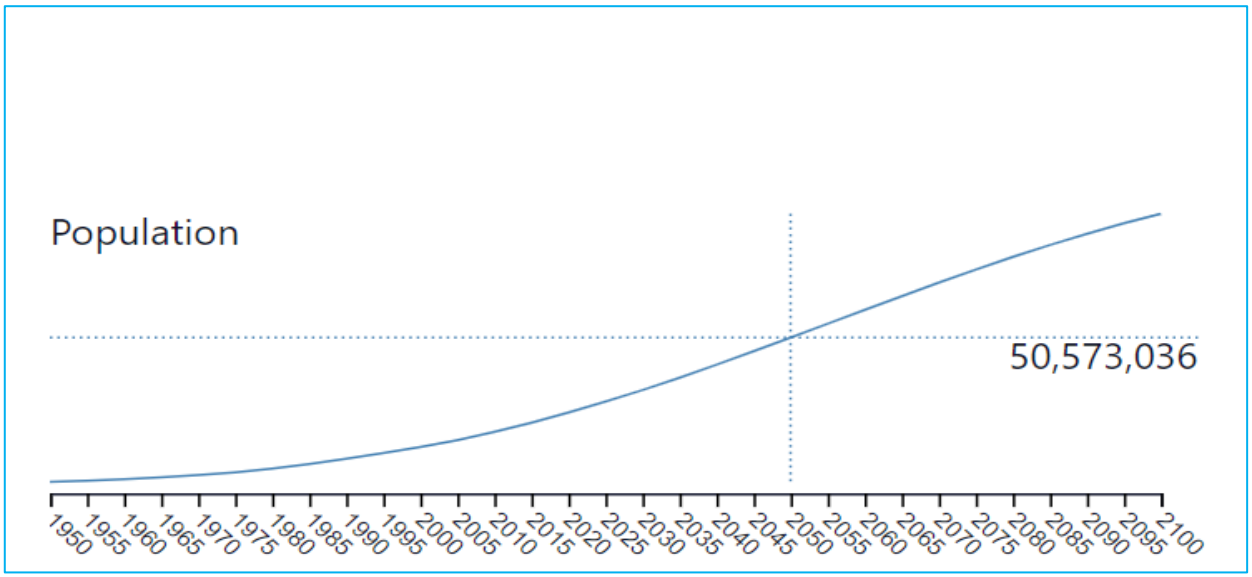


Figure 5: Projection of the population of Cameroon from 1950 to 2050[41].

This projected rapid and unplanned urbanization is likely to result in the growth of several new settlements, as well as the expansion of existing slums. However, it is unlikely for Cameroon's health care system to keep pace with this unprecedented urbanization, which in turn may create many pockets of health inequity in big cities and hamper the delivery of health services, including immunization as we have previously documented[42].

3.1.3. Macroeconomic situation and financing

Cameroon has the strongest and most diversified economy in the Central African sub-region, a region made up of 6 countries including Cameroon, Chad, Central African Republic, Congo, Equatorial Guinea, and Gabon. Figure 5 illustrates the trends of three key macro-economic indicators-GDP, Per Capita and annual growth rate- for Cameroon since she gained independence in 1960[43]. As illustrated, the trends have been positive overall. According to the world bank, Cameroon is a middle-income country[44]. In 2021, Cameroon's GDP stood at US$45.24B, a 10.087% increase from 2020. Similarly, the Per Capita was US$1,662, up by 8.1% from the figure in 2020. The growth rate was estimated at 3.49%, up from 0.49% in 2020-over a 600-fold increase. Despite this positive growth rate, nearly 40% of Cameroonians live below the international poverty line of less than US$2 per day, with

significant regional disparities[45]. Most recent data indicates that Cameroon's Human Development Index (HDI) was 0.563 in 2019 and Cameroon ranked 153rd out of 188 countries assessed[46]. The adjusted Human Development Index Inequalities (IDHI) has increased from 0.330 in 2013 to 0.344 in 2015, reflecting an increase in inequalities in areas such as health, which greatly affects the population's ability to access to health services.

It is important to note that Cameroon's economic growth has been declining since it peaked in 2015 (5.67%). This decline has been attributed to the ongoing security challenges, notably the armed Boko Haram conflict in the Far North, and Socio-political conflict in the Northwest and Southwest regions of the country[36,47]. The growth rate plummeted by roughly 3% point between 2019 and 2020, falling from 3.48% in 2019 to 0.49% in 2020 before it started recovering in 2021and projected to reach 4% by the end of 2022.

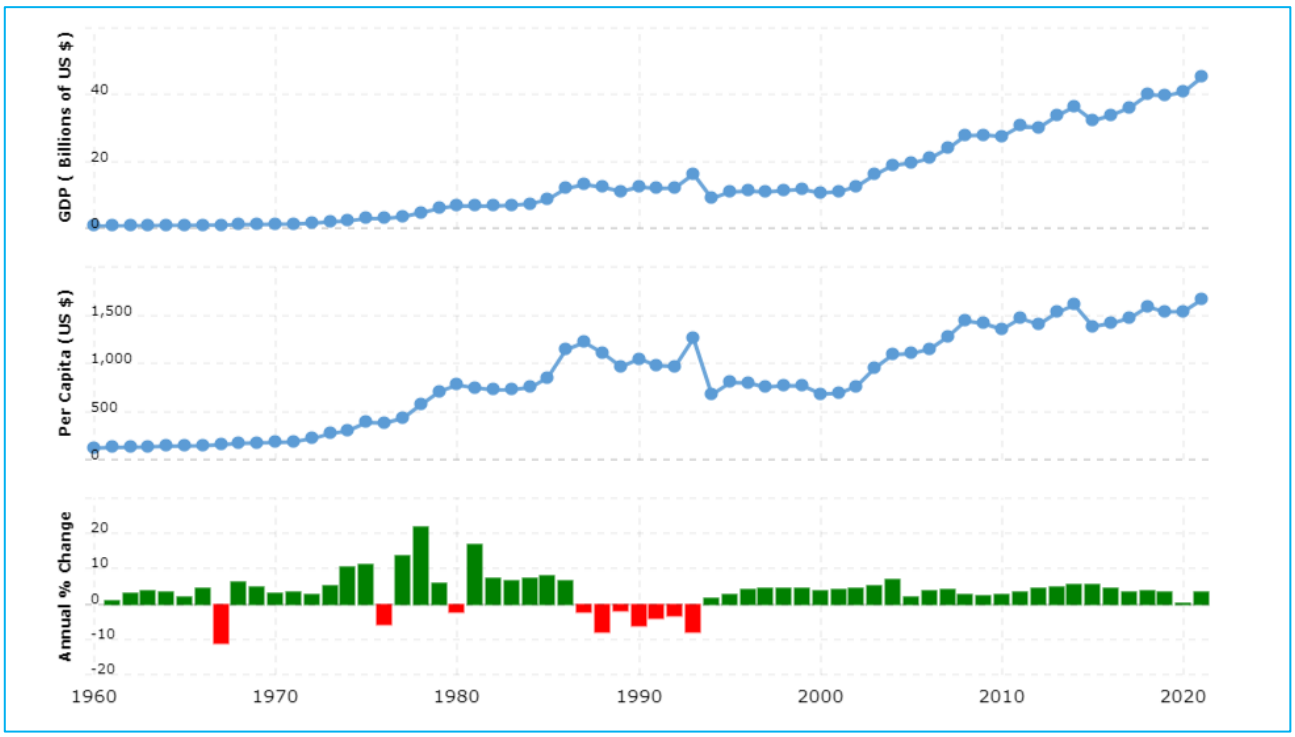


Figure 6: Evolution of key Macro-economic indicators for Cameroon (Source Reference[43])

The drastic drop observed between 2019 and 2020 is likely linked to the contraction of the global economy, a situation induced by the ongoing COVID–19 pandemic. This economic contraction also caused the state to reduce its budgetary allocation to the Ministry of Public Health. The allocation

dropped by 7.74%, falling from ~US$327M in 2020 to ~US$302M in 2021[48]. This budgetary drop considerably affected the budget of the EPI, which has also seen a significant constrained induced by the transition from the Global Poliomyelitis Eradication Initiative (GPEI) and funding freeze from Gavi.

3.1.4. Health financing

Cameroon's healthcare system is to a greater extent finance by households. For instance, households accounted for over 70% of the US$156 million health expenditures that were recorded in 2012[49]. This high percentage, which is slightly over two-fold the average (34%) for SSA, puts Cameroon in the third position of countries in the region with high out-of-pocket spending for health[50]. Asides from household accounting for over two-thirds of health expenditures, we showed that is 2019, the government contributed only 14.6% to the country's health expenditures, the private sector 7.7% and development partners 6.9%[50,51]. With the government putting in just US$ 9.2 per capita, Cameroon, clearly has one of the lowest publicly funded health system in the SSA. This low investment by the government implies a high catastrophic expenditure among households. Indeed, over a third of its citizens spends over 5% of their income on health directly and the poorest segment of the population are the ones who suffer the most[52]. To address this problem, Cameroon has taken a series of bold steps to improve access to basic healthcare for its citizens, including enacting reforms geared towards providing Universal Health Coverage (UHC) to all its citizens by 2035. This noble goal is reflected in almost all national policy documents, including the 2016-2027 National Health Sector Strategy (HSS), the National Health development Plan (NHDP)[53], the Growth and Employment Strategy paper (GESP), and the famous Vision 2035, of an emerging Cameroon. Although these are all noble aspirations, it is somehow evident from our analysis that Cameroon needs to ramp up its investments urgently and sustainably in its health sector[51] and that failure to do so may put the country off-track towards its aspiration goals[50]. To this end, the country will need to progressively increase its

budgetary allocation to the health sector to meet with the commitment it made in Abuja over two decades ago[54].

3.2. Overview of the health system in Cameroon

Cameroon's healthcare system has a pyramidal structure, with three levels namely:

- **The central or strategic level**, which develops policies and strategies in matters of health, supervises their execution and provides overall oversight of the public health system.
- **The intermediate level,** which consist of the **10 Regional Public Delegations for Health** that support the health districts in the implementation of the health policies and strategies.
- **The peripheral or operational level,** which as of 2021 was made up of **189 health districts**, and **1,784 health areas** and **5,978 health facilities** as of November 2022.

The organization structure and remits of each of these levels is presented in Table 3. As illustrated, the implementation of the national public health policies and strategies involves several stakeholders, including the ministry of public health, decentralized local authorities, households, and communities. The ministry of public health essentially intervenes in the domains of policy and strategy development, regulation, coordination, provision of resources, supporting service delivery and finally, acting as relay between public health and other ministerial departments such as the Ministries of Finance, Communication, Agriculture, Economy, Social affairs, and Territorial administration amongst others. Some Ministries are directly involved in the provision of health services, including the Ministry of Defense, and the General Directorate of National Security, which all have a network of hospitals, including secondary and primary health facilities, which are not under the control of the Ministry of Public Health. Furthermore, government departments such as the Ministry of Education run school health programs, which contribute to health promotion and disease prevention in the school milieu. And last, but not least, development partners, such as World Health Organization, the World Bank, Unicef, the Clinton Health Access Initiative, and Bilateral Organizations, such a

USAID, African CDC, Japan International Development Agency, German cooperation Agency (GIZ), Expertise France, Gavi, The Vaccine Alliance and Global Fund amongst others, play a critical role in shaping health policies and strategies as well providing the financial support to run various health programs. Some of these organizations also contribute to the development of health infrastructure as well as equiping health facilities with state-of-the arts medical equipment and technologies.

The decentralized local authorities (regions and municipalities), on the other hand, are responsible for managing and implementing health development plans at the local level. In accordance with Law No. 2019/024 on General Code of Decentralized Territorial Collectivities (CTD), the CTDs have the mandate to i.) create, equip, manage, and maintain health centers that serve the population of the municipalities in the regional of interest, ii) administer social and financial assistance for the needy. iii) organize and manage the supply of essential drugs, reagents, and medical devices in accordance with the national health policy.

Finally, the extent of the contribution of the communities in the provision of health care and services at the primary level, is poorly understood, partly because of lack of proper documentation; however, their presence and actions are clearly visible through the whole health system.

Cameroon's health sector is also segmented into three vertical components namely: i) health promotion, ii) disease prevention and iii) case management. It also has two horizontal or cross-cutting components including: i) health system strengthening and (ii) governance and steering/strategic management.

Table 3: Organization structures and roles and responsibilities for different levels of the health pyramid

Level	Administrative structures	Competence	Health Structures	Dialogue structures
Central	▪ Minister's cabinet ▪ General Secretariat for Health ▪ Secretary of State to the MoH ▪ Technical departments and Directorates	▪ Development of policies and strategies ▪ Coordination ▪ Regulation ▪ Supervision	▪ General hospitals ▪ Central Hospitals ▪ University Teaching Hospital ▪ National Drug procurement Agency ▪ Pasteur Institute ▪ National Public Health Laboratory ▪ National Public Health Observatory ▪ Chantal Biya International research Center ▪ National Regulatory Authority ▪ Center for ▪ National Emergency Operating Center	▪ National Council of Health, Hygiene and Social Affairs ▪ NITAG ▪ Scientific Council for Public Health Emergencies
Intermediate	▪ 10 Regional Delegations for public health	▪ Technical support to Health districts ▪ Coordination at Regional Level	▪ Regional Hospitals ▪ Regional funds for management of essential medicines	▪ Regional Funds for Health promotion

		▪ Regulation at Regional level ▪ Supervision at Regional level		
Peripheral	▪ 189 Health Districts ▪ +5,970 facilities	▪ Provision of Essential services at district hospitals, clinics, health centers etc. ▪ Coordination of Activities at District level ▪ Regulation of health activities at district level	▪ District hospitals ▪ Clinics ▪ Sub-divisional hospitals ▪ Integrated Health Centers	▪ District Health committee ▪ District Management committee ▪ Health Area management committee

3.3. Organization of Cameroon's Health System

In terms of organization, Cameroon's health system has three sub-sectors, including a public sub-sector, a private sub-sector, and a traditional sub-sector. The later sub-sector is an important aspect in Cameroon's health system given that about 80% of its populations use this form of medicine. Given its importance, the government is currently developing a framework to guide the operations of the sector as well as tools it can harness to better regulate and supervise the sector.

In terms of service delivery, each facility or practice- be it public, private, or traditional operate under the supervision of a health district as provided by Decree No. 95/013 of 7th February 1995, organizing facilities and practices under health districts. As of December 2021,[48], Cameroon had a total of **189 health districts** and **5,978 facilities** as shown in Table 4.

Table 4: Distribution of Health Facilities in Cameroon by type and by region

Region	GH	CH	RHC	RH	DH	CMA	IHC	Total
AD	0	0	1	1	12	17	154	**185**
CE	2	8	0	1	49	95	1,429	**1,584**
ES	0	0	1	1	21	21	220	**264**
EN	0	0	1	3	30	27	384	**445**
LT	2	2	0	2	53	78	1,159	**1,296**
NO	1	0	1	1	16	9	287	**315**
NW	0	0	1	1	30	32	346	**410**
OU	0	0	1	1	35	68	727	**832**
SU	0	1	1	1	13	34	260	**310**
SW	0	0	1	2	32	26	276	**337**
Total	**5**	**11**	**8**	**14**	**291**	**407**	**5,242**	**5,978**

AD-Adamawa; CE-Center; ES-East; EN-Extreme North; LT-Littoral; NO-North; NW-Northwest; OU-West; SU-South; SW-Southwest

GH-General Hospital; CH-Central Hospital; RHC-Regional Hospital Center; RH-Regional Hospital.

CMA-Sub-divisional Hospital; IHC-Integrated Health Center

As illustrated, over 60% of these facilities were found in just three of the 10 regions- the Center (1,584 or 26%), the Littoral (1,296 or22%) and the West (832 or 14%) regions. In Cameroon, each facility falls under one out of 6 categories: General hospitals (1st Category), then Central Hospitals (2nd Category), Regional Hospital centers (2nd Category), Regional Hospitals (3rd Category), district hospitals (4th Category), Sub-divisional hospitals (5th Category) and integrated health centers (6th category). The absolute number of each category is shown in Table 4.

The technical platforms of most of these facilities are in a state of degradation due to lack of repair and maintenance. To remedy this situation, the government launch a Three-Year National Contingency Plan, which aimed at rehabilitation and expanding the infrastructure and technical platforms many existing hospitals as well as the construction of eight regional hospital centers to meet with the rising demand of healthcare services of the population. In the same vein, the government has upgraded a few districts hospitals into regional hospitals as well as sub-divisional hospitals into district hospitals.

3.3.1. Organization of health facilities by status

Table 5 presents the distribution of facilities by status. As shown, the facilities are generally classified under one of three statuses, namely **Public owned**, **Private-for-profit** and **Private nonprofit** (mostly faith-based facilities, owned by various bodies, including religious denominations, associations, and various non-governmental organizations). Overall, 53% of health facilities are private facilities (12% [740] faith-based and 41% [2441] private for profit), and the majority are concentrated in just three urban centers, notably Yaoundé, Douala and Bafoussam. In contrast, public facilities provide a wider coverage and many of them are in remote rural areas.

Table 5: Distribution of Health Facilities in Cameroon by Status and by region

Region	Public	Faith-based	Private for Profit	Total
AD	133	33	19	**185**
CE	475	172	937	**1,584**
ES	188	45	31	**264**
EN	385	36	24	**445**
LT	223	151	922	**1,296**
NO	269	23	23	**315**
NW	248	86	76	**410**
OU	431	102	299	**832**
SU	210	55	45	**310**
SW	235	37	65	**337**
Total	**2,797**	**740**	**2441**	**5,978**

AD-Adamawa; CE-Center; ES-East; EN-Extreme North; LT-Littoral; NO-North; NW-Northwest. OU-West; SU-South; SW-Southwest

3.3.2. Spatial coverage of health facilities in Cameroon

As presented above, Cameroon currently has 5,978 health facilities for a population of nearly 28 million inhabitants, given a ratio of just 2 facilities for every 10,000 people. This is quite insignificant when compared with WHO recommendations. As shown in Figure 6, there is a remarkable regional variation in the availability of health facilities across the nation. This ranges from just 1 facility per 10,000 inhabitants in the Far North, North and Adamawa to 3 per 10,000 population in the Center, Littoral, and the South to 4 per 10,000 in the West (OU). When the data are further disaggregated, gross inequities are observed.

Figure 6 shows the spartial distribution of health facilities in Cameroon by population density per district. As can be seen, geographical distribution of facilities in the country is inequitable and

disproportional to the population. For example, the Far North region, which has the highest population in the country, has just 445 facilities, given a ratio of 0.9 facility per 10,000 population. Thus, the North and Far North regions are the least covered regions, with respective ratios of 1/13,030 and 1/8,840 while the South, West and the East are the best covered in first-level public health facilities with respective ratios of one integrated health center (CSI)/sub-divisional hospital (CMA) for 2574, 3325 and 4,172 inhabitants.

However, this does not necessarily translate into better spatial coverage for the target population. Indeed, in the different regions, and even in the Health Districts, there are still populations living more than 20 km from a health facility.

3.3.3. Offer of care and services

The supply of services and care in health facilities in Cameroon depends on their level in the health pyramid. Primary Health Care (PHC) is the strategy recommended for meeting the health needs of most of the population. However, it has difficulty accessing all the interventions of the Minimum Package of Activities (MPA) and the Complementary Package of Activities (CPA) and Package of Specialized services (SSP) offered by the first category health facilities. The provision of services and care at the community level remains weak and limited to certain priority health programs. The 1st to 4th category health facilities offers specialized care services based on their technical capacity; however, access to specialized services is seemingly low because of the high cost of such services. This challenge causes a greater segment of the population to resort to other types of care such as traditional or alternative medicine, which invariably contributes to the increased morbidity and mortality in recent years. Furthermore, it is necessary to also mention the role of the informal health care network, including homecare, self-medication, street pharmacies, which undoubtedly appear to be important contributors to the increase in morbidity and mortality at national level.

As shown in Figure 6, health facilities turn to be concentrated in health areas in less than 20% of the country's 189 districts, living many health areas and communities without a facility. For these communities to access the nearest health facility, they may have to travel for over 20km, at times on foot.

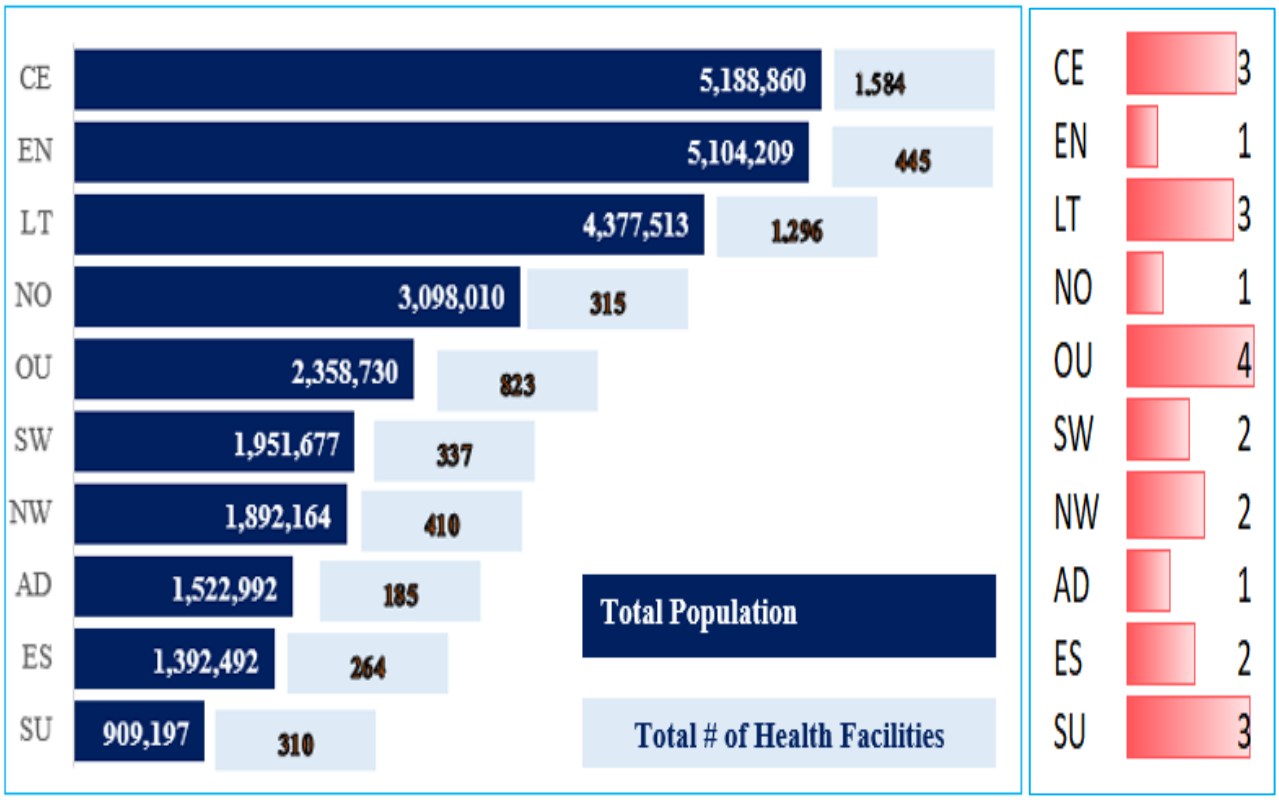


Figure 7: Distribution of health facilities region & by Population. The chart in red in the right shows the number of health facilities per 10.000 population

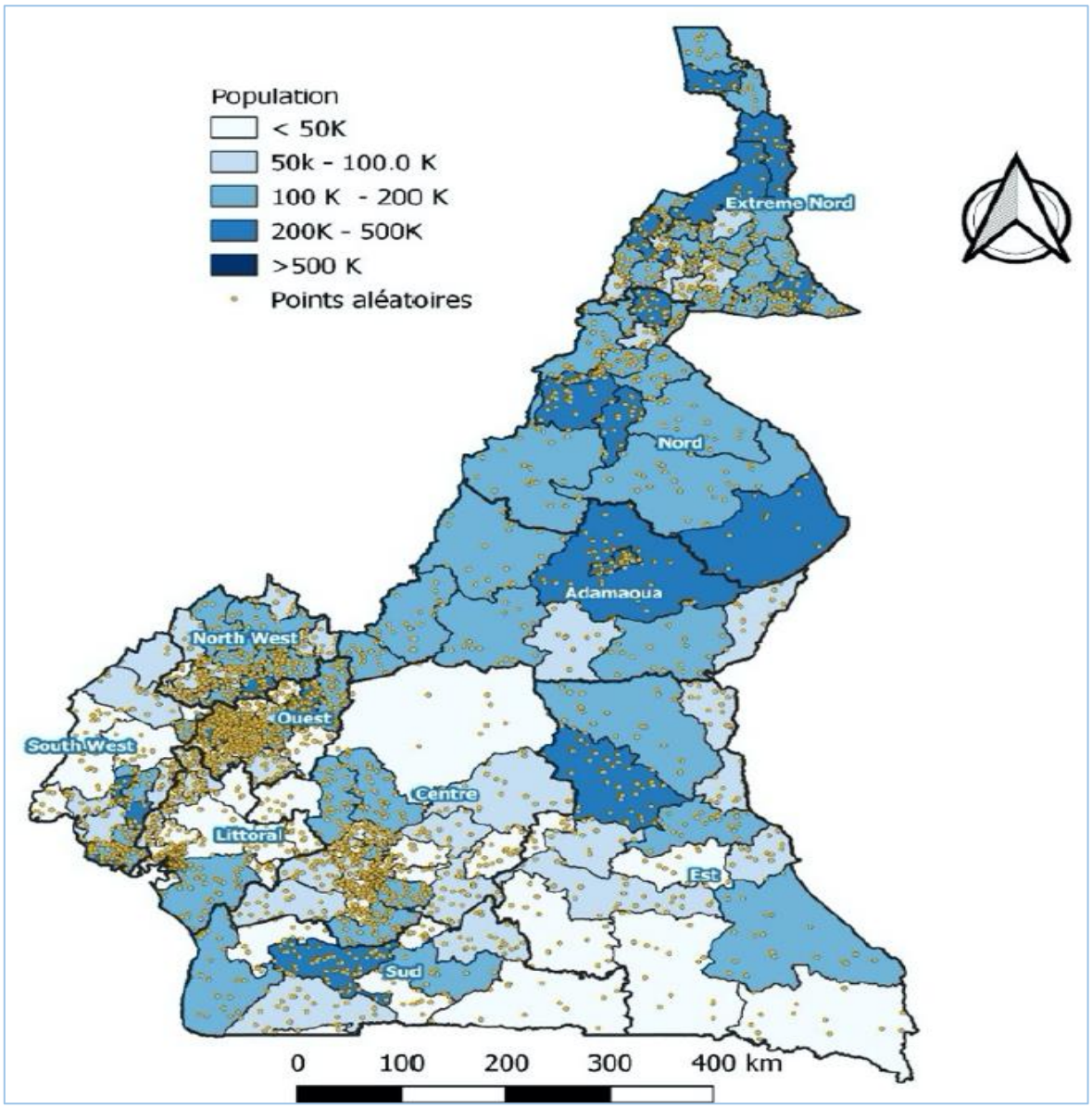


Figure 8: Spatial Distribution of facilities in Cameroon by population density per district

3.4. The Health Workforce

In 2012, the health sector had 38,207 health personnel across all categories. Of this number, 66% worked for the private sector and most of the workforce are concentrated in the three biggest and most populous cities in Cameroon, namely Bafoussam, Douala and Yaounde[48]. Furthermore, there is a critical shortage of doctors, pharmacists, nurses, and midwives. Indeed, according to the government's Strategic Plan for Human Resource Development for Health (2013-2020), the health personnel/population ratio (doctor, nurse, and midwife) is just 1.07 per 1,000 inhabitants, over 50%

lower than the WHO recommended ration of 2.3 personnel per 1,000 inhabitants[55]. The median number of people who work in immunization services is 2 (range 0-13); some facilities do not have a single staff while others, particular large hospitals in big cities have up to 13 staff in the immunization unit[10], highlight a gross inequity in the distribution of the health workforce across the country.

3.5. Overview of Cameroon's immunization system

3.5.1. Structural organization of EPI

Cameroon EPI was established in 1982. Its primary objective is to contribute to the reduction of morbidity, mortality and disability from VPD through immunization of eligible targets with quality and live saving vaccines [11]. The EPI formulates policies, guidelines and standards for vaccination and is responsible for immunization related trainings, supervision of immunization activities to ensure services are of quality. The EPI is also responsible (through its partners-mainly UNICEF) for the procurement and distribution of vaccines and immunization supplies.

Structurally, Cameroon's EPI is divided in to five sections [11]. These include 1) the routine Immunization and logistics; 2) Communication for Development (C4D); 3) Surveillance and Supplementary Immunization Activities; 4) Planning, Monitoring and Evaluation and 5) Administrative and Finance sections.

With regards to administration and management, there is a central technical group (CTG) that is responsible for immunization nationally. This group is led by a permanent secretary, who is assisted by a deputy. The permanent secretary oversees the activities of the 5 sections (listed above) and 18 units.

At regional level, the program is represented by Regional EPI heads, who are answerable to regional delegates for public health. Each regional head leads a team, consisting of a data manager, a

communication focal person, a logistician, and a storekeeper and these individuals are technically supervised by their counterparts at the CTG.

The country's 10 regions are divided into health districts, which in turn are divided into health areas. Each health district is led by a district medical officer (DMO), who reports to the regional delegate of public health. The Chief of bureau health, who reports to the DMO, oversees the implementation of immunization services at district level, including management of the vaccine supply chain.

The vaccine supply chain consists of a central vaccine depot, located in the capital city of Yaoundé and about 30 kilometers from the Nsimalen international airport. This depot receives vaccines twice annually, except for PCV13, which is delivered quarterly, primarily because of its volume. The central depot, in turn, delivers vaccines to the regional depots via a push mechanism on a quarterly basis. The regional depots, in turn, deliver vaccines to districts via a pull mechanism monthly.

Each health district is divided into health areas and each health area has a lead health facility, which is generally public (but can be private in some health areas). The lead facility coordinates the distribution of vaccines and supplies and reports coverage rates for all facilities-public and private-within the health area. At each level of the immunization pyramid, the core activities of the level revolve around the eight functions:

1. **Vaccine supply and logistics*:*** This function enables the EPI to forecast the quantities of vaccines it will require for the year, establish a procurement plan in collaboration with Gavi and the Supply Division of UNICEF, purchase and import the vaccines, clear them from the port of entry, store them at the central vaccine depot in walk-in cold or freezer rooms in accordance with the manufacturers' recommendations and distribute these vaccines to the regional vaccine deports via a push mechanism following a set of standard operating procedures. The regional warehouses, manage the stock accordingly (respecting directives for vaccine handling, storage, and inventory management). The regional depots then distribute

vaccines to health districts via a pull mechanism monthly following the requisition plans issued by the districts. The districts, in turn, distribute to health facilities monthly in accordance with their supply plans. At facility level, the facility staff maintain the vaccines in refrigerators, manage the inventory and use the vaccines to organize fixed-post and outreach immunization sessions. According to recent cold chain inventory (CCI), there are currently a total of 5,500 vaccine CCE in Cameroon, including just one Walk-in Freezer Room (WIFR), 16 walk-in Cold Room (WICR), 244 freezers, 5,226 vaccine refrigerators and 13 ultracold chain (UCC) equipment[56]. The distribution of these CCEs per region is shown in Table 6. Eighty three percent of these equipment are found at facility level and 15% at district level. Over 93% of these CCE are functional compared to just 20% in 2015.

Table 6: Repartition of cold chain equipment by region

REGION	Freezer room	Cold room	Freezer	Refrigerator	UCC	Total
AD	0	1	14	256	1	272
CE	0	1	29	1,151	1	1,182
ES	0	1	18	309	1	329
EN	0	2	33	561	0	596
LT	0	2	34	664	1	701
NO	0	1	15	498	1	515
NW	0	1	24	397	1	423
OU	0	1	40	785	1	827
SU	0	1	16	348	1	366
SW	0	1	17	257	1	276
GTC-PEV	1	4	4	0	4	13
Total	**1**	**16**	**244**	**5,226**	**13**	**5,500**

The country also has a total of 530 cold boxes and 11,856 vaccine carriers, which it uses to transport vaccines-both for distribution and outreaches.

2. **Service delivery:** This function occurs at the facility level and is the backbone of a sustainable routine immunization system as it ensures that the facilities provide the necessary immunization shots to their target population. Service delivery often occurs via two approaches, namely fixed post sessions, where facility staff deliver vaccine shots to the target population at the health facility or via outreach sessions in which staff collaborate with the communities to organize immunization sessions at locations and timing that have been agreed upon jointly by both the community and the facility staff. Figure 8 illustrates the immunization schedule for Cameroon[36]. Each vaccinate is assigned to a specific and the x-axis denotes the age at which each vaccine should be administered. The country recently introduced the second dose of the combined Measles Rubella (MR) vaccine, which should be given at 15 months of age and the Human Papilloma Virus (HPV) vaccine, which should be given to girls aged between 9-13 years. In addition, the country plans to introduce the recently approved vaccine against Malaria, the birth dose of hepatitis B vaccine and a vaccine against meningococcal meningitis.

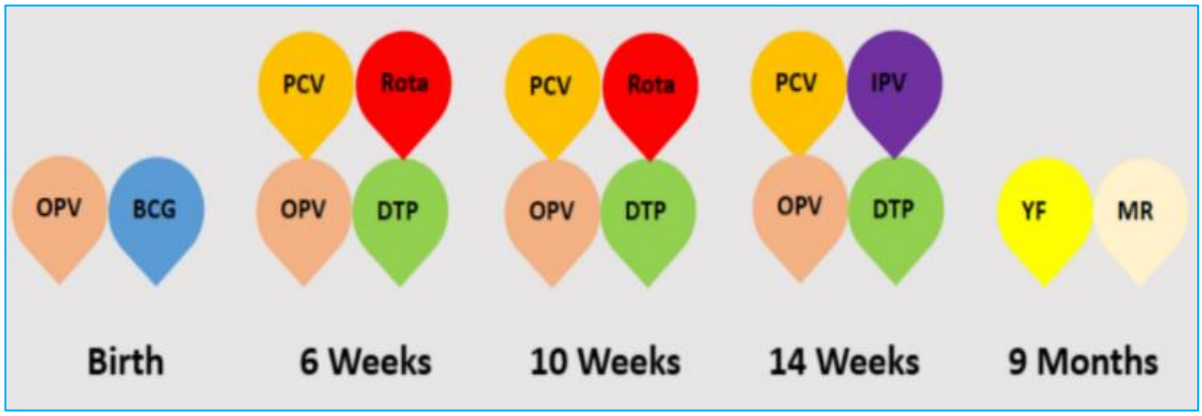


Figure 9: Schematic representation of Immunization Schedule in Cameroon.

Each color is assigned to a particular vaccine. The timeframe below each group of vaccines indicates the age from birth at which the vaccines are authorized to be administered to the target. OPV- Oral Polio Vaccine; PCV- Pneumococcal conjugate vaccines; DTP- Diphtheria-tetanus-pertussis vaccine; YF-Yellow Fever, MR- Measles-

It is important to highlight that effective and efficient immunization service delivery heavily depends on many other key components such as detailed and careful planning, continuous supplies and logistics, skilled managers and vaccinators, mastery of immunization interventions costs, communication, and advocacy on the benefits of vaccination amongst others. Data vaccination administration are captured during these sessions on standard EPI forms, including vaccination registers, tally sheets. At the end of the monthly, they are transferred to monthly progress report and subsequently entered into DHIS2.

3. **Surveillance:** This is also a core function of the EPI, and it consists of tracking, analyzing and interpretating data on VPD, which are then used to guide vaccination policies and programs as well as to ensure that immunization targets are being achieved.

4. **Advocacy and communication:** This function enables the EPI to communicate and promote the importance and benefits of immunization to various immunization stakeholders, including funders, vaccine recipients, their families, and the public. The EPI often uses this function to shape policies and influence decision-makers to create a conducive environment for immunization. Several stakeholders are often involved in this function, including the civil society. Cameroon has a very active civil society that conducts advocacies in favor of vaccination. This is spear headed by the Platform for the Promotion of Vaccination and Health System Strengthening in Cameroon (PROVARESSC) which, which is a coalition of 33 Civil Society Organizations (CSO), representing 222 community-based associations across all the 10 regions in Cameroon. Leveraging funding from Health System Strengthening grant from Gavi, this platform is implementing communication activities in favor of vaccination in 145 districts through its CBOs. These activities revolve around awareness raising on the importance of vaccination, engaging traditional leaders and healers to promote immunization, counter anti-vaccine information and support in identifying and tracking lost to follow-ups.

The civil society has also been helpful in pushing government-through public outcry- to disburse funds for vaccine procurement, particularly during prolonged stock out of some key antigens. In 2019, for instance, public outcry from the civil society led the president of the republic to request urgent disbursement of an equivalent of US$2M for the procurement of BCG vaccines to address the prolonged shortage.

5. **Planning and management:** This function begins with the development of a five-year national strategic plan for immunization, highlighting the goals and target that the program seeks to achieve during the strategic period. This plan is often aligned to global goals and targets, such as those outlined in the UN SDGs, the WHO 2030 Immunization Agenda, Gavi 5.0 strategy and other regional or global disease elimination targets. The strategic plan is then broken down into annual work plan that is frontloaded with key activities that the EPI must implement to make progress towards its defined targets. The plan is them implemented, monitored, and evaluated on a quarterly basis, using templates that CHAI helped the EPI to develop in 2016. This approach is also applied at the regional, district and facility level, including micro planning as well as planning actual immunization sessions, either in a fixed facility or in outreach activities.

6. **Data Management:** Cameroon's EPI collects routine data from every immunization session, whether it occurs at a fixed site or during outreach or mobile services, using standardized data collection tools. The data are then transmitted to upper levels for aggregation, curation, analysis, and estimation of the coverage for each antigen at health area, district, regional and national level. Despite the existence of this system, obtaining accurate, timely and complete data from facilities continue to be a challenge. To address this, the EPI has prepared and rolled out a data improvement plan as well as the district health information system (DHIS2) to improve on the quality of data that are being collected and transmitted by facilities. The

importance of quality data for informed decision-making cannot be overemphasize as this helps to improve population immunity against VPD. Because of this critical role, and her core partners including WHO, Gavi, Unicef, CHAI, Swiss TPH, University of Oslo and Bluesquare are working to implement robust data management systems at all levels, including at fixed and outreach sites.

7. **Capacity and capability building:** In 2016, CHAI supported the EPI to develop a five-year strategic capacity building plan as well as several normative documents, including Norms and standards to govern vaccination in Cameroon. CHAI and EPI then leveraged these resources to roll capacity building activities for EPI staff at all levels. Gavi has also been supporting the EPI to provide technical training of its key staff via various mechanisms, including provide staff with scholarships to study vaccination logistics in Benin as well as engaging the University of Yale to provide managerial training to EPI leaders, via the leadership, management, and coordination program. CHAI has also helped the EPI to set up mentoring systems as well as institutionalize the use of an onboarding package to facilitate acquisition of skills by newly appointed staff to address gaps that high staff attrition often creates.

8. **Finance:** Consistent financial investments in RI are required to achieve the vision of the EPI. In other words, to achieve and maintain a country's immunization objectives, sufficient financial resources must be forthcoming every year to vaccinate an ever-expanding birth cohort. Ideally, these resources should be obtained from sustainable sources. According to its workplan for 2021, the EPI had a total budget **of nearly US$20M (XAF12,534,660,120)**[48]**.** This funding came essentially from the following sources: Gavi, the State, WHO, Unicef and CHAI. As illustrated, Gavi is the largest funder of Cameroon’s EPI, a trend that has been observed since 2002.

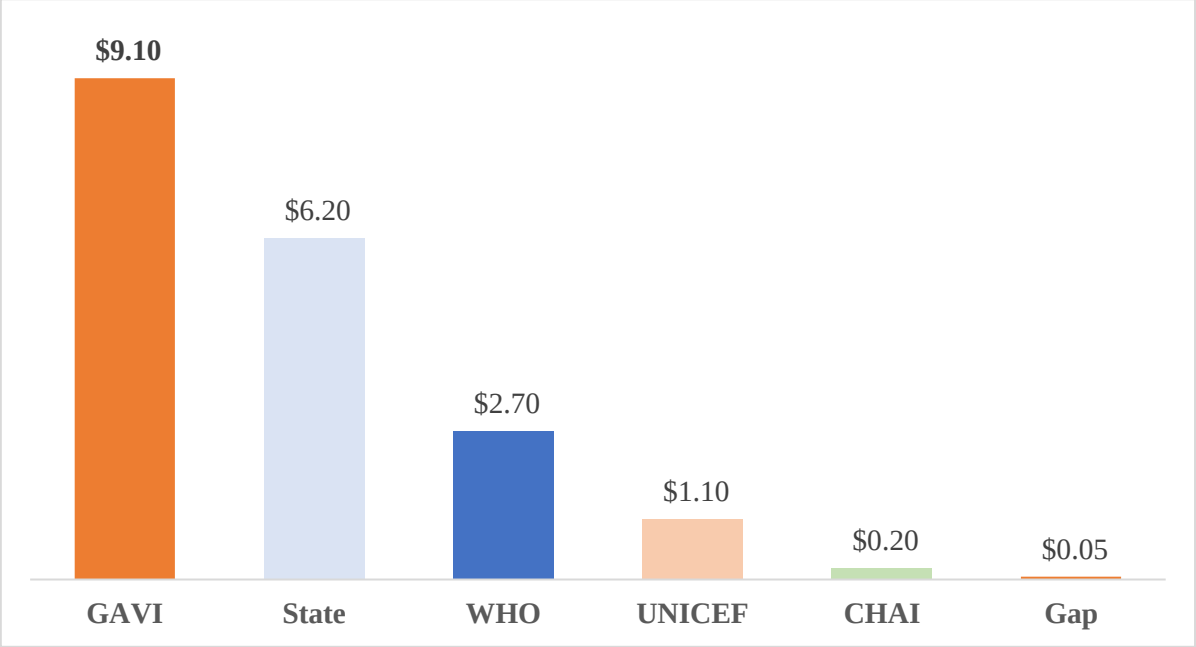


Figure 10: Funding contribution of Key stakeholders to EPI's 2021 annual budget (in Millions of US$)

At the end of 2021, all the forecasted budgets were mobilized, and the execution rate was 96%. Sixty-six percent of the budget was injected into vaccine procurement and distribution, 20% to service delivery, 6% to program management, 4% for surveillance and 4% for advocacy and communication. In addition to the above funding, the EPI received nearly US$2M (XAF1.2 billion) to drive the rollout of COVID-19 vaccines, 32% was allocated to the central and 67% to the regional and operational levels.

3.5.2. Decision Making bodies for immunization in Cameroon

In September 2020, Cameroon's Minister of Public Health issued a Decision (No. 7038 / MINSANTE/ CAB of 19 September 2022), outlining the roles and responsibilities of two decision organs of Cameroon's immunization system, namely the Inter-Agency Coordinating Committee (ICC) and the National Immunization Technical Advisory Groups (NITAG).

According to the communique, the ICC is responsible for defining the directions and the general objectives of the Expanded Program on Immunization. As such, the committee shall oversee the following: i) review, and validation of multi-year, annual and quarterly plans of the program as well as their related budgets; (ii) approve technical and financial annual reports from the program; (iii) evaluate technical and financial program performance; (iv) mobilizes resources needed to implement the program activities; (v) coordinate, harmonize and oversee the coherence of interventions of different actors and partners; (vi) approve partner's grant submission plans; (vi) rule on the program's internal audit report; (vi) oversees the implementation of the recommendations of external audits. The membership of the ICC is drawn from different ministerial departments, including the ministries of public health, finance, economy, family welfare and the civil society, including representatives from various religious groups. The ICC is chaired by the Minister of public Health and the technical secretariat is assumed by the EPI.

The NITAGs, on its part, is an independent and multidisciplinary body of national experts who will be responsible for providing evidence-based recommendations to policymakers and immunization programme managers. The NITAG shall provides either, on request from the MoH or on its own initiative, opinions, recommendations or independent reports on vaccination or vaccines to support policy and to guide the decision-making in the field of vaccination in Cameroon. It shall be responsible for: i) analyzing national policies and strategies of vaccination (routine vaccination, non-EPI vaccination, supplementary vaccination activities and epidemiological surveillance, AEFI management); ii) proposing adjustments to vaccination policies and strategies based on local evidence; iii) proposing optimal strategies for the control of vaccines preventable diseases; iv) providing support and advice to national authorities on the relevant strategies that can enable monitoring and evaluation of the impact of activities of vaccination; v) informing national authorities about the latest scientific developments and innovations in the field of immunization and vaccines; vi) establishing partnerships with other immunization advisory committees; (vii) analyzing the

constraints related to the sustainability of immunization financing and to propose optimal strategies. Currently, Cameroon's NITAG has twelve statutory members, who are experts in the following fields and specialties: vaccinology, infectiology, pediatrics, obstetrics and gynecology, internal medicine, immunology, molecular biology, epidemiology, health economics, public health, medical socio-anthropology, pharmacy, neurology, health logistics, communication, and law. The NITAG has a legal status and meets quarterly. It also meets the six WHO criteria for a functional NITAG.

4. Materials and methods

The thesis project was designed to accomplished 5 specific objectives as summarize below:

4.1. Study Design.

This PhD project was a cross sectional operational research study, which utilized both quantitative and qualitative approaches to accomplish five specific objectives. For specific objective #1, a quantitative approach was used, which involved data triangulation of 8 principal data sources, as well as Quantum Geographic information System (QGIS) technology to produce maps of underserved communities. In addition, a qualitative approach was used to explore supply and demand side barriers to reach ZDC, UIC and MC with immunization services. To accomplish objectives #2, #3 a quantitative approach was used to assess the impact of COVID-19 and civile strife on key RI indicators in two target regions. For specific objective #4, both qualitative and quantitative approaches were used to explore bottlenecks impacting sustainable procurement and financing of vaccines in Cameroon. To accomplish specific objective #5, three pilots were implemented, with baseline and an endline assessments. Thes approaches are described in the section below.

4.2. Administrative approvals

In compliance with government administrative procedures, technical documents were prepared and forwarded detailed to the Minister of Public Health (MoH), outlining the rationale and methodology for each of the above objective prior to data collection. The minister, in turn, approved the individual project (DECISION No: D21-110/L/MINSANTE/SG/DSF/GTC-PEV/PEVR-LOG/ULOG-Annex 1), designated focal points and requested regional delegates for public health to fully support the activities, by establishing regional teams to support with project implementation in their respective regions. In accordance with Ethics Guidelines for Health Research Involving Human Participants in Cameroon and CHAI's Human Research Guidelines, ethical approvals were obtained from CHAI's internal Scientific and Ethics Review Committee and the National Ethics committee in Cameroon.

All HCW's who participated in the HCW surveys provided informed consent. All study staff, including data collectors, received ethical training sessions. To ensure confidentiality, all data collectors signed a confidentiality agreement. Their activities and data safety measures were strictly supervised in the field by the author of the thesis.

4.3. Data Sources

4.3.1. Data source to identify and characterize ZDC, UI children and MC in Cameroon:

To accomplish specific objective #1, which involved granular identification (how many, where, and who) of ZDC, UI and MC in Cameroon, a combination of data sources was leveraged as shown in Table 7.

Table 7: Data sources used for specific objective #1

Number	Type of data set	Year	Reference
1	Geo-Referenced Infrastructure and Demography Data for Development (GRID3)	2022	https://grid3.org/[57]
2	Geolocated health facilities, including Immunizing facilities 2018 (from MOH/WHO) 2021 (from EPI/DHIS2) merged with geolocation in 2020	2018, 2020, 2021,	Provided by MoH[58]
3	Grided population density (WorldPop)	2020	WorldPop[59]
4	Road networks	2022	Humanitarian Data Exchange[60]
5	Malaria Atlas Project	2022	Accessibility Project[61]
6	Time to health facility (MAP)	2019	
7	Administrative boundaries (MOH)		Provided by MoH[58]
8	5x5km Coverage estimates	2022	DHIS2
9	Armed Conflict Location and Event Dataset	2022	Data Export Tool - ACLED (acleddata.com)[62]

4.3.2. Description of the data sources

- **The Geo-Referenced Infrastructure and Demography Data for Development:** GRID3 data sources are compiled by the GRID3 consortium and posted on their website as open resource for data driven decision making[57]. GRID3 displays maps that are detailed down to the location of hamlets (5 houses), and useful for visual location and GIS analysis; however, the file does not contain names of hamlets and villages. To overcome this, we engaged key local stakeholders for planning as local context and knowledge are critical. For the for zero-dose identification, we examine the location of facilities that provide immunization, using these data source in conjunction with that provided by the EPI. Combining the data of geolocated facilities and data on the immunizing facilities required extensive cleaning and merging of facilities names, particularly in instances where facility identification was not provided. This process took significant time as it required inputs from local stakeholders. For network extension optimization (NEO) work for immunization, the author leveraged recently collected data on the landscape of CCEs and potential outreaches[56]. It is important to note here that significant time wasn't invested to get actual geolocation of outreach sites since we could make assumptions about outreach sites being located within 5-15km from a facility as provided by the EPI norms and standard[22]; thus, knowing the location of the facility was judged to be sufficient.
- **Open Spatial Demographic Data and Research (WorldPop):** WorldPop provides population density estimates through several models[59]. As such, the author reviewed different population density estimates and used the one that he considered fits the purpose of this analysis.
- **Road networks are linked here through Open-Street**: The Humanitarian Data Exchange pulls maps from multiple other data sources as a catalogue for data repository, including

WHO, UNFP, Open Street Maps[60]. In addition to this, the author considered including location of internally displaced persons and humanitarian emergencies.

- **Malaria Atlas Project:** This site, also referred to as the Accessibility Project provides various analytics, including facility locations for a malaria-free world[61]. The author utilized healthcare facility locations from two of the largest global databases: (1) OpenStreetMap (OSM) data that was collated and made available for download at www.healthsites.io29 ; and (2) data from Google Maps that was extracted specifically for this project. These global datasets were subsequently augmented with continental-scale facility locations that were recently published for Africa by Maina and collaborators in 2019[63] and travel time to facilities in Australia[64]. To align temporally, each of these datasets was extracted in mid-2019. To facilitate comparisons between data sources, only facilities defined as hospitals and clinics were considered, which matched the definition used in Maina, J. *et al.* (2019)[63] and Barbieri, S. & Jorm (2019)[64], and was distinguishable within the OSM data by using the facility-type attribute. In contrast, Google Maps data were filtered to isolate hospitals and clinics from the full set of geolocated entities. For each dataset, multiple points found within the same approximately one-by-one-kilometer pixel were merged to match the resolution of the subsequent travel time to health facilities as reported by Weiss and collaborators in 2019[65].
- **Administrative boundaries**: One key target of the project was to present ZDC, IU and MC within administrative boundaries; however, data from the later were unavailable. Consequently, the Humanitarian Data Exchange[60], was used. This dataset pulls data from multiple data sources to form a catalogue for data repository including WHO, UNFP, Open Street Maps and location of internally displaced persons and humanitarian emergencies.
- **District Health Information system 2 (DHIS2):** We utilize DHIS2 or administrative data to produce estimates of health outcomes and related measures that cover entire country, including regionals, districts, and health level at a very fine, local resolution.

- **Armed Conflict Location and Event Dataset (ACLED):** This dataset covers actions of militias, opposition groups, and governments across Africa and is disaggregated by type of violence[62]. We leveraged it to run population estimates for the three conflict regions in Cameroon-EN, NW and SW.

4.3.3. Data source to assess the impact of COVID-19 on vaccination coverage in Cameroon:

The dataset to accomplish this specific objective was extracted from DHIS2, using a tool that was specifically developed for this purpose, which could enable the EPI to monitor trends over time and that can be used for future pandemics. Details of these tool are provided in section 4.4.2 (pages 70-71).

4.3.4. Data Source to assess the impact of the ongoing civil strife on immunization outcomes:

The dataset to accomplish this objective was extracted from the DHIS2, which consisted of data obtained just before the start of the conflict in 2016 to December 2019, just before the onset of the COVID-19 pandemic. 2019 was used as endline to limit the potential confounding effect of the COVID-19 pandemic.

4.3.5. Data source to map procurement and financing processes for EPI vaccines in Cameroon:

The dataset for this objective was obtained via a literature review and qualitative interviews (mostly in-depth interview) with key stakeholders involved in the procurement process.

4.3.6. The dataset set to develop and test a set of scalable interventions to improve RI coverage:

This was obtained by direct data collection from the field using interview guides and questionnaires.

4.4. Data collection, curation, and manipulation.

4.4.1. Identification and characterization of ZCD, UIM and Missed communities

Data sources described under section 4.3.1.were leveraged to conduct a robust and expanded identification and mapping analyses to identify settlements with ZDC and UIC, estimate their absolute numbers, describe the geographical specificities of these children and their communities,

and explain the context-specific supply and demand barriers of clusters of ZDC and UIC missed communities. In this light, Gavi's operational definitions for ZDC, UIC and MC were used to determine the distribution of ZDC, UIC and MC by sub-administrative unit (level 4) as well as specific settings, especially urban, rural remote, fragile/conflict and other areas. These data sources were leveraged to conduct data triangulation at granular level using GRID-3 and DHIS2, QGIS data systems and PowerBI to establish **where ZDC, UIC and MC are likely to be found** within the Cameroonian health system. The same approach was also used to estimate **how many ZDC, UIC and MC** are there in Cameroon. To do this, an extensive **Geospatial Based Data Triangulation** was conducted using the QGIS software. The databases used for this included coverage estimates from DHIS2[58], settlement location from GRID3[57], Geolocated health and immunization facilities from MOH database[58], administrative boundaries from MOH and Cameroon data health survey[58]. Based on the results from the QGIS analysis, outputs were developed, which summarized maps and characteristics of ZDC, UIC, and MCs in Cameroon.

To determine, the **‘’who”** and reasons **‘’why’’** these children are zero-dose, under-immunized or missed, a secondary data analysis was conducted. This analysis used data from Demographic Health Survey that was conducted in 2018 and RI data housed in DHIS2, Open Data Kit, Scorecards, Stock Management tools of the Ministry of Public Health website[58].

Furthermore, a qualitative study design was used to gain insights on the demand-side reasons for the high proportion of zero-dose children in some health areas (administrative level 4) in Cameroon based on the perspective of healthcare workers, community health workers, community leaders, and caregivers. To this end, qualitative assessments were conducted in six health areas with high ZDC across five regions of Cameroon. Study sites were purposively selected based on ethnocultural population distribution, including a mix of urban, remote rural, and conflict-afflicted zones, to provide a geographic and culturally representative picture of the barriers and drivers of childhood

immunization in missed communities in Cameroon. Purposive sampling was used to recruit participants for Key Informant Interviews (KII) with district healthcare workers based on their roles, availability, and willingness to participate. A snowballing approach served to recruit an intermixed population composed of male and female caregivers and community leaders for focused group discussions (FGD). Behavioral and social drivers (BeSD) framework[66] [67]was used to guide the qualitative data collection and analysis. The behavioral and social drivers of vaccination are defined as beliefs and experiences specific to vaccination that are potentially modifiable to increase vaccine uptake. These drivers of vaccination can be assessed across four main domains based on BeSD framework (Figure 11): Thinking and feeling about vaccines, social processes that drive or inhibit vaccination, motivation (or hesitancy) to seek vaccination, and practical issues involved in seeking and receiving vaccination.

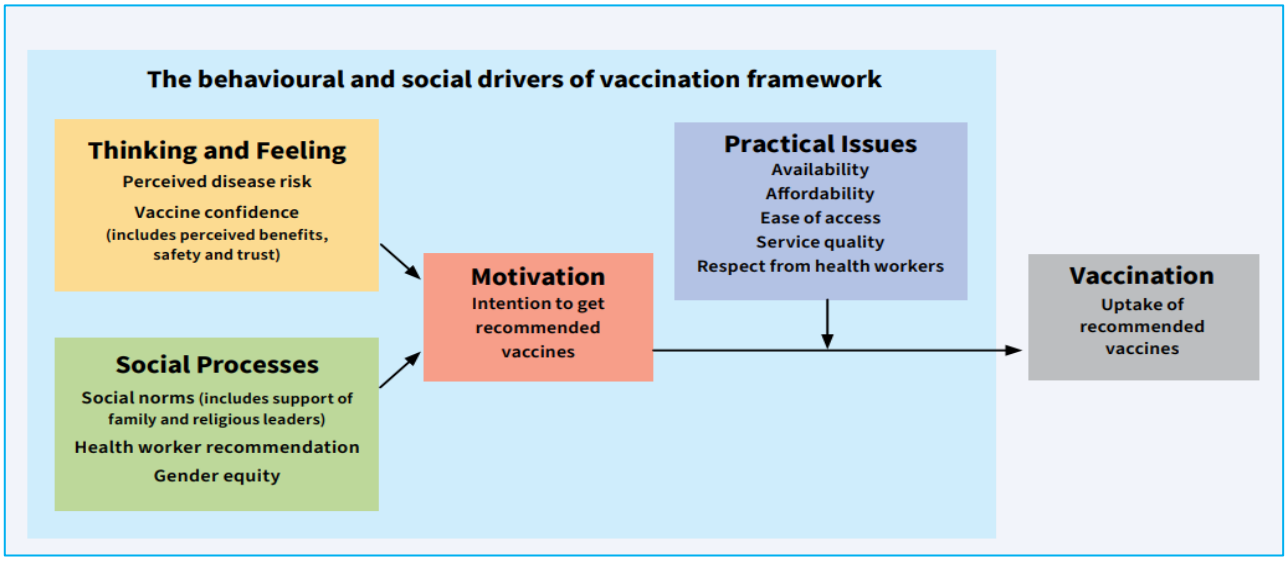


Figure 11:The Behavioral and social drivers of vaccination framework. Adapted from the WHO BeSD framework[66].

Data collectors were trained on qualitative methods and how to handle sensitive topics with participants. KII and FGD guides with open-ended questions were used for KII and FGDs, respectively and data collectors collaborated with community liaisons to ease the moderation of FGDs. Tape recorders were used, and notes were taken, where necessary. Before FGD sessions, a

survey was administered to participants to give an overview of vaccination drivers and barriers. This approach helped to distill important preliminary issues regarding study themes.

4.4.2. Assessment of the impact of COVID-19 on vaccination coverage in Cameroon

To assess the impact of COVID-19, an Excel-based tool was developed and deployed to track the impact of COVID-19 on RI. Figure 13 below depicts the process for developing the tool: Indicators were first modelled and validated (leveraging on DHIS-2 immunization data for 2019 and 2021) through a series of consultative meetings with key stakeholders. The modelled indicators were **drop in access** (*decrease in BCG or penta1*), **drop in utilization** (*increase in Penta dropout or BCG-MR1 dropout*), **drop-in facility services** (*decrease in fixed sessions*), **drop-in community services** (*decrease in outreach sessions*) and **rise in zero-dose children** (*increased number of unvaccinated children*).

Figure 12: Process step for developing the immunization tracker.

These indicators were then used to highlight and prioritize areas of worst performance at each level of the health system. The tool was deployed to six priority regions and 55 priority districts through a series of capacity-building workshops and provision of continuous technical support and later rollout to all the health districts in the country. DHIS2 data between 2019 and 2022 were used to performed quarterly trends analytics and determined organizational units i.e., regions, districts, health areas and

health facilities, that may have been impacted by COVID-19 in 2021, when compared to 2019. The tool was then leveraged to support EPI staff with rapid tracking of quarterly immunization trends before and after the peak of the pandemic in 2020.

4.4.3. Assessment of the effect of the ongoing armed conflict in the NW and SW on key immunization indicators:

The method used to assess this objective has been published elsewhere[36]. Briefly, data for this specific objective were retrieved from the standard data reporting tool used by EPI teams in the NW and SW regions. In each region, a predefined questionnaire was used to collect data on the following immunization variables: coverage data for key antigens, service delivery, vaccine logistics, amongst others for 2016 when the conflict erupted and 2019, before the onset of the COVID-19 pandemic. Following data collection, completed questionnaires were returned to the author, who then screened them for accuracy and completeness before data entry. Identified data discrepancy were addressed by the author by directly contacting the team lead of the concerned district. Data were then analyzed using Excel 2016 and summary statistics were used to estimate the variables of interest individually for the years 2016 and 2019.

4.4.4. Evaluation of the procurement and financing processes for EPI vaccines in Cameroon

As described in section 1.4, obstacles in procurement and financing of vaccines are seemingly a key contributor to vaccine stockouts, which in turn disrupt vaccine service delivery, and by extension, impact coverage in unparallel ways. Until now, little was known about the bottlenecks in these processes. In a bid to sustainably address recurrent stockouts, resulting from these bottlenecks, a detailed mapping of the entire process was conducted to gain a better understanding of the various obstacles to complete and timely procurement and funding of vaccines in Cameroon. The goals of these process were three-fold: first, document vaccine procurement and funding practices; second, describe current processes for vaccine procurement and funding; and third, identify challenges to procurement and funding of vaccines in Cameroon.

To achieve the above goals, a retrospective mixed-method study was designed and implemented. This study consisted of a comprehensive desk review of various documents, followed by in-depth interviews of key stakeholders involved in the procurement and funds mobilization process during the study period (2015- 2020). In preparation for key informant interviews, a desk review of relevant documents was undertaken to gain an understanding of vaccine procurement and funding practices in Cameroon. Documents that were consulted included reports, legislations, policies, finance laws, annual forecasts, annual procurement plans, Vaccine Arrival Reports, payment requests and Gavi decision letters amongst others and this consultation was limited to documents that were generated between January 2015 and December 2020. Findings emanating from this desk review were synthesized, and organized into a table, with defined indicators, outputs as well as the relevant resource for each indicator and output as shown on Table 8. An Excel spreadsheet was then used to extract key variables of interest for data management and analysis for the following three themes:

1. **Allocation and Mobilization of funds,** which enabled the collection of data on fulfillment funding requirements and timeliness for mobilization of the funds.
2. **Supply Planning and Arrival,** which enabled the collect of data on order fulfilment for traditional vaccines, such as BCG, OPV, MR, and on order fulfilment for co-financed vaccines, such as Rotavirus vaccine, PCV, IPV, YF and DTP containing vaccines.
3. **Stock Assessment and Coverage,** which enabled the collection of data on stock status for traditional and co-financed vaccines as well as vaccination coverages for both categories of vaccines under the study period (2015-2020).

The desk review was followed immediately by the qualitative aspect of the study, which focused on collecting information via interviews of key Informant on the following variables: **Forecasting and Supply Planning, Budgeting and Mobilization of funds, Coordination of Vaccine Procurement and Challenges and Suggestions for improving the process.** Data collection were done in line with

an interview guide that was developed for this study, the details of which are described in the study protocol[37]. The KII sought to:

- Address information gaps or validate information from the desk review to ensure an accurate description of the procurement and funding processes, including challenges and opportunities for improvement.
- Gauge the perceptions and attitudes about the role of various stakeholders.
- Vet ideas for potential improvements to vaccine procurement and funding processes.

The key informants, as well as their roles and responsibilities are presented in Annexes 1 & 2.

Table 8: Indicators, inputs and sources used to evaluate the vaccine procurement and financing process in Cameroon.

	Indicator	Input	Source
Input A	Stock Trends (Months of stock)		SMT
	5-year Immunization Coverage Rates	Cumulative percentage of children immunized	WUENIC indicators
	Overall funding picture of the EPI programme in Cameroon	Funding allocated to EPI	SAF-PEV
	Percentage of budgeted expenditure	Actual expenditure (Qty received x Unit cost of vaccine)	Cost Estimates, Vaccine arrival reports Quantities, UNICEF price lists
	Percentage forecast fulfilment	Actual # of doses received	Vaccine arrival reports Validated forecasts
	Lead Time for funds disbursement	Planned Date of disbursement	SAF-PEV
	Future forecast (2021 - 2025)	Planned Date of disbursement	Gavi co-financing document
	Percentage order fulfilment	Actual # of doses received	Shipment invoices, VAR
	Percentage of forecasted expenditure	Actual expenditure (Qty received x Unit cost of vaccine)	Cost estimates Vaccine arrival reports Quantities,
	Percentage fulfilment on time (Funds disbursement)	Funds released on Time	SAF-PEV
	Forecast vs. Allocated	Total amount of money allocated for vaccines procurement	SAF-PEV
Input B	Stock Trends (Months of stock)	NA for Input B	NA for Input B
	5-year Immunization Coverage Rates	NA for Input B	NA for Input B
	Overall funding picture of the EPI programme in Cameroon	NA for Input B	NA for Input B
	Percentage of budgeted expenditure	Budgeted expenditure (Amount "released" .	
	Percentage forecast fulfilment	# of doses in the forecast	Forecasts
	Lead Time for funds disbursement	Actual date of disbursement	SAF-PEV
	Future forecast (2021 - 2025)	NA for Input B	NA for Input B
	Percentage order fulfilment	# of doses ordered	UNICEF orders
	Percentage of forecasted expenditure	Forecasted expenditure (forecast quantities x unit cost of vaccine)	UNICEF forecasts
	Percentage fulfilment on time (Funds disbursement)	Total Funds required	SAF-PEV
	Forecast vs. Allocated	Total amount required for vaccines procurement, based on	SAF-PEV

SMT-Stock Management Tool; EPI- Expanded Program on immunization; SAF-PEV-*Section Administrative et financieres du Programme Elargi de Vaccination*; WUENIC-WHO and Unicef Estimation of National Immunization coverage; NA- Not applicable.

In terms of procedure for the KII, trained data collectors, who are familiar with qualitative research methodology introduced the study to the target stakeholder and obtained informed consent before proceeding to administer questions contained in the interview guide. The questions were semi-structured and open-ended, allowing for detailed and in-depth discussions of the issues of interested in and these discussions were recorded using an audio recorded. The discussions elicited information on vaccine procurement processes and funding mechanisms and the information collected were exploratory in nature including, the overall procurement process, challenges to disbursements of funds, timeliness in preparing necessary documentation, and concerns from various stakeholders amongst others. These recordings ended either at the maximum or when thematic saturation was reached and were subsequently transcribed at the end of the study. No personal identifiers were collected during data collection. All audio recordings were kept by supervisors during the informed consent process and deleted after the completion of the study. All collected data were stored securely on password protected servers and only persons authorized by the author of the thesis had access to the data.

4.4.5. Development and testing of a package of scalable interventions for the above specific objectives.

The last specific objective for this thesis project was to develop and test a set of scalable interventions that could address the identified barriers, and by extension improve immunization coverage and equity in Cameroon and other similar settings in SSA. To accomplish this, three key interventions were designed and tested, namely those aimed at improving RI coverage: i). amongst ZDC, UIC and missed communities; ii) for key antigens in a conflict setting amidst COVID-19 pandemic; and iii) by improving the procurement and funding processes of traditional and co-financed vaccines.

4.4.5.1. Interventions for reaching Zero-dose and under immunized children in missed communities: Under specific objective #1, ZDC and UIC are likely going to be found in communities that are traditionally missed out by the conventional health care system. These communities can broadly be

regrouped under four thematic areas, namely Crisis Zones, Fluvial communities, City Slums and Enclaved rural/semi urban settings. Each of these settings have context specific characteristics as shown in Figure 14.

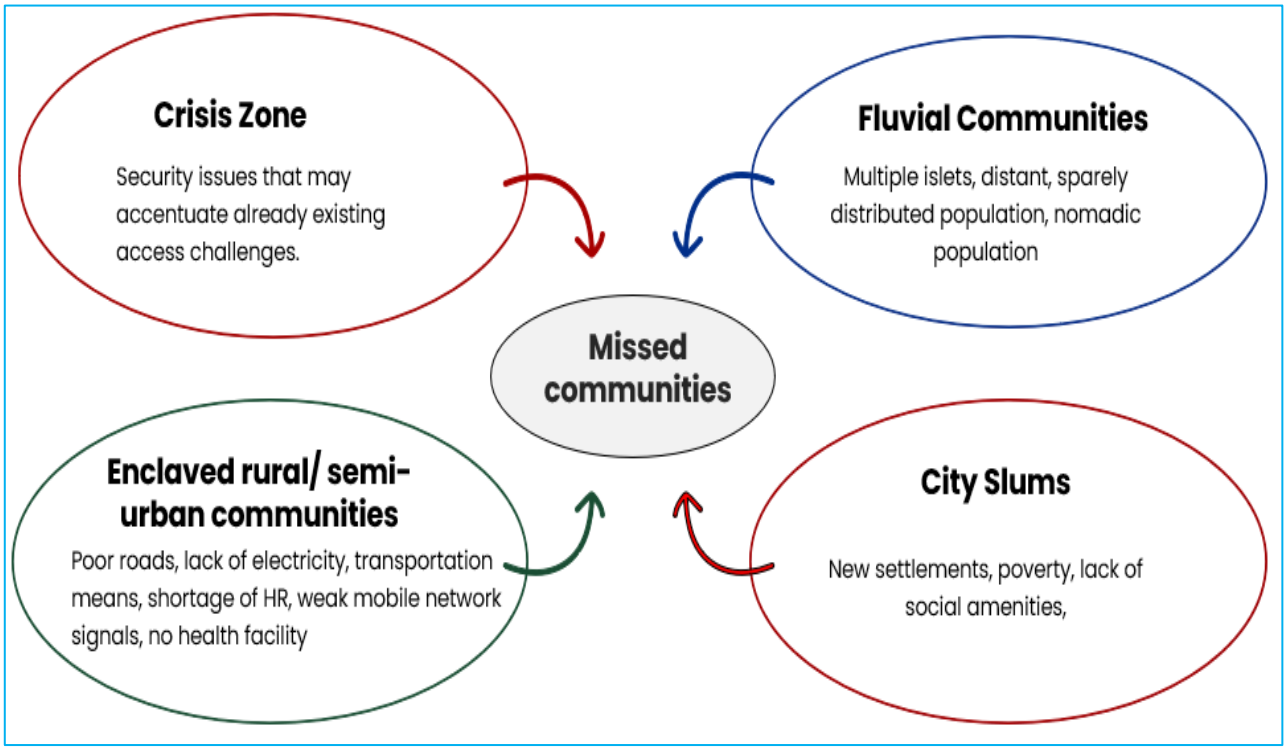
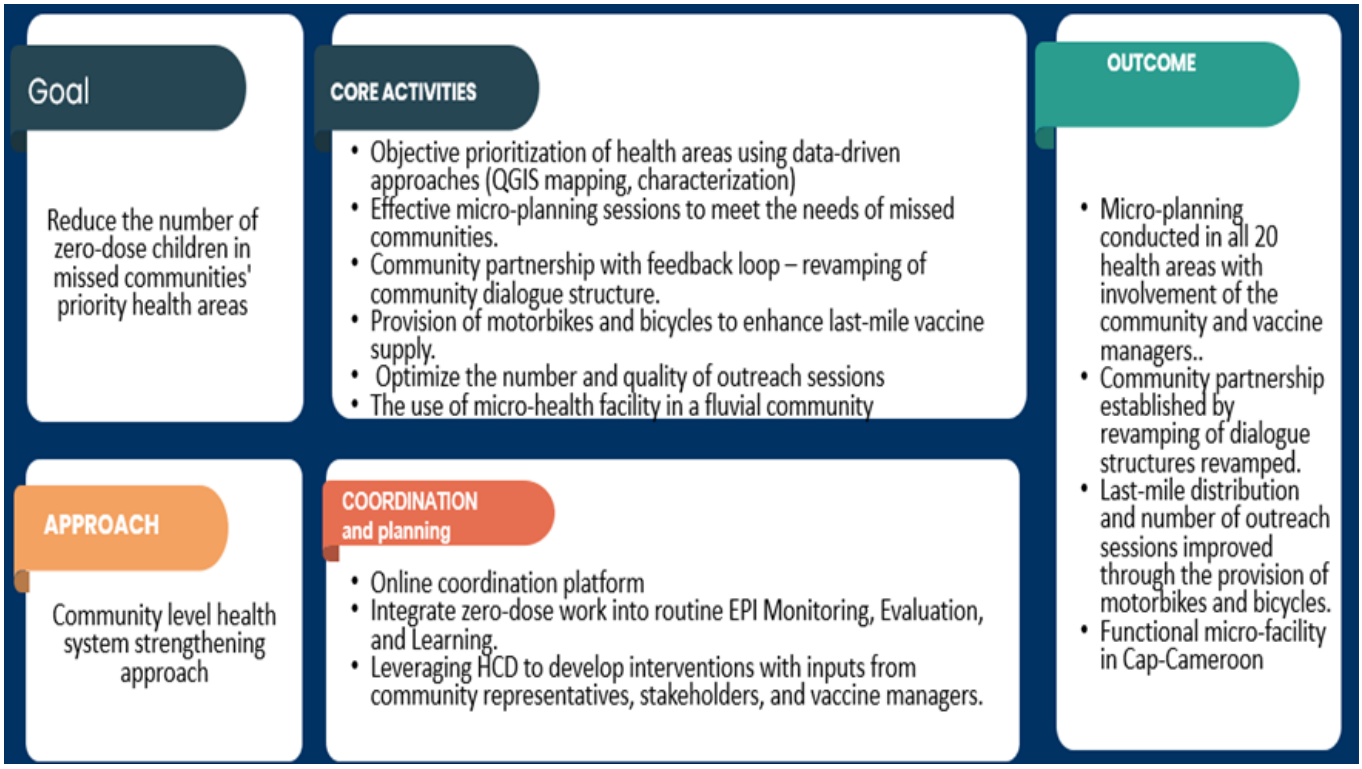


Figure 13: Characteristics of missed communities.

Reaching each of these communities will require context specific strategies that should be developed in consultation with local stakeholders. During this project, 20 health areas with than 500 villages and no existing health facility were selected from a list of 100 priority health areas. In particular, 2 health areas with different characteristics were selected from each of the 10 regions of Cameroon and the decision to limit to 20 health areas was purely driven by insufficient funding to test the interventions. Through consultation with local stakeholders, 7,500 ZDC aged 0-11 months were enumerated. The author then designed a model that was leveraged to deliver vaccines to in each of the identify missed communities (Figure 15). The first core element of the model was the goal of immunizing 7,500 ZDC in the 20 priority health areas. To reach this goal, the following core activities were implemented: i) Prioritization of target health areas using QGIS mapping, ii) conduct of evidence-based microplanning with district staff and community members to established trusted

partnership with the communities, who in turn supported with sensitization and mobilization of the target population. Prior to this, HCD approach was used to jointly developed activities and schedules that are aligned to the culture, tradition, and the key community schedules.

Table 9 Proposed approach for reaching missed communities.



The next step involved designing a context specify last mile logistic system, which will enable vaccines, consumables, and the necessary health personnel to reach these communities. Once this was figured out, some key inputs were provided to each of the 20 health areas. These included provision of vaccine carriers and a transportation means (Bike, bicycles, canoe, donkey) that is appropriate for each operational context. In one fluvial setting, a makeshift micro facility was set up, which now provides integrated primary health care activities (PHC) to over 10,000 inhabitants. The outcome of this intervention is presented in the result section.

4.4.5.2. Interventions to improve RI coverage for key antigens in a conflict zone amidst the COVID-19 pandemic.

In this sub-objective, the author explored the hypothesis that coverage for all antigens can be improved amid the conflict and the ongoing COVID-19 pandemic, without healthcare workers being killed by separatists or contracting COVID-19. First, the author convinced the MoH to set up a taskforce to redress the worsening RI indicators in one of the regions, notably the SW region, with 19 health districts. The taskforce then collaborated with each of the 19 districts to develop realistic microplans that could enable them to deploy vaccines to target communities as well as to children of internally displaced people. The microplans enlisted the vaccines, consumables, human and financial resources as well as personal protective equipment that will be needed to implement three rounds of Periodic intensification of Routine Immunization activities (PIRIs) and the plan was used to mobilized funding from Unicef and the State. In the plans, periods that could interrupt the smooth rollout of the PIRIs were anticipated and the teams refrained from conducting immunization during these periods, such as periods involving major hunting of separatist, trial of arrested separatist and forced imposed lockdowns. The microplans made provisions for the utilization of trusted healthcare workers residing in each community and providing them with online training on all the aspects of the campaigns. Vaccines and consumables were then packed and shipped via local transport in vehicles known to the communities. Upon reception of the vaccines, the trusted community health workers used a combination of approaches as described in the microplans, including door-to-door and outreaches posts in communities as well as sites where IDPs were residing. To mitigate anti-vaccine skepticism, the plan previewed the delivery of other interventions, including mebendazole, Vitamin A and Sulphadoxine-pyrimethamine and tetanus toxoid to pregnant women. The healthcare workers captured data of each of the intervention administered into standard data recording tools, which were then transmitted to the district level for entry into DHIS2. The detailed methodology used for this intervention was published in the British Medical Council Series *Conflict and Health*[68].

4.4.5.3. Interventions to improve the procurement and funding processes of vaccines in Cameroon.

The last intervention tested in this thesis project, was how to address procurement and financing bottlenecks for vaccines in Cameroon. To do this, a high-level meeting was organized, which brought together the key informants who took part in the KII as well as key decision makers in each critical stage of the vaccine procurement process in Cameroon. The findings of the mapping were then presented to the audience in a plenary session. The audience was then asked to deliberate on the findings and propose recommendations that the country could use to ensure adequate budgeting and timely release of funds for vaccine procurement. The recommendations were acted upon and the outcomes, in terms of vaccine fund allocation and released, monitored by the technical working group.

4.5. Data analysis

A combination of approaches was used to analyze the data collected for each objective of thesis. All quantitative data were organized in Excel and cleaned before detailed analysis. For specific objective #1, data on road networks and location of health facilities in Cameroon were combined to a create a polygon of about 1 hour of travel time (walking or driving) to immunizing facilities. The polygons were then overlaid over the GRID settlement maps and geolocation of health facilities to identify locations that laid in the “hard-to-reach zone”, which enabled identification of the so call missed communities, irrespective of population coverage. Next, WorldPop density layers were used to estimate the number of children under 5 living in these areas. Then, data from MoH (shapefiles, geographic boundaries, GIS coordinates and ACLED) were used to categorize these areas as remote rural, urban, slums and conflict zones. Furthermore, DHIS2 data were used to estimate the number of ZDC (those who have not received DTP1) and UIC (those who have not received DTP3) in each administrative unit identified above. Furthermore, QGIS was used to create maps that visually display absolute numbers of ZDC, UIC and MC per location or administrative unit. PowerBI in Excel was

then used to estimate the percentage and absolute number of ZDC and UIC by all administrative levels, in urban, rural and conflict zones as well as percentages and absolute numbers of ZDC and UIC by gender, geographies and conflict zones.

To identify demand and supply side factors contributing to ZDC and UIC, qualitative data obtained from audio recordings during FGDs and KII were transcribed by four masters' students who are familiar with handling of qualitative data. These students were recruited and trained by the PhD candidate on how to go about the transcription as well as coding the transcripts using dedose software. The students independently coded the transcripts according to participant responses to each question and this involved identifying passages of text and applying labels to indicate themes. The author then reviewed the coding together with the coders to agree upon standard themes and codes for the analysis going forward, ensuring inter-coder reliability. The coders and PhD candidate periodically debrief on emergent themes to update the coding list throughout the analytical process. When no additional emergent themes were identified from a sufficiently diverse sample and the code structure was finalized, this final code was applied to all transcripts in a uniform way. Dedoose software was used to facilitate coding and data organization and retrieval. The PhD candidate then interpreted the findings according based on themes suggested by the WHO BeSD framework. The results are presented as a set of key themes and ideas.

For specific objectives #2, summary statistics were used to estimate the impact of the ongoing civil strife on key vaccination indicates in the NW and SW regions. Similarly, summary statistics were used to estimate the outcome of impact of the intervention that was implemented for Specific objective #5. Findings are presented in tables, graphs, and text.

For Specific Objective # 3, the Excel-based tool that was populated with child immunization data from DHIS-2 and the data used to compute the relative differences in immunization coverages, dropout rates, fixed/outreach sessions, and unvaccinated children (no DTP-1) in 2021 versus those of

2019. Focused was paid on variations in access (coverages), utilization (dropouts), service offers (sessions), and zero-dose (unvaccinated) children. A decision aid dashboard - created by applying basic probability formulas on some grouped variables (e.g., access and utilization) - helped to rank facilities and generate user-friendly statements to ease decision-making.

For specific Objective #4, qualitative responses were used to develop a process map for each of the activity in the procurement and financing process for EPI vaccines. The process map conveys the sequence of activities in each step of the process from the point of developing the vaccine forecast to the point when the supply division of Unicef receives funds from the state of Cameroon. This includes the individual steps, activities or tasks that happens within the confines of each of the stakeholders involved in the procurement process.

5. Results

This section presents the findings from the five specific objectives that were investigated.

5.1. Identification and characterization “Zero-Dose Children”, “Under-immunized” and Missed Communities in Cameroon

This specific objective sought to investigate four questions: i) Where are ZDC, UIC and missed communities found in Cameroon; ii) how many of these ZDC and UIC are there; iii) Why are there not vaccinated and iv) what are the contributing factors-both from demand and supply side perspectives. The findings for each of these questions are presented below.

5.1.1. Where are ZDC and UIC found in Cameroon?

Figure 14 shows the regional distribution of ZDC and UIC in Cameroon. As illustrated, ZDC appear to be heavily concentrated in EN and LT regions, with estimates ranging from 22,146 to 26,507 ZDC. These were followed by SW and OU regions, with about 15,387-22,146 ZDC.

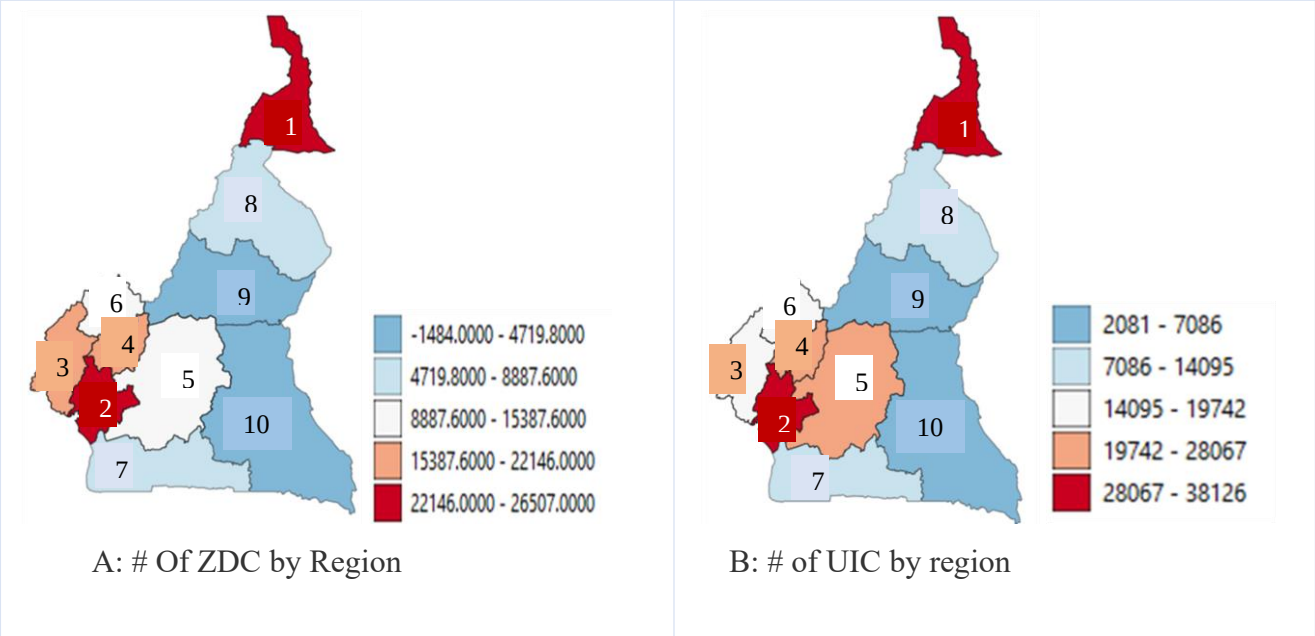


Figure 14: Regional Distribution of ZDC and UIC in Cameroon

1=EN, 2=LT; 3=SW; 4=OU; 5=CE; 6=NW; 7=SU; 8=NO; 9=AD; 10=ES. The dark red color shows regions with heavy concentration of ZDC (A) and UIC (B). As shown in A, the number of ZDC per region ranges from as low as 1,484 in the ES to as high as 26,507 in EN. The same pattern is seen with the absolute number of UIC that ranges from as low as 2,081 in the ES to as high as 38,126 in the FN. However, note that the absolute number of UIC is higher in the CE than in the SW, a pattern which contrast that of ZDC.

Similarly, UIC is heavily concentrated in EN and LT, with numbers ranging from 28,067 to 38,126 UIC. This was closely followed by CE and OU regions, with numbers ranging from 19,742 to 28,067. Other regions, including ES, AD, SU also have significant number of ZDC and UIC.

Figure 15 shows the distribution of ZDC and UIC by health district across the 10 regions. As can be seen, the pattern of distribution of these ZDC and UIC appears to be similar in the country across the 10 regions of the country but their concentration is clearly different from the regional distribution. Overall, there were 17 health districts with heavy concentrations of ZDC (dark red), with numbers ranging from 1,344 to 4,195 ZDC. Similarly, there were 18 districts spread across the national

territory with the number of ZDC ranging from 817 to 1344 ZDC. As shown within the green circles, the number both ZDC and UIC are heavily concentrated in just six regions, namely EN, SW, NW, OU, LT, and SU regions.

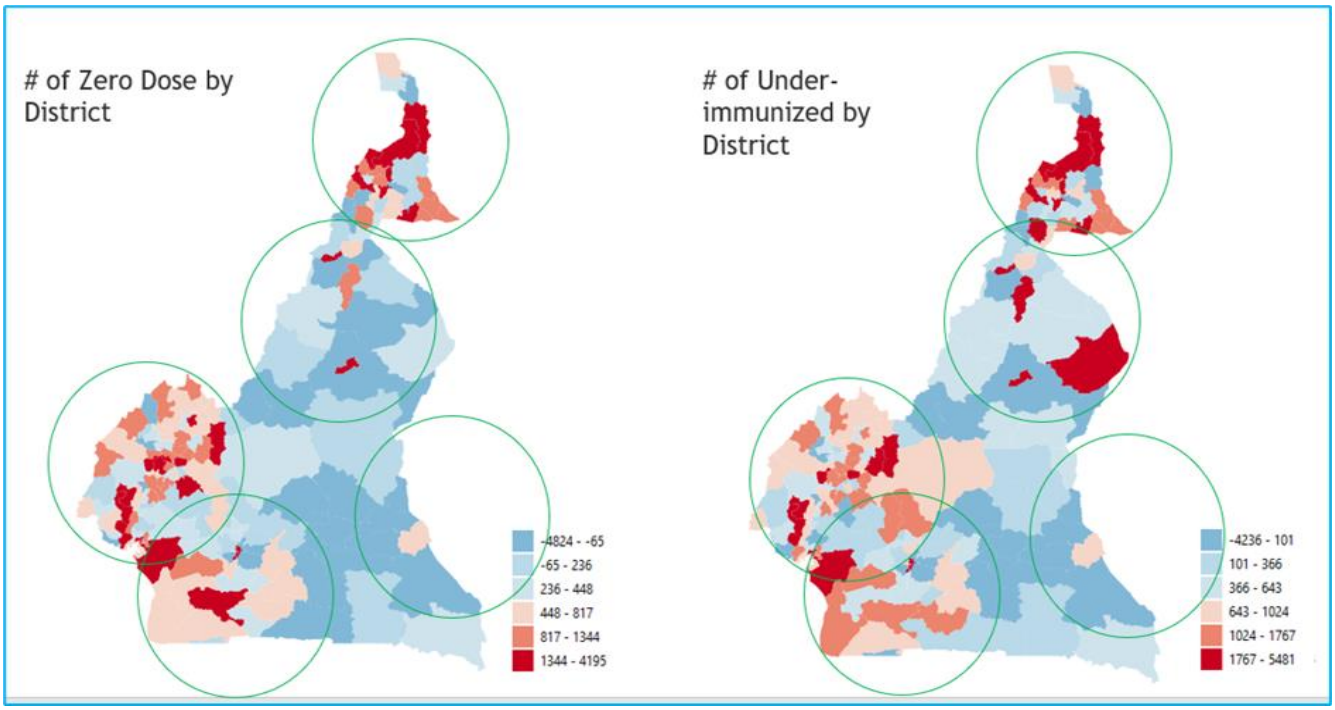


Figure 15: Distribution of ZDC and UIC by health districts within the regions

The figure on the left shows the distribution of ZDC by districts in Cameroon. These children are heavily concentrated in EN, NW, SW, OU, LT and SU. The concerned districts illustrated within the green circles. The figure on the right shows the distribution of UIC by district in Cameroon. As illustrated within the green circles, UIC are heavily concentrated in about 40 districts in 6 regions.

The distribution of UIC by district (figure to the right) follows a somewhat similar pattern to that of ZDC. The only notable difference is one district in the NO, where the number of UIC ranges from 1,767-5,481, which is a sharp contrast when compared to the number of ZDC in the same district (236 to 448).

Figure 16 shows the distribution of ZDC and UIC by health areas (administrative level 4) in Cameroon). Contrary to regional or district distributions, these children a dispersed across numerous health areas and communities in Cameroon. Overall, there are over 200 health with heavy concentration of both ZDC and UIC across the different regions. These health areas are concentrated

in basically all the 10 regions. The estimates in areas of heavy concentrations or hot spots range from 100 to over 3,000 children per health area.

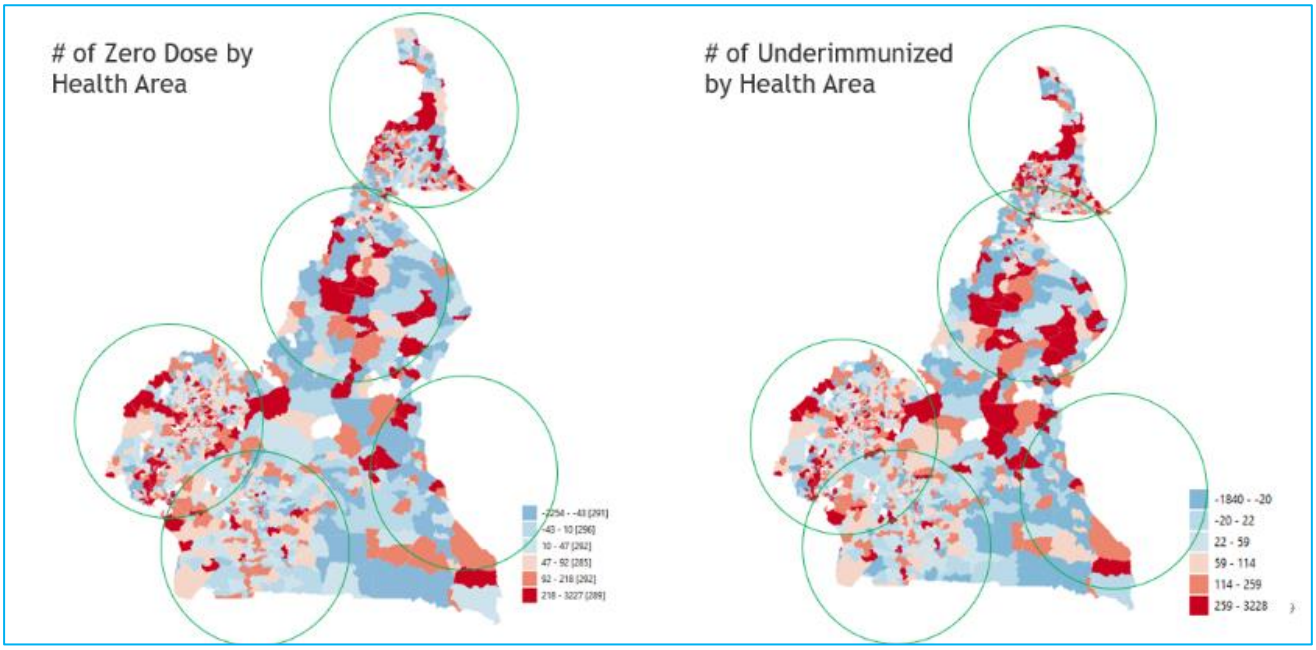


Figure 16: Distribution of ZDC and UIC by health areas (administrative level 4) in Cameroon

The figure on the left shows the distribution of ZDC by health areas in all 10 regions of Cameroon. These children are heavily concentrated in health areas in EN, NW, SW, OU, LT, and SU. The identified health areas are illustrated within the green circles. The figure on the right shows the distribution of UIC by health areas in Cameroon. As illustrated within the green circles, UIC are heavily concentrated in about 200 health areas in 6 Cameroon.

5.1.2. How many of these ZDC and UIC are there?

Table 9 presents the distribution of ZDC and UIC by region in terms of absolute numbers. As illustrated, the estimated total absolute numbers of ZDC and UIC in Cameroon in 2021 were 128,614 and 180,520, respectively. The analyses also suggest that LT region had the highest number of ZDC (n=26,507), followed by EN (n=26,142) and the OU (n=21,147) regions. In contrast, EN had the highest number of UIC (n=38,126), followed by LT (n=31,414) then OU (n=27,230). The Centre region also had a high number of UIC (n=22,252).

Table 10: Repartition of ZDC and UIC by region in Cameroon

Region	Infant population	Zero Dose	Under Immunized
Region Littoral	107974	26507	31414
Region Extreme Nord	225857	26142	38126
Region Ouest	95697	21147	27230
Region Sud Ouest	55959	17232	18068
Region Nord Ouest	59118	14158	15275
Region Centre	139461	10648	22252
Region Nord	130305	6247	12326
Region Sud	26416	5194	7228
Region Adamaoua	57827	2823	6520
Region Est	44502	-1484	2081
Total	943116	128614	180520

Figure 17 presents the distribution of the proportion of ZDC and UIC with respect to the EPI target population of each region. As shown, the fraction of ZDC and UIC in terms of the total EPI target population for the regions is highest in SW region, followed by LT.

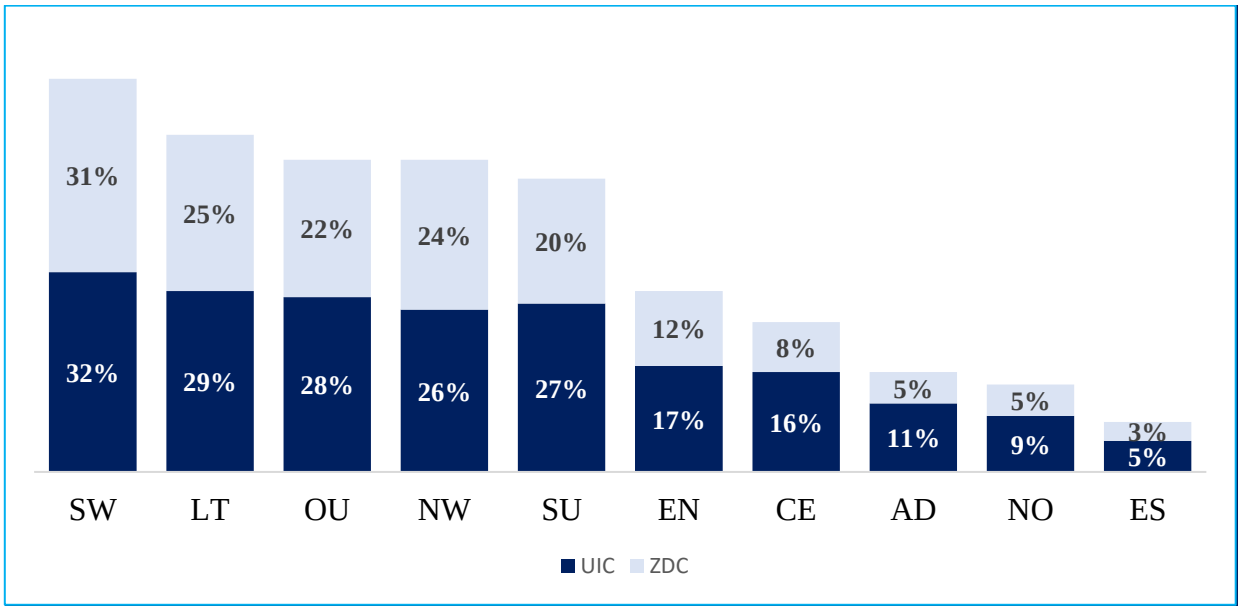


Figure 17: Distribution of the proportion of ZDC and UIC by region in function of birth infant population

A schematic representation showing the proportion of ZDC and UIC across the 10 regions of the country. SW- South West Region, LT=Littoral, OU=West, NW=Northwest, SU=South, EN=Far North, CE=Centre, AD, NO=North. ES=East.

In other words, 32% of the 55, 959 estimated EPI target for the SW region is under-immunized or hasn't received DPT-3. Similarly, 31% of the EPI target in this region has not received DPT-1 and as such considered as ZDC. It should be noted that despite having higher absolute numbers, the proportion of UIC or ZDC in EN, OU and CE are lower compared to other regions.

Table 11 presents the ranking of districts based on the absolute number of ZDC and UIC. Given the limited resources, designing, and implementing targeted interventions in these 42 districts may result into a >50% reduction in ZDC and UIC in Cameroon.

Table 11: Districts to prioritize for intervention to achieve >50% reduction in ZDC and UIC

District	Infant population	ZeroDose	UnderImmunized
District Deido	14421	4195	4613
District Ngaoundere Urbain	15443	4193	5048
District Mifi	18137	4063	5481
District Djoungolo	15613	4027	5304
District Boko	8417	3876	3800
District Nkolndongo	11432	3633	4734
District Cite Verte	11317	3569	4496
District Kousseri	20713	3303	2987
District Efoulan	11512	3066	3217
District Garoua II	13995	3057	3245
District Fontem	3767	2957	2929
District Konye	3996	2633	2608
District Maroua 1	9198	2524	2891
District Muyuka	3484	2504	2492
District Bamenda 3	6217	2443	2239
District Bonassama	12793	2211	2780
District New Bell	8548	2119	2992
District Edea	5352	2061	2447
District Mora	14091	1861	4181
District Kolofata	5627	1746	2538
District Kumbo West	3356	1698	1754
District Dschang	9778	1685	1370
District Mokolo	13813	1679	1873
District Maroua 2	9505	1599	1903
District Mozogo	3996	1556	1830
District Batcham	3729	1548	1743
District Tiko	4648	1542	1674
District Malantouen	6161	1498	2447
District Ebolowa	6889	1485	1767
District Bangangte	4896	1474	1718
District Belabo	3961	1426	2014
District Garoua I	12832	1407	1819
District Logbaba	6301	1405	1984
District Kumba-South	7281	1363	1808
District Guidiguis	8442	1350	2305
District Nylon	10418	1332	1767
District Vele	7183	1283	1522
District Cite Des Palmiers	7835	1282	1639
District Ndop	5962	1247	1217
District Nkongsamba	3557	1229	1450
District Kar Hay	6349	1224	1403
District Eseka	2877	1222	1279
District Guider	10828	1202	1827
Total	943116	128614	180520

5.1.3. Why are there not vaccinated?

The next important sub-objective was to explore why ZDC are unvaccinated and UIC have not completed their vaccination series. To respond to this, the WHO BeSD framework was leveraged to explore the why under four main themes of the framework:

5.1.3.1.Thinking and Feeling About Vaccines:

Although most participants strongly agreed that vaccines play an important role in disease prevention, many expressed distrust in vaccine safety, citing reasons such as the fear of post-vaccination fever, diseases, sterility, and deaths. This is reflected in the comment made by a mother in a rural community in the East region: "It makes the child hot... you come to give diseases to children." More specifically for urban settings, inhabitants in slums face a lot of hardship and poverty, making vaccination the least of their priorities. Also, they fear possible catastrophic spending or loss of life resulting from the side-effect of vaccines. A breadwinner of a family in an urban health area in the Littoral Region expressed his worry:

"Directly we say no to vaccine. We don't say no because we don't want to [be vaccinated], but we say to ourselves if something serious happens again. I can't even eat well at first, if they put another disease in my body, how am I going to do? Am I going to be able to get through this?"

Similarly, some women indicated that they do not vaccinate their children because they feel that vaccines are unsafe, which is why they are offered free while treatment for other illnesses like malaria are expensive and effective. This was noted during FGD in an urban settlement in the West Region: *"I said, and I repeat, that many parents in the district currently refuse vaccination. They ask why vaccines are free, but we cannot lower the cost of essential care..." A* mother explained. *"There is nothing here in Cameroon that we do for free; when it is already free, it means that there is something abnormal."* Another woman concluded.

5.1.3.2. Social processes

To better understand how social processes affect vaccination uptake in missed communities, the results are discussed under two sub-themes: family and social norms, and gender issues.

Family and social norms

Most participants reported that their family members and acquaintances supported the vaccination of their child; however, some family members were against vaccinating children, particularly in urban areas. This trend was also observed when assessing whether religious and community leaders supported vaccination. However, the number of participants who admitted that religious and community leaders were against vaccination was comparatively higher than those who agreed that family members did not support vaccination. This is an important finding as it emphasizes the need to sensitize community and religious leaders, especially in urban areas.

In the Northern regions, the decision to vaccinate children in the community mostly lies in the hands of the chief, his notables, and older men in families. They are usually highly respected, and their culture demands that their instructions be followed. Also, in a rural area in the Northern region, a healthcare provider explained that the role of church leaders in vaccine hesitancy is glaring in these missed communities. Another explained that Christians in these churches refuse vaccines because they believe that God protects their children. The key issue raised during in-depth interviews with healthcare workers was the frequently changing policies of these churches on vaccination issues. This is a significant finding given that the predominant religion here is Islam, making it easy to overlook the involvement of church leaders in vaccination programs in these Northern regions.

Generally, in urban settings, schools serve as an important vaccination post. However, teachers and school managers have had ugly experiences, with parents retaliating over the vaccination of their children, especially without formal consent. As a result, teachers and school directors systematically

refuse school-based vaccination. Moreso, they have the misconception that childhood vaccines now include the COVID-19 vaccine, which they consider unsafe.

The situation in settings like Mabanda (an urban health area, Littoral Region) is even more complex as parents are often unavailable during the day in search of daily bread. To meet their busy schedules, they leave the children at home with their grandmothers. Unfortunately, most grandmothers are elderly, uneducated, and grew up without vaccines, making them hesitant to childhood vaccination. Moreso, they are traditionally missed during sensitization programs. This poses a significant problem because grandmothers do not trust vaccines and hide children during door-to-door vaccination sessions. This issue was summarized during FGD by a father in *Mabanda* who said:

Grandmothers are the ones who live in the house. But they grew up without knowing vaccines, so they run away with their grandchildren during vaccination programs. They say that the child can grow up like that without vaccines, so that's why many children don't take the vaccine in this neighborhood.

An interesting finding was that traditional healers had a role in influencing vaccination uptake in urban settlements, while churches gravely contribute to vaccine hesitancy in rural areas. A father in one setting explained that a known case of poliomyelitis refused vaccination services because of the instructions of a traditional healer never to accept vaccines and any injectable medications.

A critical finding that cut across the different study settings was a recommendation by participants that children of community leaders be vaccinated in public to increase vaccination demand by community members. *"Because when a block leader is vaccinated, his notable is vaccinated, the wives follow, the children follow, the rest of the community will accept vaccination," o*ne of the healthcare workers in Mambanda explained.

Gender issues

The key indicator that used to assess the autonomy of mothers to vaccinate their children was whether they needed to obtain permission from the male folk each time there is a need to vaccinate a child. It was clear during the FDGs that many women needed permission from their husbands for their children to be vaccinated, a practice that was well engrained in AD, EN, NO. In these regions, the decision to vaccinate the child comes from the man, who is the head and the person who must be contacted before vaccination sessions. This was obvious from the articulation of one traditional ruler.

> *"…he is also responsible for informing the wife about vaccination programs if he dims it necessary… [as] he is the one who manages his family just the way I manage everyone. So, when I want to contact the family, we [chief and his notables] talk to the father of the family before he translates to his wife."*

Despite this, no gender-related disparities influence vaccination preferences for male or female children. Once permission is given by the husbands, mothers are responsible for taking their children for vaccination. Indeed, men who take their children for vaccination are considered weak and mocked for doing a woman's job as posited by one healthcare worker:

> *"The tradition and the customs of the village make fun of the fathers who come with the children to the hospital. Here, if you do something that your wife should do, they say that your wife has got you, she has the upper hand, and then they make fun of you. Except in case of illness where, if the father is present, he will take the mother and child to the hospital."*

Also, there are restrictions on women's movement, making home-based vaccination a preference in most communities. However, the gender of the health personnel responsible for vaccine-related activities is vital in such settings. A female healthcare provider can go everywhere, but a male will face some hindrances to vaccinating in communities because they consider vaccines to be a "woman's thing" and should be addressed by women. *"Yes, in some communities, we prefer female community*

health workers because the woman can go anywhere while the man often it is difficult in this community." A health care work explained.

Like the findings in the Northern regions, women are responsible for the vaccination of children in households in other settings. However, in these settings, women have heavy workloads that make remembering or respecting vaccination schedules difficult. Unlike in the Northern regions, they are required to perform numerous societal and family roles daily, making them unavailable to take their children for routine vaccination as beautifully captured by one woman in the west region.

> *"It can also be the lack of time; moms are so overloaded, they have to take care of household chores, multiple children; in the end, we postpone [vaccination] every time until we forget."*

The observation that many women require authorization from their husbands to vaccinate their children can pose a significant problem, particularly in instances where the fathers is against vaccination. Interestingly, some women have figured ways on how to navigate this situation- they do so in hiding because they are cognizant of the potential implications of not getting their children vaccinated. *"As in my case, I go to vaccinate the children and even my grandson; I don't wait for the authorization because if he gets sick, I am the one who will take the child to the hospital."* A woman in the East Region explained.

5.1.3.3. Motivation

The two main demotivating factors for vaccination that cut across the different settings are difficult access to health facilities and long waiting times at the health facility. Other factors identified during FGDs and KII were primarily around vaccine trust and were similar in crisis zones, rural, and urban settings. To give a snapshot of valuable information learned from the study, the results are presented in sub-themes as follows:

Vaccine distrust

One important misconception among the elderly in communities in the Northern regions was a fear that that vaccines can *"brainwash"* children to render them dishonest. To corroborate this point, a health worker in the Northern region posited that *"…they run away, so they don't uninstall their children's brains, sharing the misconception that their children will become dishonest if they are vaccinated."* The fear of vaccine side effects heightens when many vaccines are offered simultaneously, especially during vaccination campaigns. *"Well... I sometimes have reservations about multiple vaccines coming in at the same time. So, there is a lot of reluctance because we wondered how do you line up one vaccine, and just a week later you line up another?"* a participant emphasized.

Effect of COVID-19 on routine immunization

The media, including social media and television, has propagated false information using dead cases to demonstrate the negative effect of COVID-19 vaccination. The spillover effect of COVID-19 vaccine hesitancy to childhood immunization is quite evident in most communities as they feel that the routine childhood vaccines now contain the COVID-19 antigen. *"It's even Covid that has made other vaccines lose their value."* A healthcare worker in the East region explained. A mother in an urban area in the Littoral region shared what she saw on the media: *"We saw on the television the people who took the vaccine and then died."*

Effect of non-vaccination of healthcare personnel and their families during Campaigns

Healthcare personnel's refusal to vaccinate their children or themselves during campaigns fueled vaccine hesitancy in the community. "*So, the neighbors are there, and they're asking that, "you didn't vaccinate at the Doctor's there, but you want us to vaccinate at our house?"* A father in Mabanda, Littoral Region, cited an example.

5.1.3.4.Practical issues

The spillover effect of the cost of other health services on vaccination uptake

In urban settings, most participants consider PHC services to be expensive. This has gravely affected the usage of health facilities, consequently affecting vaccination uptake. Parents would rather go after other activities that will give them money than take children for vaccination. A father explained that vaccination uptake would increase if it were accompanied by food distribution: "*If we say that there is awareness there, then there is a buffet; all Mambanda will come out. Even if we say there is only a sandwich. They will come out!"* This finding is similar in some rural areas such as Yagoua, as explained by a healthcare worker: "When I ask them why they don't want to vaccinate their children? They only respond by saying, *"We rather need money. We need food."*

Unlike in urban settings, most participants in rural areas considered health care to be affordable. However, communities in crisis zones who have benefitted from several free healthcare services for a long time expect every health service to be free. As a result, utilization of health facilities is poor irrespective of the cost as long as it is charged for a fee. This may have affected the demand for vaccination services, as explained by a healthcare worker in a crisis zone in the Northern part of the country:

"Because of the insecurity, NGOs that come here give them rice and other food items... [even when offering free health services], they have gotten used to receiving free services. So, when a health personnel arrives perhaps for a service [they will be hoping for free services], but when we say no, it is for this fee, ah they take it differently."

Lack of trust in health facilities and health personnel

Although most respondents expressed trust in health personnel, a significant number, especially in urban settings, expressed general distrust in the capacity of health facilities to offer needed care.

Moreso, they believe most vaccinators during campaigns are unskilled. *"You can't see a man at the bar drinking with people, and then the next day he'll come to vaccinate; it's no longer a question of health, there's no longer any trust."* A father in the Littoral region explained.

Many existing private health facilities are non-vaccinating.

Participants in urban settings explained that most community members prefer private health facilities. This is the case in one health area, where they prefer private health facilities because they are relatively more welcoming even though they are less equipped. However, this poses a problem as most private facilities do not offer vaccination services.

Timing, frequency, and duration of vaccination in facilities are not favorable.

Some facilities do not vaccinate children at birth – instead, they wait for vaccination days. This is the case in a rural community in the East region of Cameroon. *"They only give vitamins when you have just given birth. They say that nothing else will be given since the delivery was void of complications,"* mothers explained during FGD.

Although vaccination frequency could be once in two to three months, the time given for vaccination sessions is short; latecomers are sent home. *"No, they are not going to receive you; you are not even going to find the people maybe they will have gone to the nearby village,"* mothers in a rural setting in the East region shared their frustration.

Sub-optimal sensitization

Sensitization is done only during vaccination campaigns and is irregular. Participants considered the sessions to be too short and insufficient. *"But if it's not a campaign, I don't think they're doing any awareness beforehand. So, that's to say that it's not even getting through, and people are not informed about what vaccination is,"* a father in the Littoral region explained.

Long queues and slow vaccination progress are discouraging factors, especially for women. *"it's so slow; I don't know if we can improve,"* a mother in Littoral Region suggested.

5.2. Impact of COVID-19 on vaccination coverage in Cameroon

The Excel-based tool that was developed helped to measure the impact of COVID-19 on key vaccine indicators at facility, district, and regional levels. A snapshot of the tool is provided in Figure 19. The tool enabled ease use of DHIS2 to measure drop in access to immunization service (defined as a decrease in DPT1 or PENTA), a drop in utilization of immunization services (defined as an increase between the difference between DTP1 and DPT3, a drop in facility services (mainly fixed-post

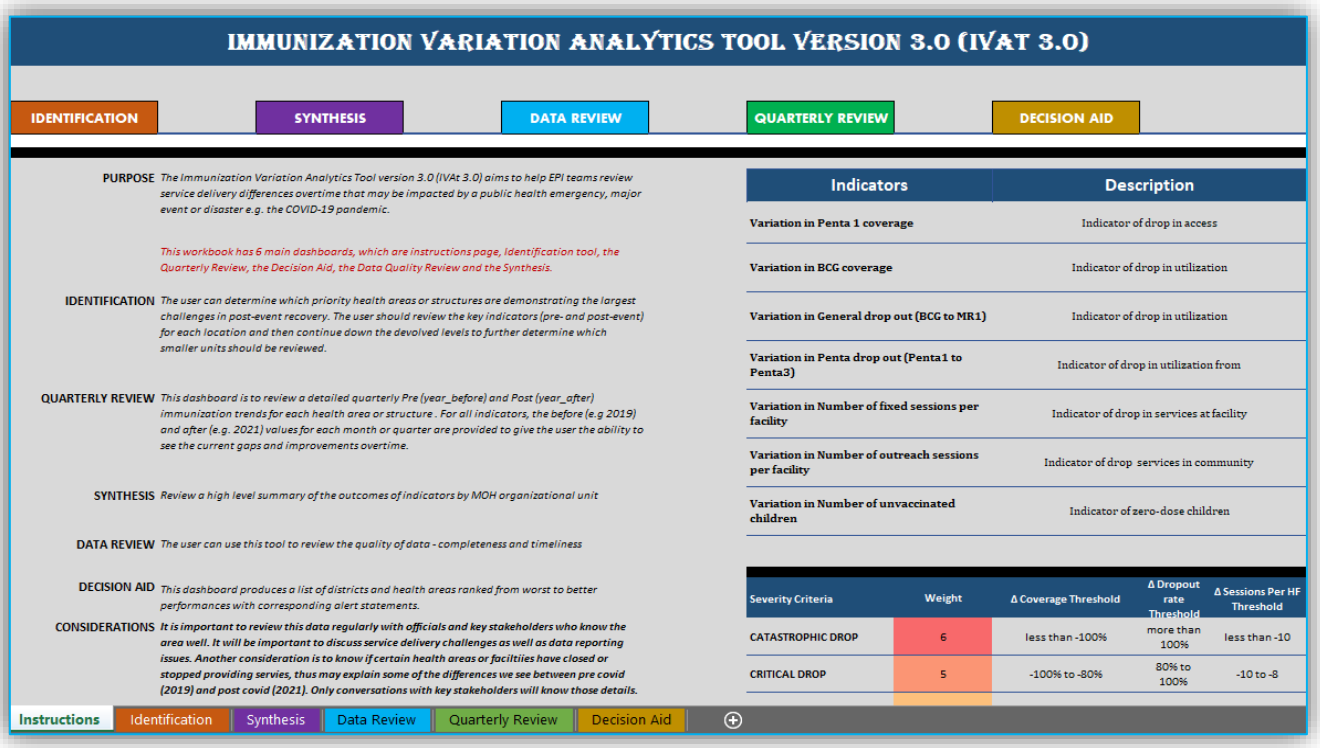


Figure 18: Snapshot of the Excel-based tool to track impact of COVID-19 on Key RI indicators.

immunization services), a drop in community services (mainly immunization outreaches) and an increase in ZDC between pre-COVID-19 period in 2019 and 2022. Overall, the tool was used to extract data from 3,669 facilities, 1,797 health areas, and 197 districts.

Table 12 presents estimates regarding the drop of key immunization indicators in 3,669 facilities across the ten regions of Cameroon between 1st January 2019 and December 31st, 2021.

Table 12: Estimation of the drop in key immunization indicators at facility level by region

Region	Total HFs	Drop in Access n (%)	Drop in Utilization n (%)	Drop-in Facility Services n (%)	Drop-in Community Services, n (%)
AD	168	57 (34)	76 (45)	51 (30)	45 (27)
CE	914	508 (56)	327 (36)	318 (35)	148 (16)
ES	224	98 (44)	108 (48)	67 (30)	56 (25)
EN	334	115 (34)	168 (50)	106 (32)	98 (29)
LT	485	228 (47)	178 (37)	195 (40)	37 (8)
NO	253	94 (37)	106 (42)	84 (33)	66 (26)
NW	305	119 (39)	98 (32)	96 (31)	41 (13)
OU	615	290 (47)	245 (40)	209 (34)	61 (10)
SU	203	112 (55)	88 (43)	76 (37)	54 (27)
SW	168	50 (30)	46 (27)	39 (23)	14 (8)
Total	**3,669**	**1,671 (42)**	**1,440 (40)**	**1,241 (33)**	**620 (19)**

As shown, there was an overall decrease in access by 42% between 2019 and 2021- that is the number of facilities that delivered at least a of dose of DPT1 to children. Regional variations ranged from 30% of facilities in the SW to 56% in the CE. Similar trend was observed for utilization of immunization services (defined as the difference between DPTI and DPT-3). Overall, 40% of facilities experienced a drop in utilization, with regional variations that ranged from 27% of facilities in the SW to 50% of facilities in EN. Likewise, similar trends were observed in the execution of fixed-post immunizations (Facility services) and Outreaches (community services). Overall, facilities offering fixed-post immunization dropped by 33% while those offering outreaches dropped by 19%. A similar drop in all variables of interest was observed in the 1,797 assessed health areas as illustrated in Table 13. Overall, Access dropped in 47% of health areas, Utilization in 44% of health areas,

Fixed-post immunization in 28% of health areas and outreaches (community services) in 25% of health areas. At the same time, the number of ZDC increased in nearly half (48%) of the 1,797 health areas. The regional variations of these variables are also presented in the Table.

Table 13: Estimation of the drop in key immunization indicators at health area level by region

Region	Total Health Areas	Drop in Access	Drop in Utilization	Drop-in Facility Services	Drop-in Community Services	Increase in ZDC
AD	79	31 (39)	33 (42)	26 (33)	23 (29)	43 (54)
CE	284	192 (68)	111 (39)	102 (26)	121 (43)	80 (28)
ES	113	58 (51)	51 (45)	31 (27)	32 (28)	53 (47)
EN	300	117 (39)	140 (47)	89 (30)	82 (27)	163 (54)
LT	186	112 (60)	69 (37)	60 (32)	33 (18)	61 (33)
NO	146	68 (47)	82 (56)	51 (35)	31 (21)	75 (51)
NW	233	50 (21)	96 (41)	63 (27)	36 (15)	182 (78)
OU	235	143 (61)	122 (52)	68 (29)	59 (25)	80 (34)
SU	104	66 (63)	50 (48)	22 (21)	41 (39)	34 (33)
SW	117	26 (22)	41 (35)	15 (13)	6 (5)	78 (67)
Total	**1,797**	**863 (47)**	**795 (44)**	**527 (28)**	**464 (25)**	**849 (48)**

And last, but not least, variations of key indicators of interest at district level were assessed and the findings are presented Table 13. Worth noting is that the total number of districts in Cameroon increased from 189 in 2019 to 197 in 2021. Indeed, 8 new districts were created by splitting some districts to improve on the implementation and coordination of health activities in districts that have witnessed a massive increase in their populations. As can be seen from the table, Access and Utilization dropped in over 50% of the districts between 2019 and 2021. The number districts offering

fixed-post immunizations and outreaches dropped by 11% and 24% respectively. Furthermore, nearly half (49%) of the country's 197 districts experienced an increased in the number of ZDC.

Table 14: Estimation of the drop in key immunization indicators at district level by region

Region	Total Districts	Drop in Access n (%)	Drop in Utilization n (%)	Drop-in Facility Services n (%)	Drop-in Community Services n (%)	Increase in ZDC n (%)
AD	10	5 (50)	6 (60)	0 (0)	1 (10)	5 (50)
CE	32	24 (75)	7 (22)	8 (25)	12 (38)	7 (22)
ES	15	6 (40)	6 (40)	0 (0)	5 (33)	9 (60)
EN	32	13 (41)	16 (50)	5 (16)	5 (16)	20 (63)
LT	24	19 (79)	9 (38)	7 (29)	10 (42)	4 (17)
NO	15	7 (47)	13 (87)	1 (7)	1 (7)	8 (53)
NW	20	3 (15)	12 (60)	3 (15)	2 (10)	18 (90)
OU	20	15 (75)	14 (70)	0 (0)	9 (45)	5 (25)
SU	10	8 (80)	5 (50)	1 (10)	3 (30)	2 (20)
SW	19	2 (11)	9 (47)	1 (5)	1 (5)	17 (89)
Total	**197**	**102 (51)**	**97 (52)**	**26 (11)**	**49 (24)**	**95 (49)**

5.3. Effect of the ongoing armed conflict in the NW and SW regions on key immunization outcomes

To achieve this specific objective #3, we measured the effect of the ongoing armed conflict in NW and SW regions on key immunization outcomes in Cameroon. We focused on how the conflict has affected the coverage for three tracer vaccines, namely BCG, DPT-3, and MR. We also assessed how the conflict has affected geographic equity in immunization and other immunization variables such as functioning of health facilities and availability of health workers in the two crises regions between 2016, when the conflict erupted and 2019- just prior to another disrupter, the COVID-19 pandemic.

5.3.1. Effect of conflict on tracer vaccines

Figure 20 shows the effect of the conflict on three tracer vaccines in the two regions. As shown, coverage rates for these tracer vaccines plummeted between 2016 and 2019. The declined ranged from 22 % for BCG in the NW region to 42% for DPT-3 in the SW region. Similar observations ere made for other vaccines not displayed in the diagram, including, OPV, Rota and PCV-13 amongst others. For example, vaccination coverage for PCV-13 in the NW declined by 28%, dropping from 71% in 2016 to 43% in 2019. Likewise, coverage rate for IPV slumped by 27%., dropping from 70% in 2016 to 43% in 2019. Like in the NW region, coverage rates for these vaccines also witnessed a significant declined in the SW region. For instance, coverage for IPV declined by 40%, falling from 87% in 2016 to 47% in 2019. Similarly, coverage rate for PCV-13 plummeted by 41%, falling 88 in 2016 to 47% in 2019, likewise that for Rotarix-2, which fell by 38%, dropping from 87% in 2016 to 49% in 2019.

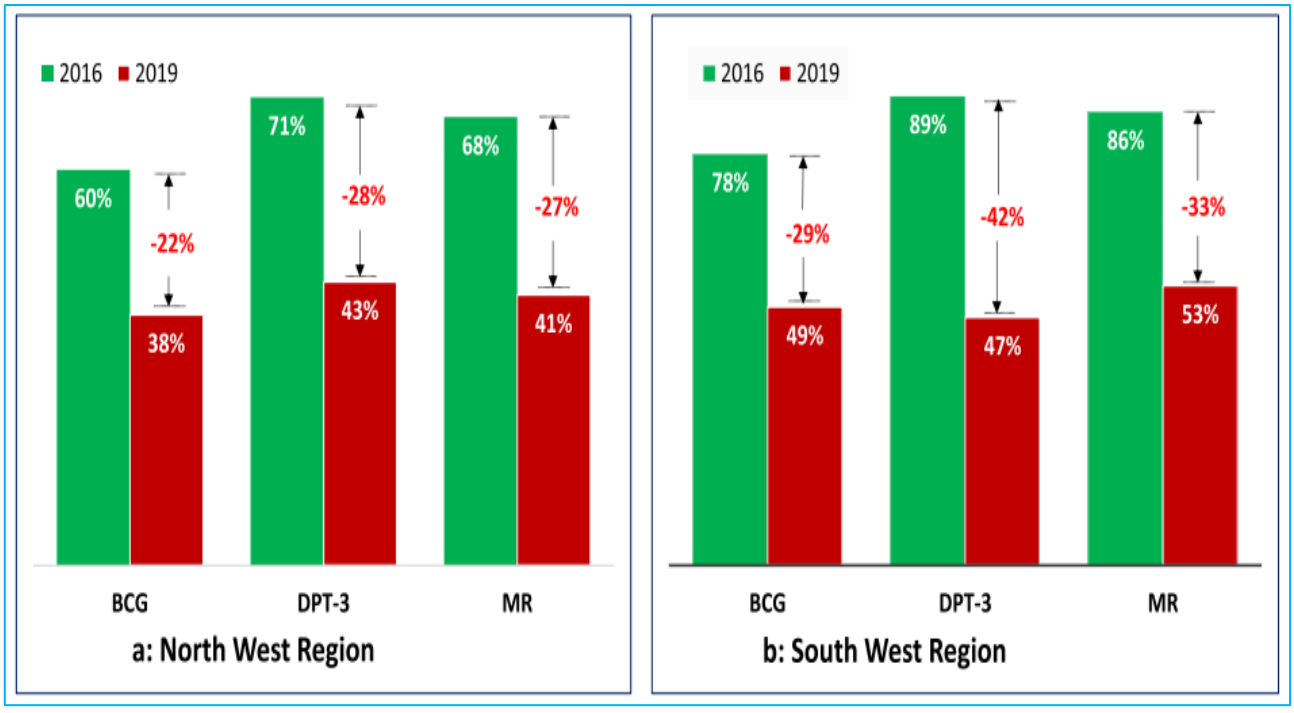


Figure 19: The Effect of the conflict on the coverage rates for three tracer vaccines in the NW & SW

The two graphs illustrate the percentage of the total vaccination coverage for three tracer antigens (BCG, DTC-3 and MR) for the NW (A) & SW (B) in 2016 and 2019. The bars color corresponds to the year whose coverage is represented for each of the vaccines presented. The gap whose value is represented in red indicates the absolute difference between the 2016 and 2019 vaccination coverages for each of the vaccines.

5.3.2. Effect of conflict on geographic equity

Table 15 presents a comparison of the trends in immunization coverage the three tracer vaccines (BCG, DPT-3, and MR) during the study period 2016 and 2019. As illustrated, nearly 80% of districts in the NW had registered VC rates for these tracer vaccines of over 80%; however, less than 15% of these districts attained a coverage rate of at least 80% for these vaccines in 2019. Indeed, about 3 in 4 districts registered coverage rates below 40%, and almost two-fifth (39%) of these districts had coverages below 20%. A comparable trend was noted for the SW region, even though the coverages rates were lower in 2016 compared to their NW counterparts.

Table 15: Trends in vaccination coverage (VC) in the NW & SW regions

	North West Region				South West Region			
	2016	2017	2018	2019	2016	2017	2018	2019
BCG								
District with VC < 20%, n (%)	0 (0)	0 (0)	0 (0)	7(37)	0(0)	0(0)	2(11)	7(39)
District with 20% < = VC < 40%, n (%)	0 (0)	0 (0)	3(16)	6(32)	0(0)	2(11)	5(28)	5(28)
District with 40% <= VC < 60%, n (%)	0 (0)	6(32)	9(47)	2(11)	0(0)	1(6)	6(33)	2(11)
District with 60% <= VC <80%, n (%)	4 (21)	8(42)	7(37)	2(11)	4(22)	5(28)	1(6)	2(11)
Districts with VC >=80%, n (%)	15 (79)	5(26)	0(0)	2(11)	14(78)	12(67)	4(22)	2(11)
DPT-3								
District with VC < 20%, n (%)	0 (0)	0(0)	0(0)	8 (42)	0(0)	0(0)	2(11)	3 (17)
District with 20% < = VC < 40%, *n (%)*	0 (0)	0(0)	3(16)	5 (26)	0(0)	1(6)	5(28)	9 (50)
District with 40% <= VC < 60%, *n (%)*	0 (0)	2(11)	8(42)	1 (5)	0(0)	1(6)	6(33)	3 (17)
District with 60% <= VC <80%, n (%)	3 (22)	8(42)	8(42)	4 (21)	3(17)	2(11)	1(6)	3 (17)
Districts with VC >=80%, *n (%)*	15 (76)	9(47)	0(0)	1 (5)	15(83)	14(78)	4(22)	0 (0)
Measles Rubella Vaccine (MR)								
District with VC < 20%, *n (%)*	0 (0)	0(0)	0(0)	7 (37)	0(0)	0(0)	2(11)	7(39)
District with 20% < = VC < 40%, *n (%)*	0 (0)	0(0)	4(21)	5 (26)	0(0)	2(11)	6(33)	5(28)
District with 40% <= VC < 60%, *n (%)*	1 (6)	2(11)	9(47)	2(11)	1(6)	0(0)	4(22)	1(6)
District with 60% <= VC <80%, *n (%)*	3 (17)	10(53)	6(32)	3 (16)	3(17)	3(17)	2(11)	3(17)
Districts with VC >=80%, *n (%)*	14 (78)	7(37)	0(0)	2 (11)	14(78)	13(72)	4(22)	2(11)

The table depicts the evolution VC the surveyed districts of in NW & SW from 2016 to 2019 for the three tracer antigens. The absolute numbers (n) indicate the number of districts per region whose coverage fall within the respective coverage ranges for each of the vaccines. In brackets are the percentages obtained from the denominator of 19 health districts for the northwest and 18 for the SW. BCG Bacillus Calmette-Guerin, DPT-3 Third dose of Diphtheria, Pertussis and Tetanus containing vaccines, MR Measles Rubella Vaccine, VC Vaccination Coverage

Table 15 also shows that, in 2016, less than 16% of district in the SW had a coverage of over 80%; however, no district attained this rate for any of the tracer vaccine in 2019. Over half (50%) of the districts in this region registered coverages below 50% for these tracer vaccines. The same trend was observed for other vaccines not shown in the table.

5.3.3. Effect of the conflict on other immunization variables

Figure 20 depicts the effect of the crisis on the functioning of immunizing health facilities in both regions. As illustrated, the number of immunizing facilities witnessed a dramatic declined between 2016 and 2019. This decline ranged from 30% in the NW to 53% in the SW.

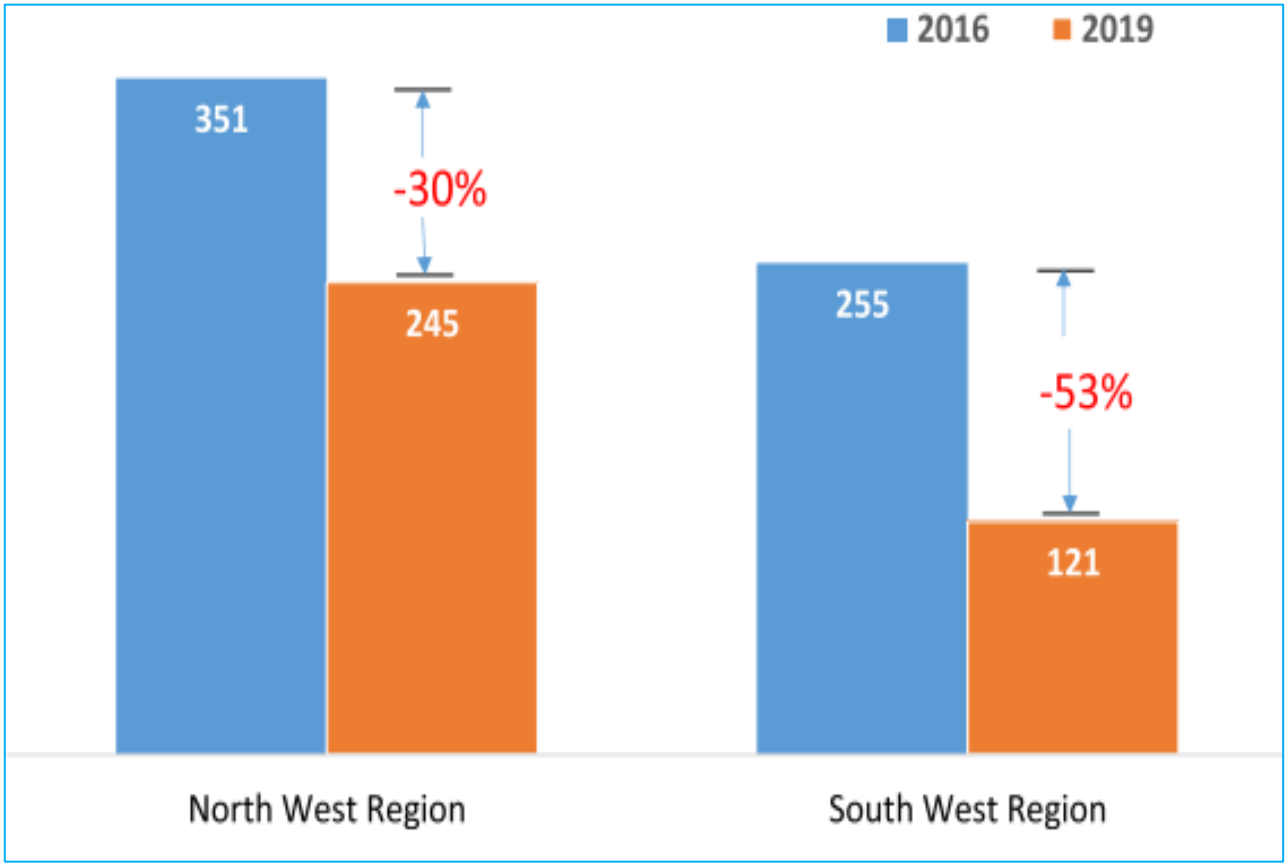


Figure 20: Effect of the conflict on the functioning of vaccinating facilities

The drop in the total number of vaccinating health facilities in NW & SW between 2016 and 2019. The color of each bar corresponds to the year whose number of functional health facilities are represented by the bar. The gap whose value is represented in red indicates the percentage drop in the number of functional health facilities for the respective regions between 2016 and 2019. This gap is obtained by dividing the number of vaccinating health facilities that were no longer functional after 2016 by the number of functional vaccinating health facilities in the respective regions in 2016.

Overall, 26 facilities were destroyed in the SW. In addition, 128 facilities in this region as well as 106 facilities in the NW were closed because of the growing levels of insecurity. As of December 2021, a total of 11 HCW were brutally murdered, and this incident pushed several other HCW to abandon their duty stations. Taken together, these factors, negatively impacted other key immunization functions, including disruption of vaccine supply chains as well as submitting standard EPI reports to higher levels. For example, by December 2019, less than 10% of facilities in these regions submitted their monthly reports, largely due to disruption of the reporting system, including lack of staff to complete reports, lack of standard forms and lack of internet to transmit these reports. In the same vein, significant disruptions were observed with immunization service delivery. In the NW, the percentage of fixed-post immunization sessions fell from 8,947 sessions in 2016 to 6,523 in 2019, representing decline of nearly 30%. Outreaches also dropped by 75%, dropping from 8,362 sessions in 2016 to only 2,092 in 2019. Similar trends were observed the SW, with fixed-post sessions and outreaches dropping by 46% and 65%, respectively during the study period.

5.4. Overview of procurement and financing processes for EPI vaccines in Cameroon

Specific objective #4 was designed to address four key themes: i) describe the procurement and funding process for traditional and co-funded vaccines, including mapping the process, evaluating government's contribution in funding the EPI program as well as mobilizing and disbursing funds for vaccine procurement; ii) forecast fulfilment rates; iii) the consequences of not meeting funding requirements on vaccine stock levels and the impact on coverage for key antigens; iv) obtain information on key obstacles from key informants via KII.

5.4.1. Description of the annual procurement and funding process for traditional and co-financed vaccines

Figure 21 illustrates the vaccine procurement and funding process for both traditional and co-finance vaccines in Cameroon. As shown, the process is complex and involves several stakeholders. It begins

with forecasting the individual vaccines need for the country and ends with the transfer of funds from the Autonomous Sinking Fund (CAA) to the supply division of Unicef (Unicef SD), in Copenhagen, Demark. In between several approvals, which are often lengthy, are needed. This includes Cameroon's minister of health approving the forecast and requesting for a cost estimate (CE) from Unicef SD. While waiting for the approved CE from Unicef SD, the EPI's finance manager (SAF PEV) prepares documents requesting for engagement of funds, in line with the local financial procedures of the state. These documents are then sent to the Directorate of Financial Resources and Properties (DRFP) of the MoH, who in turns prepares a decision letter to request for the engage of the expenditure. This decision letter is then reviewed by a financial controller (CF), assigned to the MoH by the Ministry of Finance (MINFI). If this decision letter is validated by this staff, it is sent to the Minister of Public Health for approval. Once the minister approves the letter, it is sent back to the DRFP to prepare another decision letter to authorize the engagement of the expenditure and this letter is sent to the EPI finance manager, who will use it, alongside the approved CE from Unicef SD, as supporting documents to prepare a letter for the minister of health to approve and transmit to the CCA to authorize the transfer of funds from CCA to Unicef SD. The letter and its supporting documents must be reviewed by the CF and if he validates it, then the minister of health will approve the transfer of funds for the account of the ministry of health to CCA. Once, CCA receives the money, it will prepare and transfer the funds to Unicef SD, accordance with law on international transfer of funds. Once the funds arrive Unicef SD, the organization will prepare orders, purchase the vaccines, and ship them to the country. The vaccines and other consumables will then be received at the port of entry and transported to the central vaccine store for warehousing, inventory management and subsequent distribution to the regions as outlined in section 3.1.5.

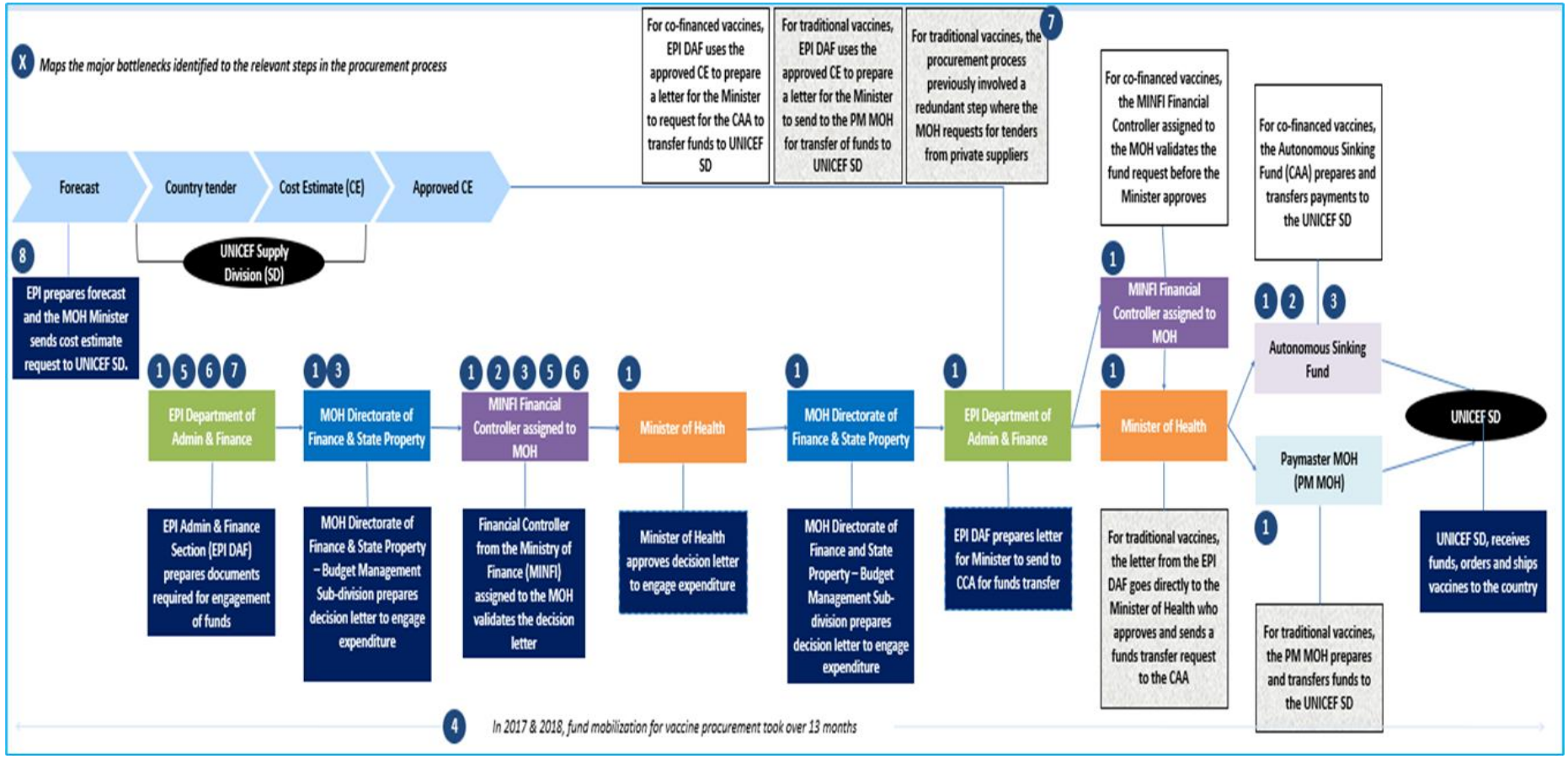


Figure 21: Figure 21: Process map for vaccine procurement and funding in Cameroon

BEAC - Bank of Central African States; **CAA -** Autonomous Sinking Fund; **DRFP** - Directorate of Finance and State Property – MOH; **EPI** – Expanded Program on Immunization; **EPI DAF –** EPI Department of Admin & Finance; **MINEPAT -** Ministry of Economy, Planning and Land Planning; **MINFI:** Ministry of Finance; **MOH -** Ministry of Health; **PM MOH -** Paymaster MOH.

5.4.2. Assessment of forecast fulfilment rates

Table 16 shows MoH's contribution towards the financing of the EPI. The amount allocated to EPI has remained relatively constant over the past five years and averages about US$5M, despite the introduction of new vaccinations and expansion of the birth cohort.

Table 16: Government's contribution in EPI financing (in US$ million)

Year	MoH Budget	Budget allocated to EPI	% MoH's budget allocated to EPI
2015	316.61	4.63	1.46%
2016	361.11	5.22	1.45%
2017	318.35	5.78	1.82%
2018	266.42	4.98	1.87%
2019	316.07	5.73	1.81%
2020	326.68	5.53	1.69%

This challenge makes it difficult for the EPI to fund the procurement of its vaccines as will be described below.

Table 16 shows the funds that were allocated for the procurement of co-financed and traditional vaccines as well as to fund EPI's operations. Between 2015 and 2017, the government did not respect its co-financing commitment with Gavi, which led to freezing of all Gavi's investments in Cameroon, resulting into stockout of co-finance vaccines.

Table 17: Overview of funds allocated to EPI for vaccine (vx) procurement and EPI operations (in millions of US$)

Year	Co-financed Vx	Traditional Vx	EPI Operations	Total
2015	2.20	0.92	0.0	3.12
2016	1.61	0.92	0.0	2.52
2017	1.85	1.22	0.0	3.08
2018	1.75	1.16	1.2	4.13
2019	3.15	1.43	1.6	6.20
2020	4.97	0.00	0.8	5.76

Vx= Vaccine

To alleviate this situation, the government engaged in efforts to pay its co-financing commitments for 2015, 2016 and 2017 in one block and these payments were made in 2018. Co-financing commitments for 2018 were only paid in three installments according to a plan that was agreed upon with Gavi- US$1 million in January 2019, US$225k in March 2019 and US$1.2 million in August 2019. Similarly, Co-financing commitments of US$3.1 million for 2019 were paid in five installments as follows: US$535K in September 2019, US$ 917K in October 2019, US$911K in November 2019 and US$ 724k in Jan 2020. The Co-financing requirement for 2020 of ~US$5 million was paid in three installments as follows, US$ 908K in September 2020, US$795k in October 2020 and US$ 2.4 million in January 2021. Meeting these commitments was a pre-requisite for Gavi to continue supporting Cameroon, be it for vaccine procurement, health system strengthening funding and funding for cold chain equipment optimization. While these were achieved, the country did not disburse a single dollar for the procurement of traditional vaccines, which resulted in to prolonged stockout of these vaccines and by extension coverage for these antigens.

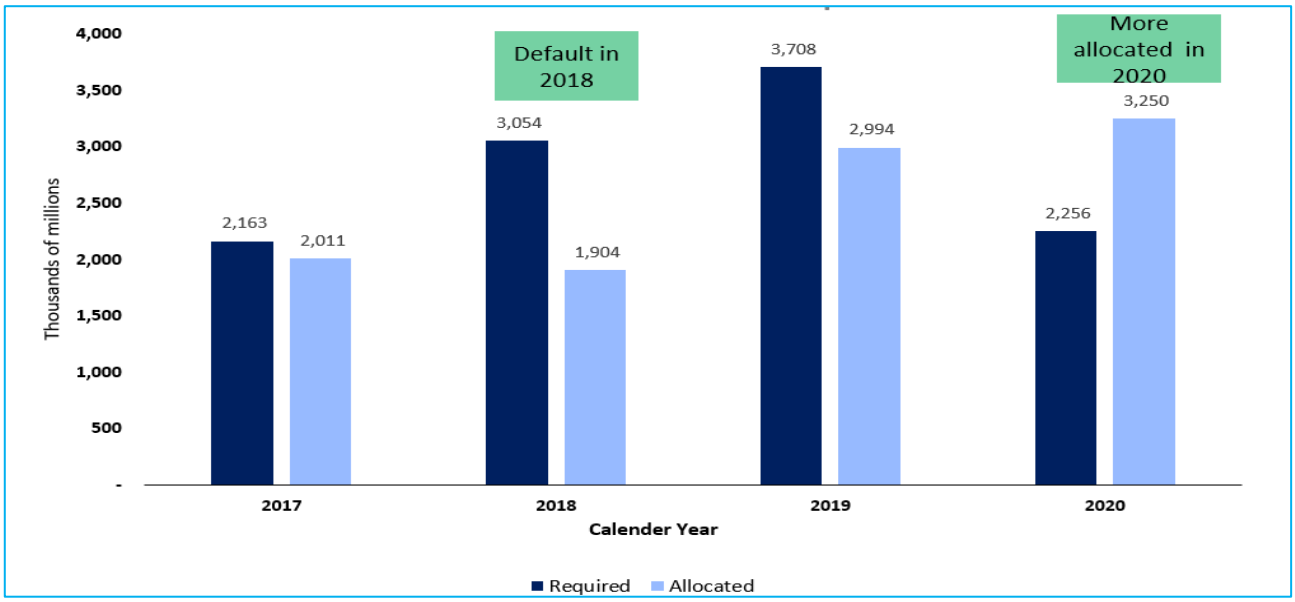


Figure 22: Forecasted versus allocated funds for vaccine procurement.

Figure 22 illustrate that the allocation of counterpart funding is often not aligned with vaccine procurement needs for the country. This situation caused the country to default in its co-financing commitments in 2018. Generally, less funds are allocated than required. The only exception to this was in 2020 where more funds were allocated (Figure 23).

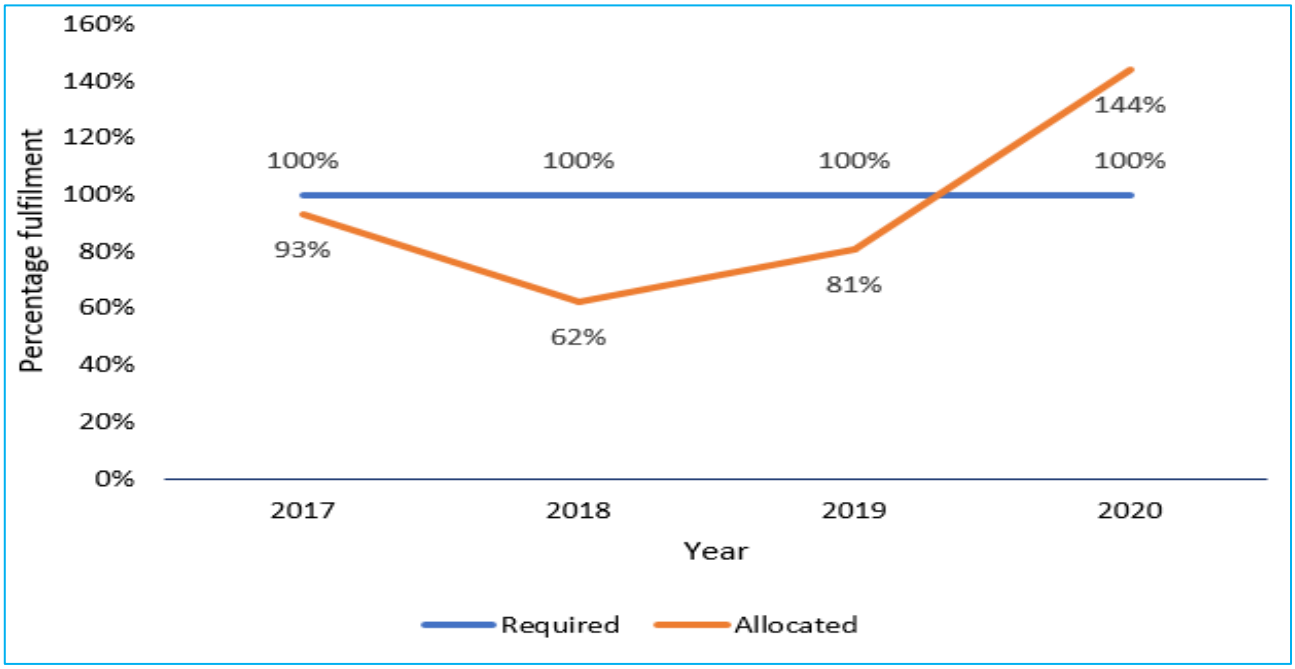


Figure 23: Required versus allocated funds.

Proper allocation of funds has been a challenge, but mobilization of the funds to execute is an uphill task. As showed in Figure 24, only 67% of the allocated funds for vaccine procurement were mobilized. Although current laws require mobilization to start in January, the lead time for mobilizing funds is generally long, averaging about 11 months.

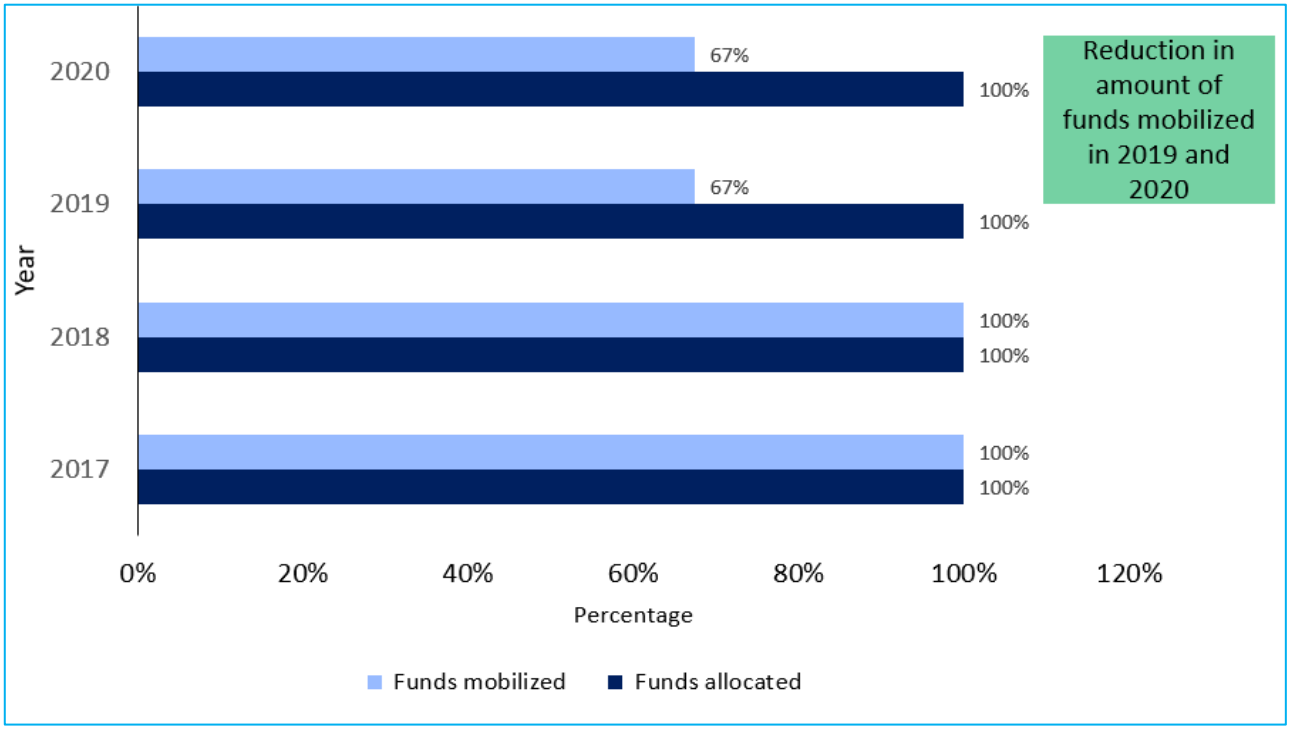


Figure 24: Percentage of fulfilment of allocated funds for vaccine procurement

Figure 25 shows the lead time for mobilization of funds for each year. As illustrated, it took 13 months for funds to be mobilized for vaccine procurement in 2017 and 2018. In 2018, payments were completed 18 months after budget approval, and this was partly because the country expected to start mobilizing the funds only after they have been approved.

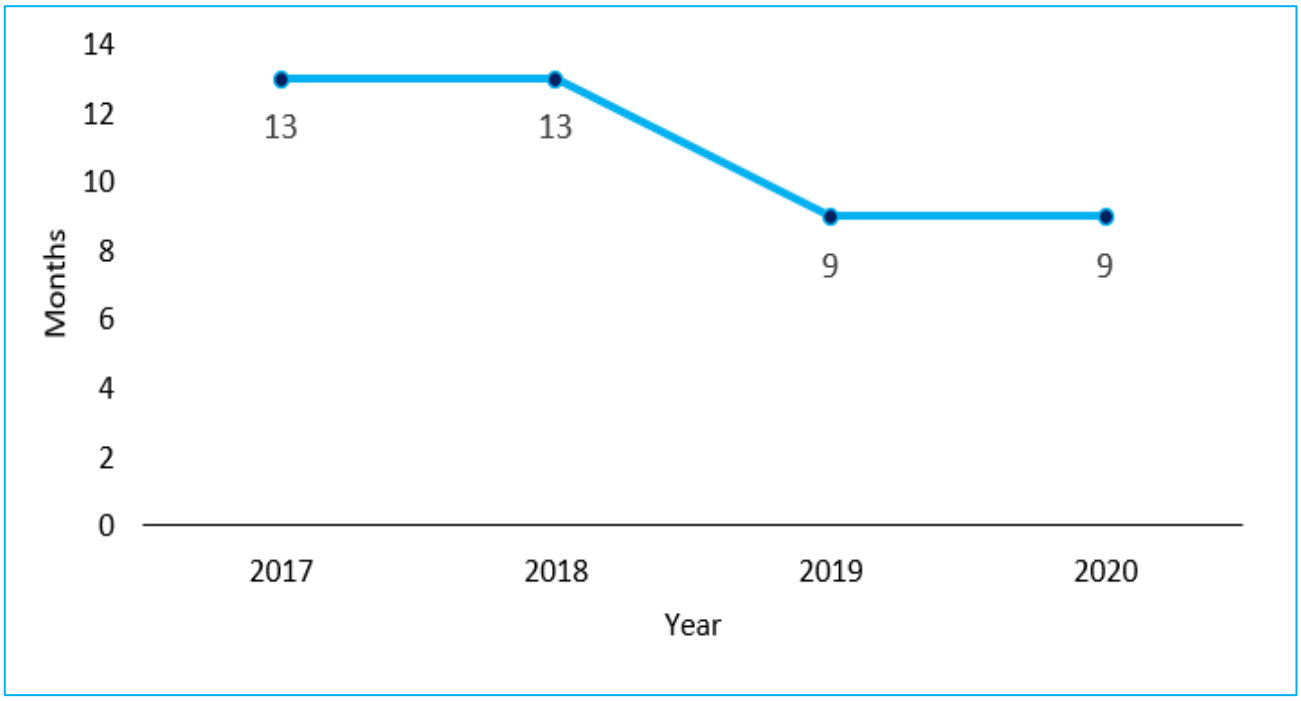


Figure 25: Lead time for mobilization of funds for each year

Table 17 presents a picture of some of the procurement bottlenecks frequently encountered during funding allocation, mobilization and payments and lead times. As illustrated, the allocated funding is usually less than what is required. Similarly, the funds mobilized are generally less that what has been allocated, given extremely low mobilization rates. Indeed, the rate was zero in 2017 and 2018, causing the country to default from its commitment. The unnecessary lengthy lead time contribute to delayed procurement, which in turn results to prolonged periods of stock outs.

Table 18: Overview of allocation, mobilization, disbursements, and lead times for vaccine procurement

Year	Required (millions)	Allocated (millions)	Mobilised (millions)	Required vs Mobilised (millions)	Amount mobilised current year (millions)	% Mobilisation current year	Date first payment	Date mobilisation complete	Lead time from January (months)
2017	2,163	2,011	2,011	- 152	0	0	Jan-18	Jan-18	13
2018	3,054	1,904	1,904	- 1,150	0	0	Jan-19	Aug-19	18
2019	3,708	2,994	2,020	- 1,688	1,546	52	Sep-19	Jan-20	13
2020	2,256	3,250	2,094	+ 994	594	18	Sep-20	Jan-21	13
Total	**8,925**	**6,909**	**5,935**	**- 1,996**				-	

Between 2016 and 2019, the government was unable to purchase all the volume of vaccines required for its immunization program. This inability was clearly linked to inadequate funding and delayed disbursement. Figures 26 and 27 show the percentage forecast fulfilment- (PFF) for both traditional vaccines like BCG, bOPV, MR and TD and co-funded vaccines, including PCV-13 DTP-3, YF and HPV.

PFF is a stock management concept that refers to the percentage of forecasted stock requirement that is procured or received and this percentage generally should equate 100%. It is often computed as the fraction of the quantity received divided by the quantity forecasted, multiplied by 100. As shown in Figure 26, the PFF has been low for most government procured vaccines (BCG, bOPV, MR, Td) since 2016. These are the vaccines that are most affected by funding inadequacies. Indeed, PFF of 0% was recorded for MR and TD in 2017 and BCG and TD in 2019. The prolonged stockout of these vaccines in 2017 led to a public outcry, which caused the president of the republic to request for immediate disbursement of US$2 million to redress the situation and this is the main reason why PFF for these traditional vaccines appeared to be high in 20218.

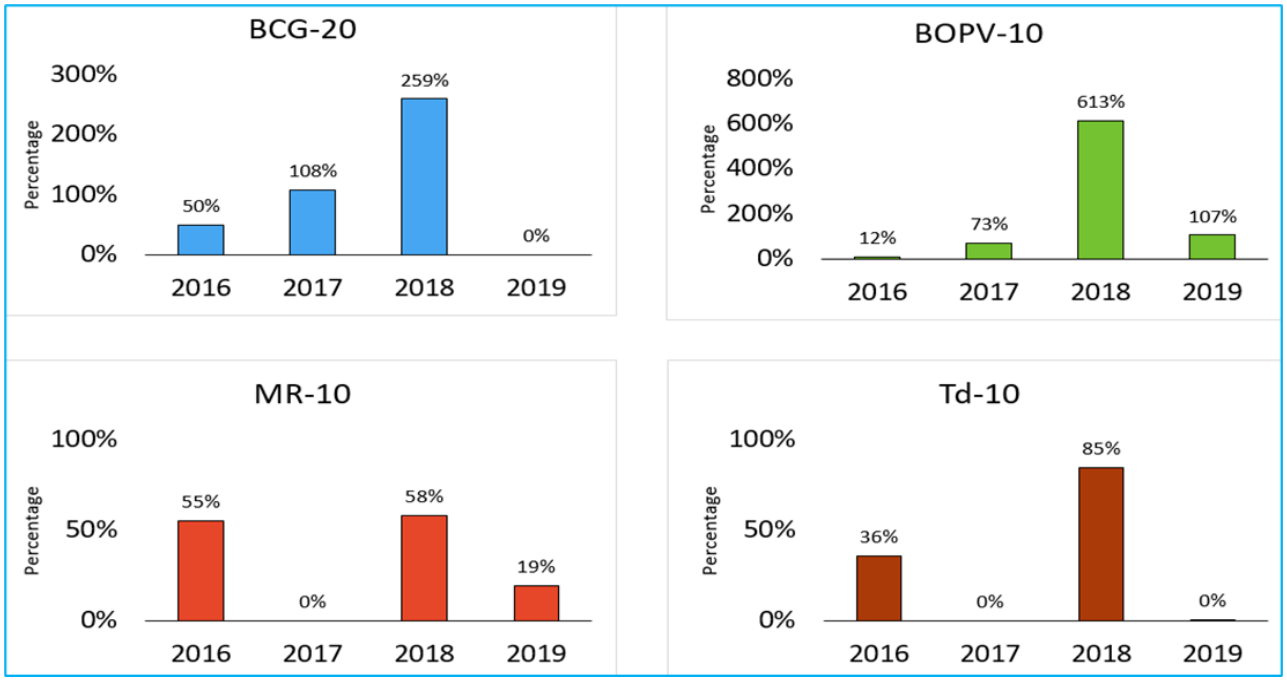


Figure 26: Percentage forecast fulfilment for traditional vaccines

In contrast to traditional vaccines, Gavi co-funded vaccines were less severely affected by funding challenges. However, apart from YF, PCV-13, and Rota, none of these vaccines were procured at 100% PFF rate. It should be noted that there are no data for HPV for 2016-2018 as this vaccine was only rollout in 2019.

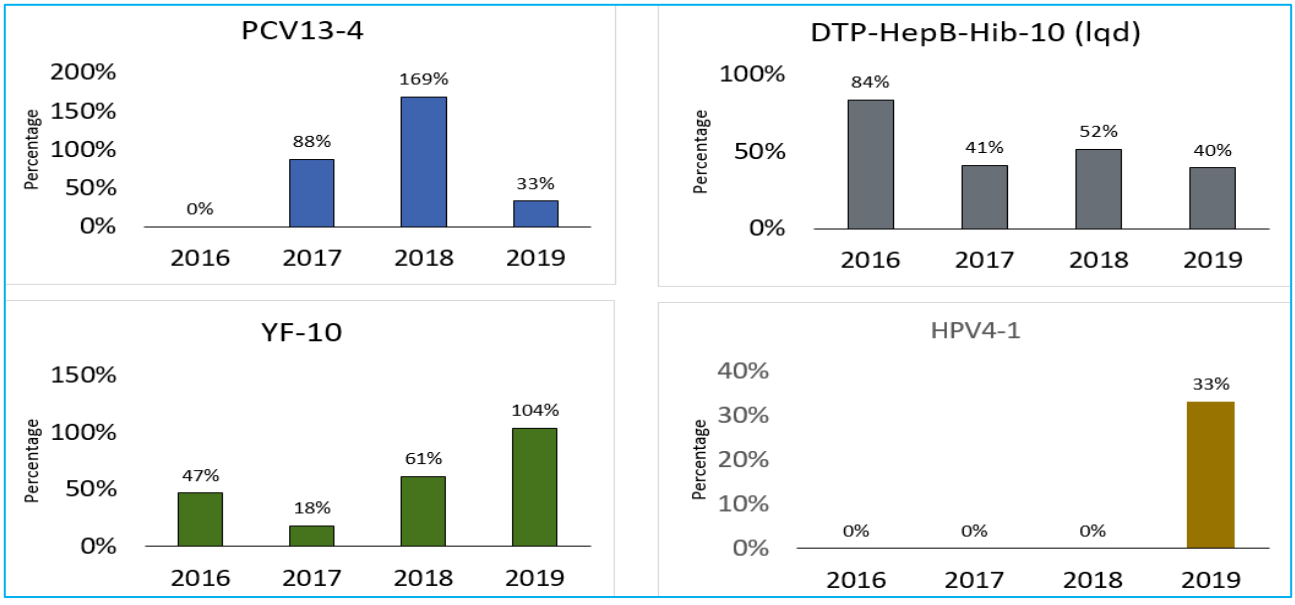


Figure 27: Percentage forecast fulfilment rate for Gavi Co-funded vaccines

From 2016 to 2019, a 4-million USD deficit in vaccine procurement funding prevented EPI from purchasing vaccines on time, affecting the availability of vaccines at service delivery points. Indeed, during this period, Cameroon spent $4M less than the forecasted need, impeding the procurement of 20M doses of vaccines as planned, especially BCG, MR, Td, bOPV. This failure severely disrupted the vaccine supply chain and this disruption led to 41 months of stockouts of at least 1 antigen. The section of this thesis will provide a snapshot of the consequences of this challenge.

5.4.3. Consequences of not meeting funding requirements on vaccine stock and coverage

According to EPI's SMT, the inability for the government to meet all funding requirements for Government-procured vaccines have contributed to the regular stockouts of bOPV, BCG, Tetanus Diphtheria and MR at central level (Figure 28). The country experience prolonged stock of for almost of these vaccines with many lasting over 60 days.

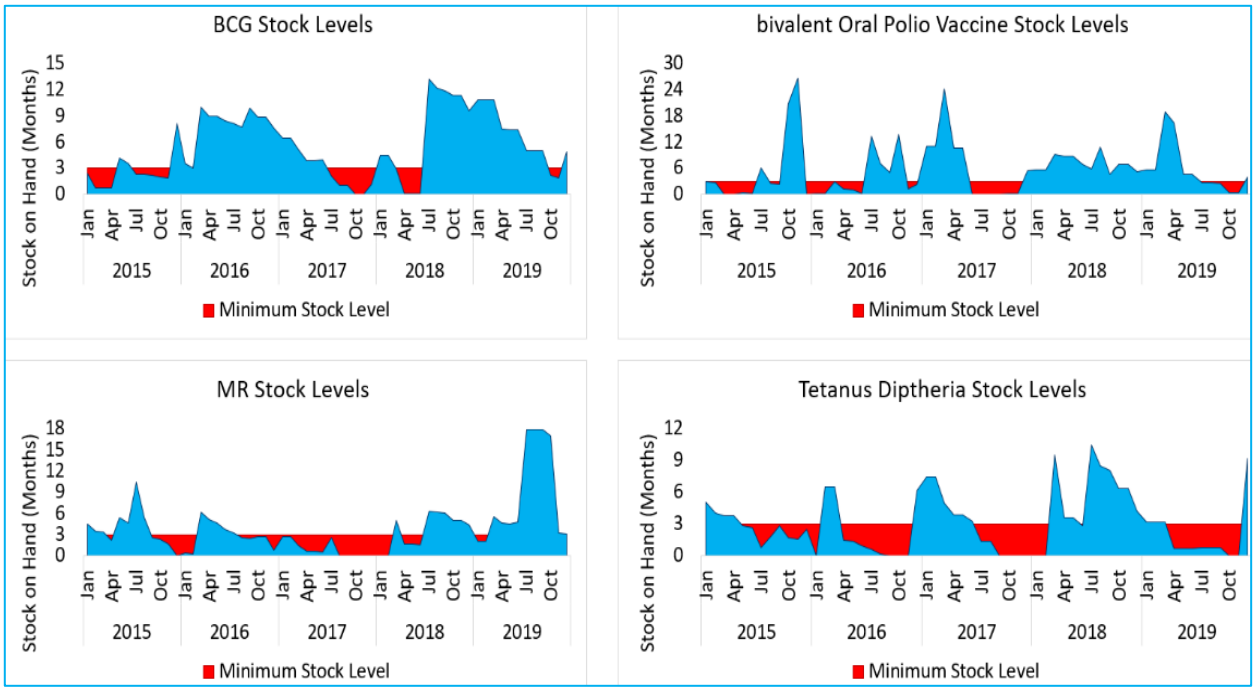


Figure 28: Stock on hand (in months) for Traditional vaccines from 2015 to 2019

Similar situation was observed with Gavi-funded vaccines, including yellow fever, Rota, IPV, PCV-13 and Pentavalent vaccines. As illustrated in Figure 29, the country experienced spikes in stockouts of these vaccines, particularly from 2018 onwards for Rotavirus and Pentavalent vaccines, and IPV and YF between 2015 and 2016. The country experiences spikes of stockouts of Pentavalent vaccine from quarter 2 of 2017 to quarter four of 2019.

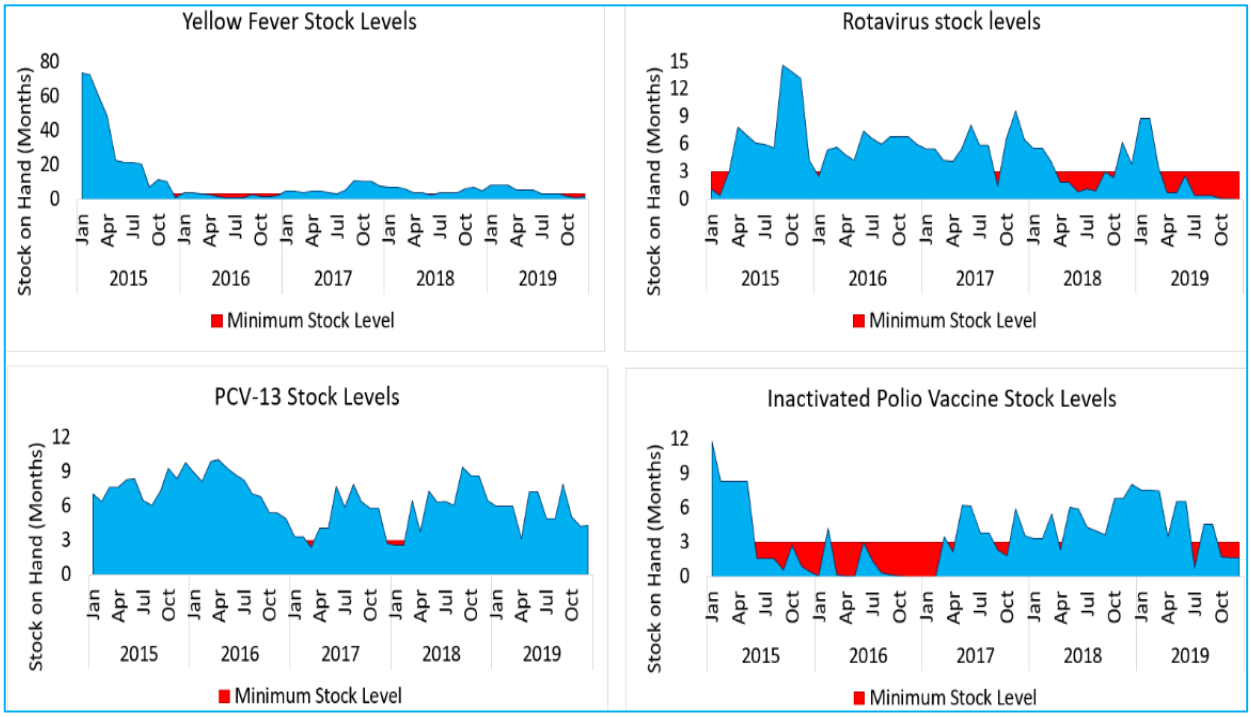


Figure 29: Stock on hand (in months) for Gavi-funded vaccines from 2015 to 2019

When stock levels are modelled with WHO-Unicef Estimates for National immunization Coverage rates, a pattern depicting declining coverage level and stock on hand for almost all tracer antigens is apparent. These declines are depicted in Figures 30 and 31.

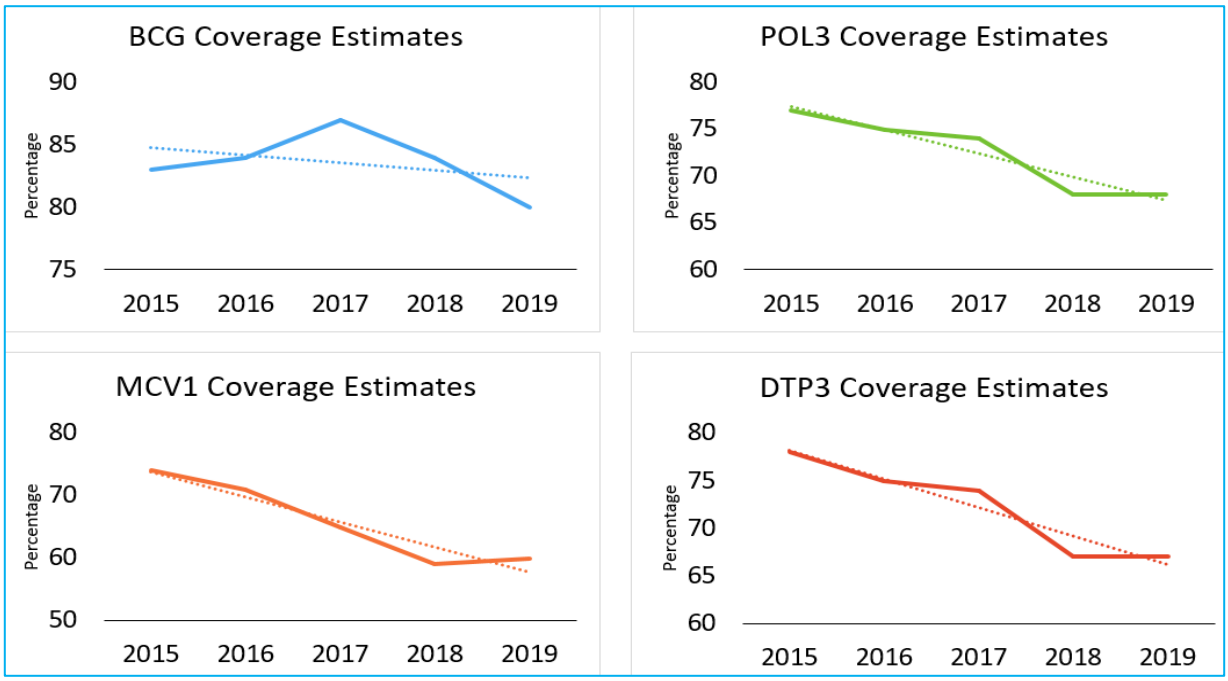


Figure 30: WUENIC Estimates for vaccination coverage for BCG, Polio 3, MCV DTP-3 from 2015-2019

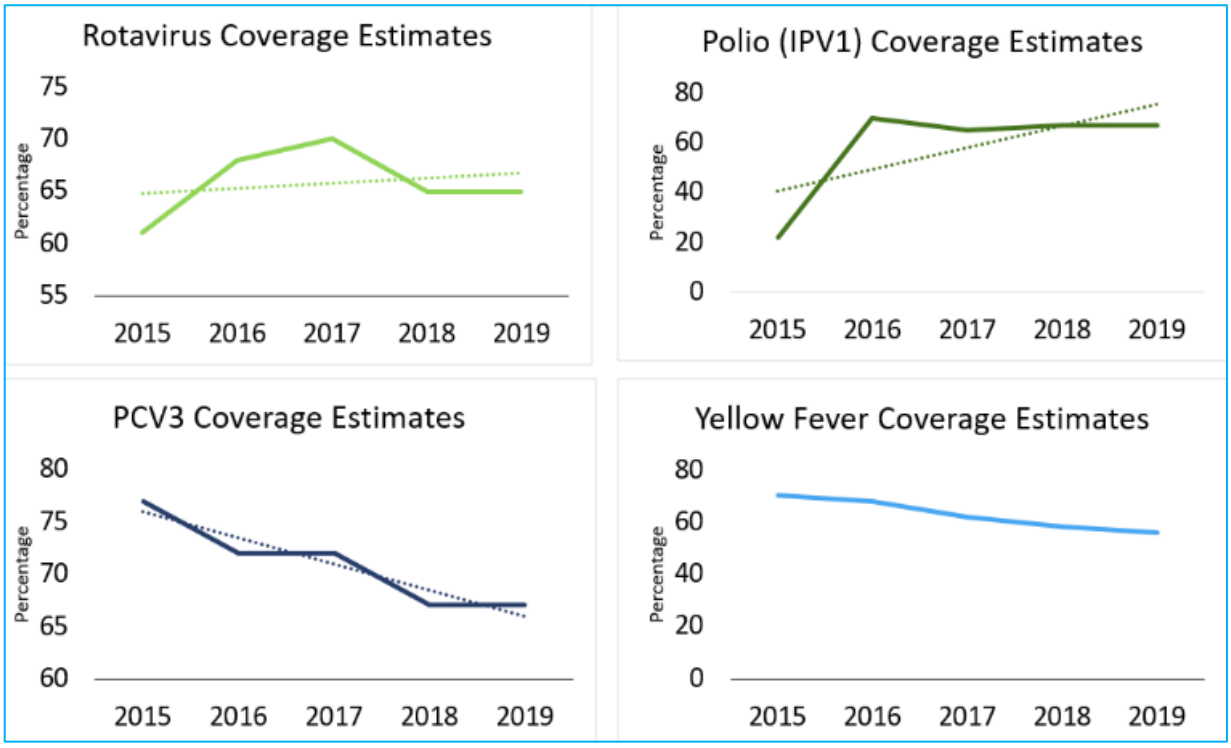


Figure 31: WUENIC Estimates for vaccination coverage for Rota, IPV, PCV3, YF from 2015-2019

5.4.4. Key informant perspectives on challenges regarding funding and how to mitigate them.

To gain better insights into the root causes of procurement and funding bottlenecks as well as perspectives on how to mitigate them, key informant interviews were conducted. These KIIs targeted 9 key stakeholders involved in the entire process. The respondents included three staff from the EPI Staff, the Director of Cooperation (DCOOP) and the Director of Financial Resources and Property (DRFP) at the MoH, the Immunization specialist at Unicef, a representative from the Ministry of Economy and Planning (MINEPAT), the Director of budget at that Ministry of Finance (MINFI) and the Director of the Autonomous Sinking fund (CAA). The perspectives of these respondents are summarized below according to their respective themes.

- **Delayed fund mobilization, due to:**
    - Lack of coordination amongst multiple stakeholders
    - De-prioritization of disbursements for vaccine procurement due to large sums requested by the EPI.
    - Poor awareness on the importance of timely disbursement of funds for procurement of vaccines
- **Inefficient processes, leading to:**
    - Lengthy administrative process for fund mobilization
    - Misalignment between fund allocation and procurement needs.
    - Misalignment between budgeting & procurement cycles
    - Redundant step in the process for traditional vaccine procurement – request for tenders
- **Poor data use, which results into:**
    - Poor data use for quantification and forecasting
    - No review of past procurement to guide future forecast.
    - Challenges with visibility of lower-level stock status

The three key recommendations that emerged from these KII are summarized below:

1. **Establish a technical working group for vaccine financing & procurement (TWG FPV)** to ensure regular, rapid, adequate & sustainable supply of vaccines.
2. Appoint of a **Focal Point at the EPI to monitor government commitments** & lead advocacy for more efficient processes and timely disbursement of funds.
3. Set-up a disbursement plan to **split the amounts requested by the EPI** into five installments for easier mobilization, approval, and disbursement.

Table 18 provides a synthesis of these problems as well as suggestions on how to address them.

Table 19: Summary of insights from Key informant interviews

Processes	• **Timing of processes leads to delays** o Lengthy process for MOH and financial controller discussion to release funds o To save time, request that funds are transferred to the UNICEF country office instead of UNICEF Copenhagen o The process of pulling allocated money out of the centralized BASKET fund is lengthy o MOH/EPI negotiations at meetings to justify budget to others is lengthy
Gavi Transition	• **Covering financial gaps once GAVI support ends** o Look to businesses to invest in Cameroon's health sector o Involve civil society, mobile phone companies, public sector, banks and other local institutions
Coordination	• **Greater EPI involvement could lead to greater clarity and efficiency** o Work planning involvement alongside MOH, MINEPAT & MINFI would be ideal o May ensure funding arrives on time, correct payment terms are agreed, and the final budgets are sufficient o Sharing the MOH/EPI workplan and activities calendar with MINFI would improve visibility of funding needs per period, while allowing th Treasury DG to better manage the situation o Monthly working sessions would enhance collaboration and help avoid delays
Funds availability	• **Liquidity is a problem** o Agreements can be made, and budgets can be approved, but available cash is an ongoing issue o This is made more difficult by a few scenarios including having to catch-up on past payments that are in default, and navigating the need to release funding for unplanned emergency situations

Financial Planning	• **Large lump sums are too big and cause delays** o Massive budgets condensed into one funding request is difficult to mobilize, justify and pay o Breaking up funding requests into multiple, smaller sub-requests would help with justification of various need, is easier to manage logistically and financially, and may make payments more achievable
HR capacity	• **Logisticians' knowledge to inform budget decisions** o Shared belief that well trained logisticians will lead to better programmatic planning practices and more accurate budgets o Involvement at a lower levels including regional and district levels would help improve accuracy of forecasted needs o Setting up logistics committees at regional level and dedicated vaccine logistics staff at district level would help massively
External priorities	• **National emergencies strain immunization program** o These unforeseen and last-minute demands place undue stress on vaccine budgets o Re-prioritization of funds elsewhere may lead to unfunded vaccine program needs o Inability to later reimburse or fill existing gap causes programmatic challenges
Stakeholder engagement	• **Raising awareness is key** o Vaccine procurement is a unique process that needs to be better understood by various stakeholders. o Rising awareness of others would help reduce need for lengthy negotiations and justifications of budgets/quantification/needs etc.

5.4.5. Package of scalable interventions for addressing barriers to optimal immunization coverage and equity in Cameroon and other SSA settings.

Three sets of scalable interventions were developed to address the barriers to optimal immunization coverage identified during this thesis project. The methodology used to develop these interventions has been presented in Section 4.4.5.1. Here I will focus on the outcomes of testing these interventions.

5.4.6. Outcome of interventions to improve RI coverage for ZDC and UIC in missed communities.

The approached outlined Table 9 (page 77) was leveraged to designed and implement service delivery strategies to immunize 7,532 ZDC identified during the mapping exercise in 2021 across 20 priority health areas. As shown in Figure 32, immunization shots were successfully delivered to 8,326 children age 0-11 months across 20 health areas, 10% more than the initial target. These shots were delivered via routine outreaches that were organized by the lead health facility in each of the health areas, after they were provided them with motorbikes for transportation and other vaccination materials, including cold boxes to transport vaccines and registers to document vaccinations.

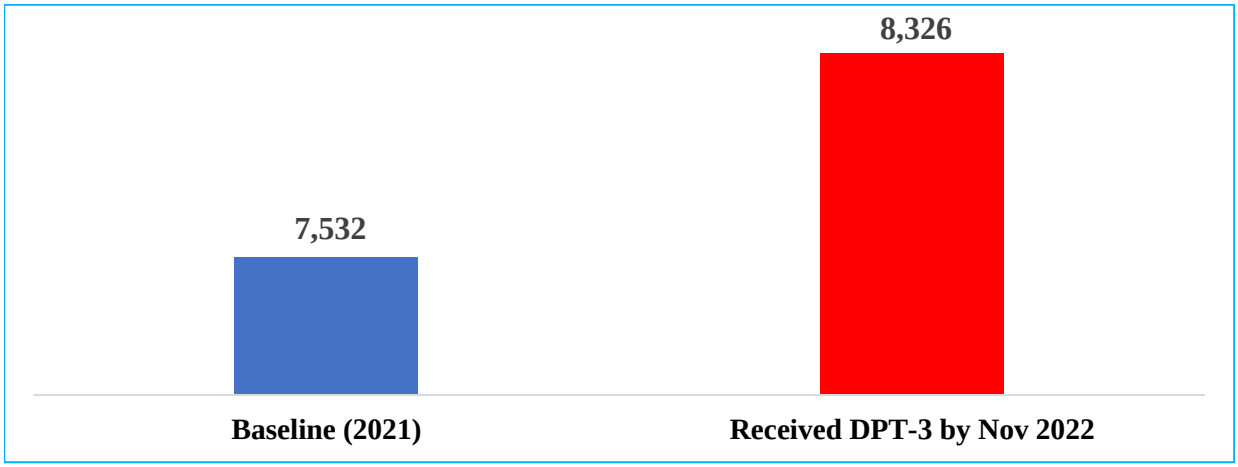


Figure presents the number of ZDC enumerated in 20 health areas in 2021 (the bar in blue color) with support of community healthcare workers in 20 health areas. The goal of the tested intervention was to vaccinate all the 7,532 children using the approached described in Table 9, page 77. After implementing the approach, a total of 8,326 children were vaccinated, 10% more than the initial target.

Figure 32: Target number of ZDC vaccinated in 20 priority health areas.

Figure 33 shows the regional distribution of the vaccinated children in the 20 priority areas of the pilot across the 10 regions. Over 50% of these children resided in health areas that were previously identified as zones with high concentration of ZDC as illustrated in Figure 16 (page 84).

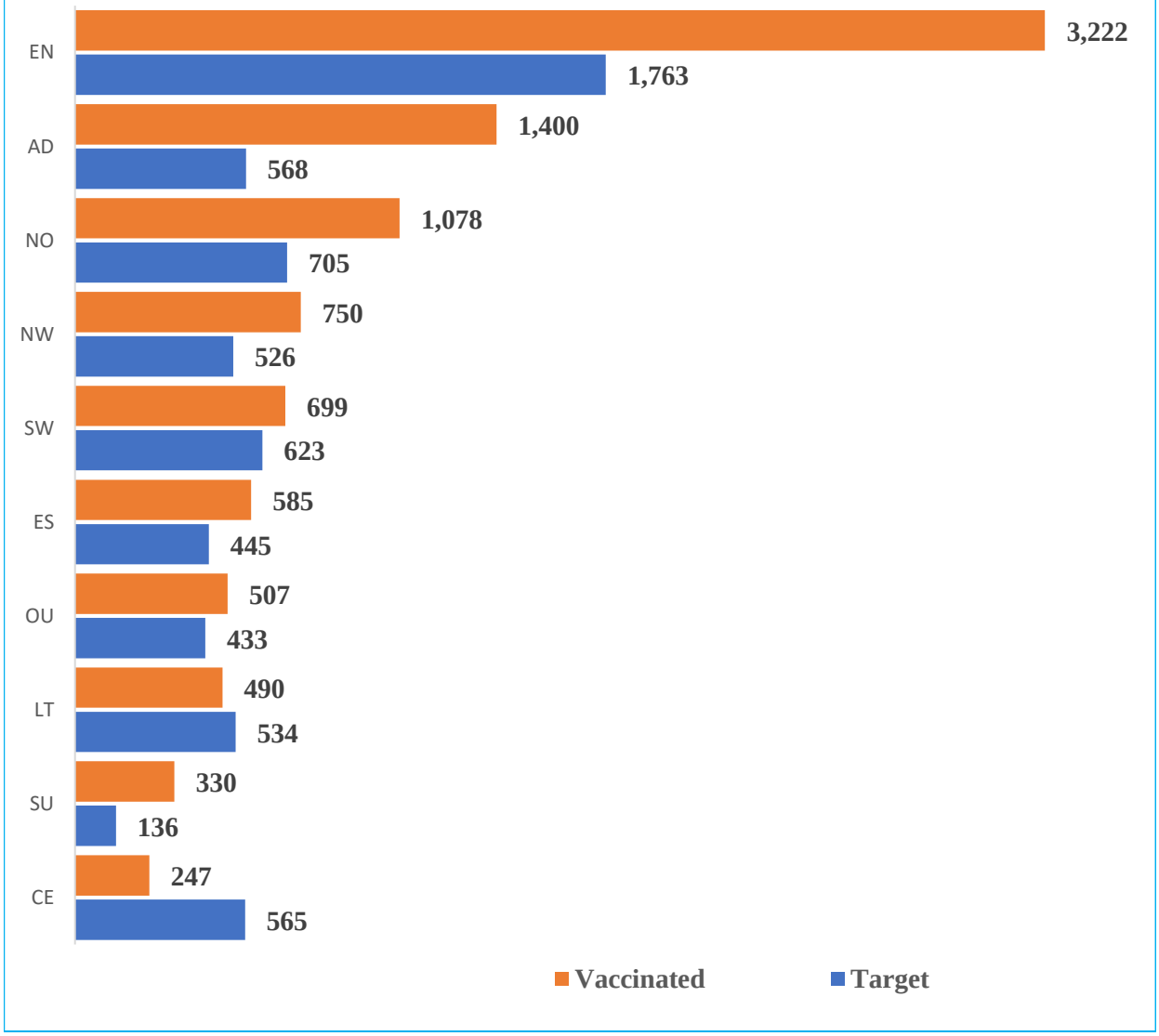


Figure shows the regional distribution of the number target ZDC (in blue bars) for the pilot intervention as well as the number of ZDC who were finally vaccinated in (in orange bars).

Figure 33: Distribution of target ZDC vs Vaccinated in the 20 priority health areas across the 10 regions.

5.4.7. Outcome of interventions for improving RI coverage in a conflict setting amidst the COVID-19 pandemic

To demonstrate this outcome, three rounds of PIRIS were designed and in all the 18 districts in the SW region during the peak of COVID-19 pandemic in 2020 as outlined in section 4.4.5.1, page 77. In total, 37, 407 received DTP-3 in 2020 compared to just 24, 751 children in 2019, improving the DTP-3 coverage in the region by 28% point, rising from 43% in 2019 to 71% in 2020. Interestingly, the number of immunized children peaked during the months when the PIRI rounds were being implemented.

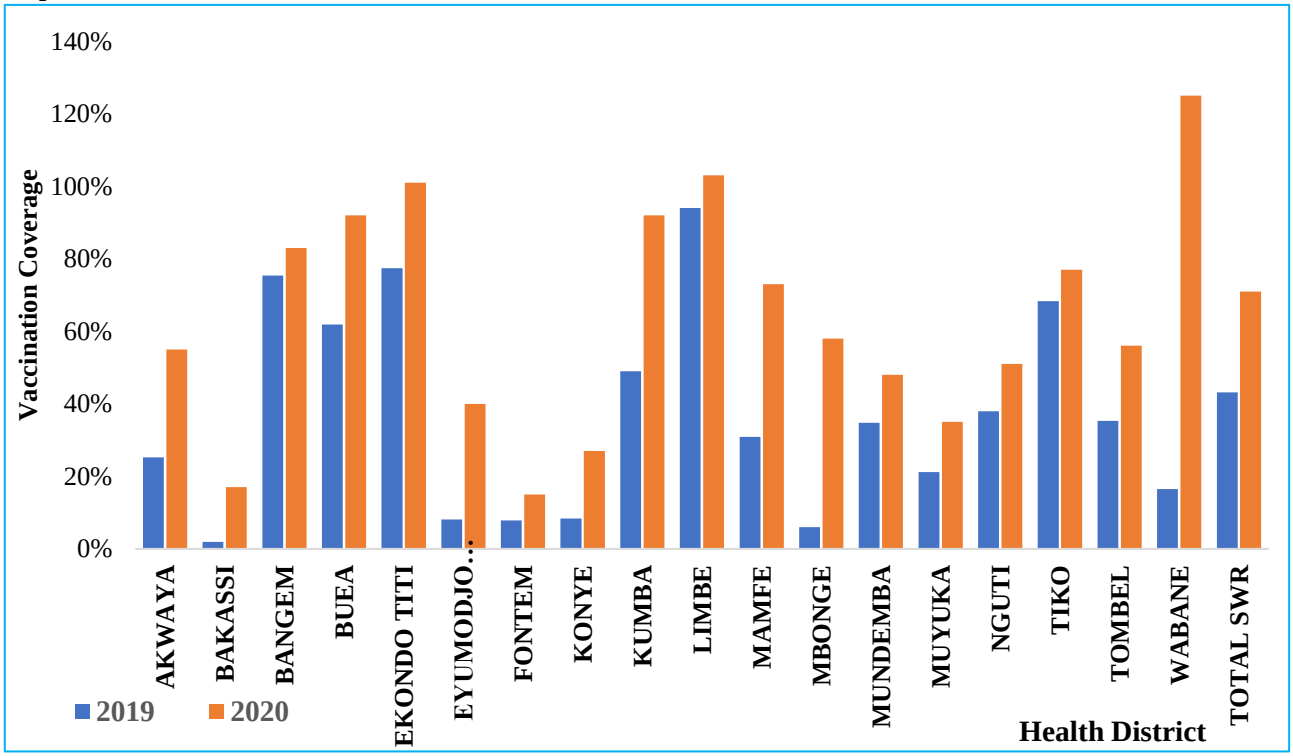
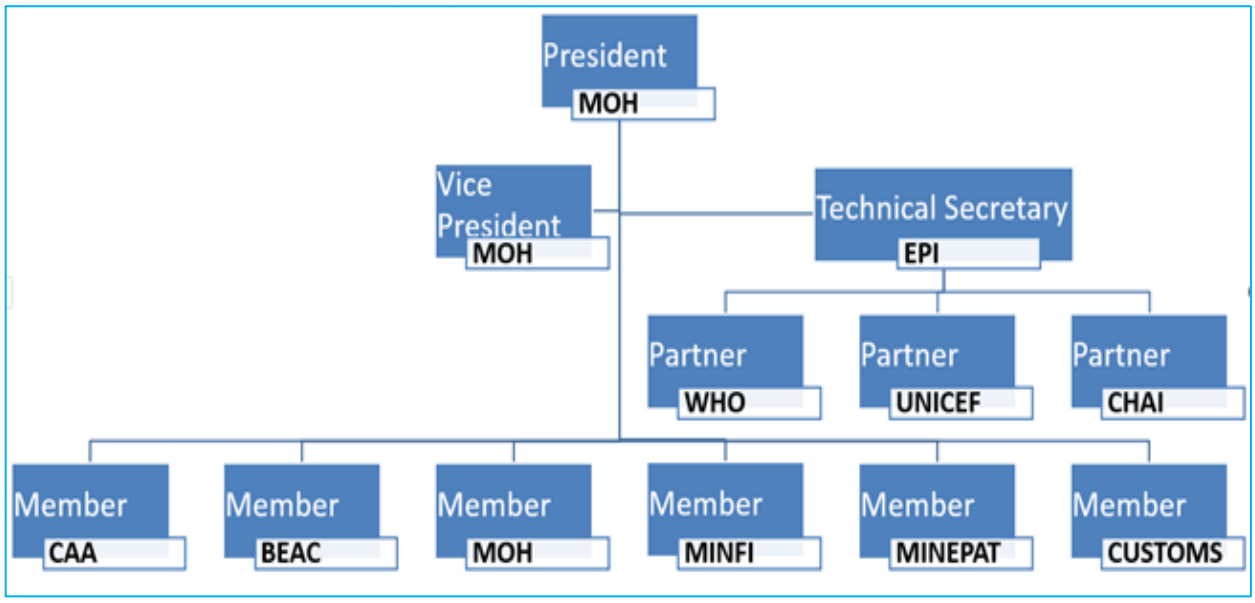


Figure 34: Comparison of DTP-3 coverage per district between 2019 and 2020

As shown in Figure 35, all districts recorded marked improvement in their DTP-3 coverage in 2020 compared to 2019. Similarly, coverage rates for other antigens including OPV3, IPV, MR improved considerably (data not shown). No staff involved in the PIRIs was injured or killed by separatist or government fighter neither did anyone contract COVID-19.

5.4.8. Outcome of testing interventions to improve procurement and funding process of traditional and co-financed vaccines.

Given the finding that most stakeholders involve in key decision making do not often fully understand the value of vaccination and why so much money should be allocated for vaccine procurement, a key recommendation that emerged was to establish a multi-sectorial technical working group (TWG) for vaccine financing and procurement that will be responsible for ensuring regular rapid, adequate, and sustainable supply of vaccines. The functional structure of this TWG, which was established under the leadership of the PhD candidate, is presented in Figure 35.



The figure depicts the structure of the finance working group for vaccine procurement in Cameroon. The Group is presided by Minister of Public health and the technical secretariat is assumed by the EPI and core immunization partners, including WHO Unicef and CHAI. Its member extends to all key plays in the immunization supply chain, including the autonomous sinking fund (CCA), which is responsible for transferring funds to the supply division of Unicef, the Bank of Central Africa State, which is responsible for regulating flow of funding within and out of the country, The Ministry of Finance (MINIFI), which is responsible for mobilizing and transferring the necessary funds for vaccine procurement and transferring them to the covers of the ministry of health (MoH), the Ministry of Economy and Planning (MINEPAT), that is responsible for programming state budget and allocating budget lines for vaccine procurements and the Custom services, which is responsible for executing exoneration orders from MINIFI and facilitating clearing of the vaccines and consumables once they

Figure 35: Structure of the vaccine financing working group.

The next step was to provide the TWG with a clear term of references, annual workplan, monitoring and evaluation framework and the necessary resources to function. Once these were established and

approved, the next step was to hold regular quarter meetings to monitor progress. Following the establishment of the TWG in May 2021, with a clear mandate, the group met on several occasions to validate the forecasted vaccine needs for the country, obtained the Cost Estimates from the supply division in a record time, fragment payments, and worked with the different departments to get the necessary approvals which led to timely payment of all Cameroon's co-financing requirement for Gavi-funded vaccines. By December 2022, Cameroon has transferred all the necessary amount for vaccine procurement to Unicef SD as shown in Table 19.

Table 20: Funds transferred to Unicef SD for procurement of Co-funded vaccines in 2020.

Vaccine	Co-financing Amount ($)	Budget Period
MR-R-1&2	78,229	2022
PCV	1,092,720	2022
PENTA	181,740	2022
YF	131,157	2022
RV	483,735	2022

Funds for traditional vaccines, have also been transferred leading to the importation of 1.6 million doses of BCG, all the forecasted doses of bOPV and MR.

6. Discussion

The overall goal of this project was to explore barriers to optimal immunization coverage and equity in Cameroon and leverage the findings to develop scalable strategies and interventions that can be used to improve immunization coverage and equity, not only in Cameroon but also in similar settings in Sub-Saharan Africa.

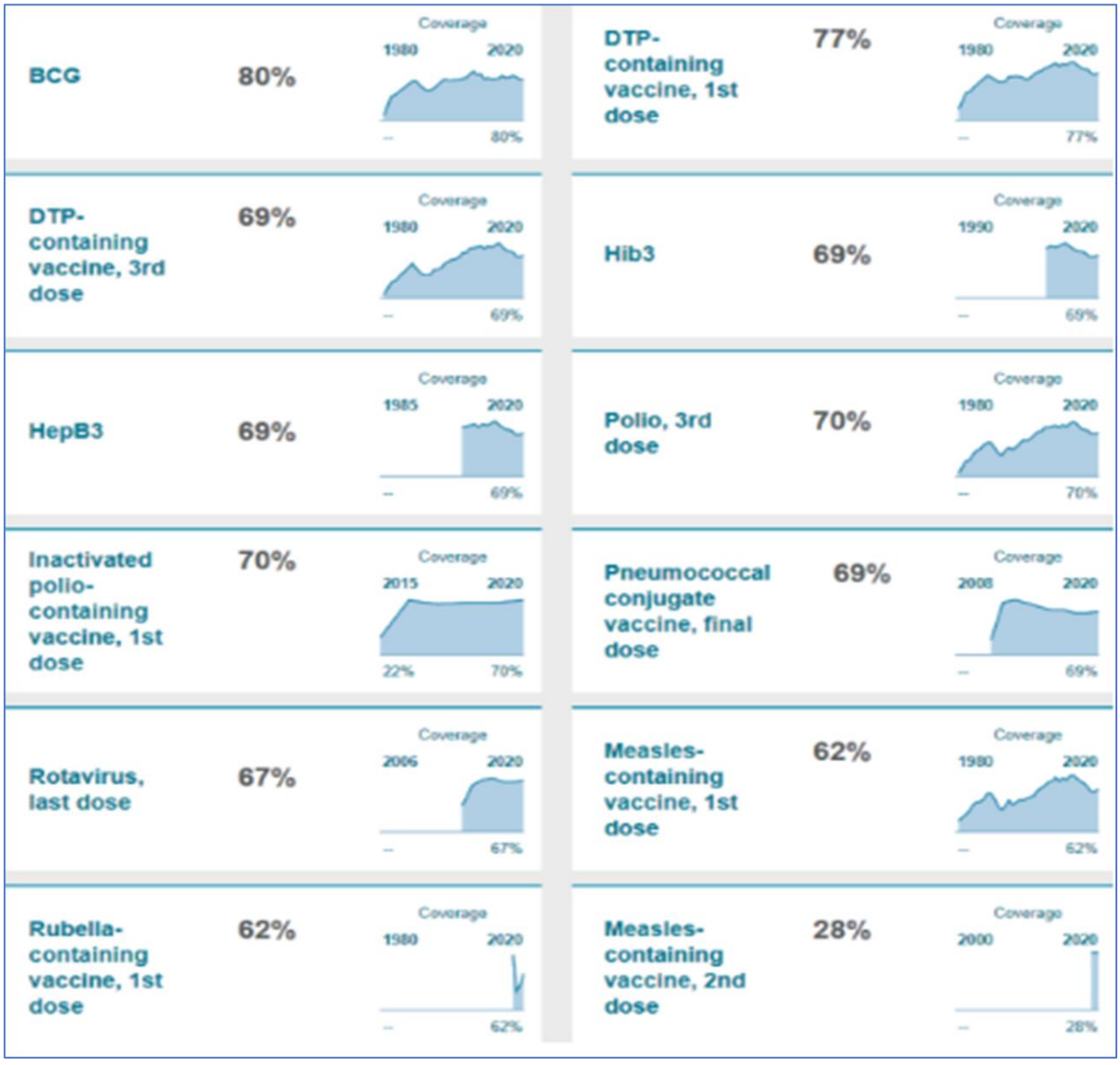


Figure shows the evolution of vaccination coverage for various antigens from the time the antigens were introduced into Cameroon's EPI system.

Figure 36: Evolution of vaccination coverage of various antigens following their introduction into Cameroon's EPI system.

The rationale for the project was driven by the declining immunization coverage and equity that the country has been facing for over a decade. As shown in Figure 36, immunization coverage in Cameroon plateaued in 2014 and then started slipping backward[69]. This backward sliding is occurring despite multiple investments the country and several development partners have made to stop and reverse this trend, expand on the breath of preventing deaths from VPDs and improving the underlying system that delivers vaccines. Indeed, Gavi alone has invested over US$221 million to strengthen several aspects of Cameroonian's immunization program as shown in Figure 37[70].

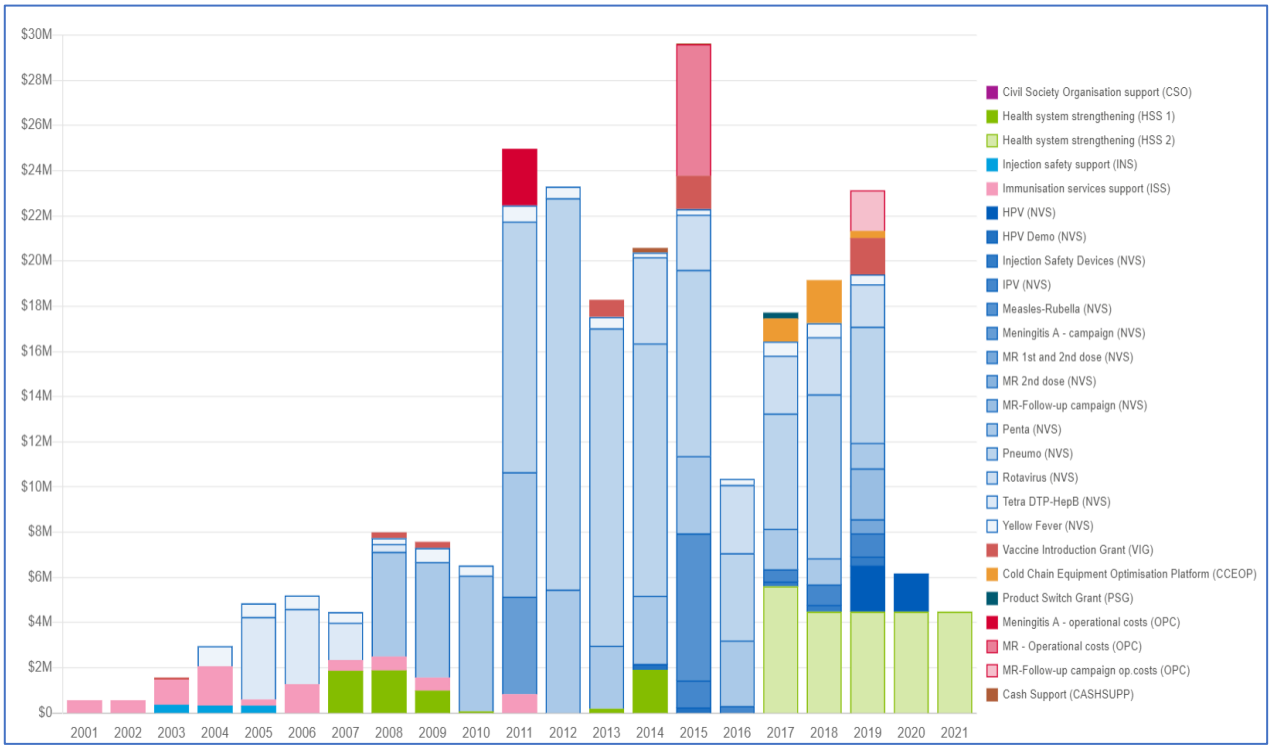


Figure 37: Gavi support to Cameroon from 2000-2021

This support compliments that made by the state and its development partners. Yet, these massive investments are failing to yield the intended outcomes in recent years. Several efforts have been invested to investigate the underlying causes for this declining performance, which have led to the implementation of multiple actions to redress the situation; however, the expected results are not forthcoming. This challenge was the underlying reason why the PhD candidate decided to undertake

this thesis project. The project's overall goal was to explore barriers that have not been previously studied by either the author or other researchers. To achieve this goal, the author investigated the role of four thematic areas on the immunization system in Cameroon. These included: i) the equity challenge of reaching hard-to-reach populations, ZDC and missed communities with immunization services; ii) the impact of COVID-19 on vaccination coverage in Cameroon; iii) the effect of the ongoing armed conflict in the NW and SW region on key immunization outcomes in the Cameroon and iv) the impact of procurement and financial bottlenecks on stock availability and vaccination coverage.

With regards to the equity challenge, it was obvious from this study that Cameroon has several communities that are often missed by its traditional healthcare system. The study identified settlements with clusters of ZDC and UIC. The study also estimated their absolute numbers in these settlements, with information aggregated to give findings at health area, district, and regional levels. Using choropleth maps, the project showed the distribution of 128,614 ZDC, 180,520 UIC in 176,192 missed communities across the country. This high number of ZD children resonates well with past studies[71 72 737475] and also lends support to that reported by Chard and collaborators highlighting that Cameroon is amongst the top 10 countries accounting for 86% of the 7.3 million ZDC in the world[1]. This granular finding at different system tiers is critical to support vaccine managers from health area to district, regional and national levels to conduct effective micro-planning to reach ZDC in hard-to-reach communities. It is therefore essential to compute resources required to vaccinate ZDC and IUC in missed communities and to inform partner investments and MOH policies and strategies. Given the limitation in resources, our analysis suggests that the country and her development partners should prioritize reaching ZDC and UIC in 42 districts across the nation. To do so, a ranking of high-priority districts was conducted using the districts with the highest ZDC and the priority regions in the top 30%. This ranking will help Cameroon to prioritize resources and strategies for reducing zero dose and under immunized according to the country's National Immunization Strategy. The study therefore serves as a solid platform for developing and implementing nationwide context-specific

strategies and interventions to reach ZD children, UI, and missed communities. Results from this study have already triggered great interest from the government and other traditional partners. Indeed, reducing the rising number of ZDC and UIC has become a central focus of Cameroon's Ministry of Public Health (MoH) as reflected in the national strategy for reaching ZD children[72]. This is therefore a timely study that gives insights on the distribution of ZDC, and UIC, and hard to reach communities – the so-called missed communities in Cameroon. The findings have already been leveraged by the government to apply for funding from the Gavi Equity Accelerator Fund (EAF), which is a funding platform established by Gavi to help countries reduce the number of ZDC by 25% by 2025. Access to this funding, and leverage some of the strategies proposed in this thesis may enable Cameroon to drastically reduce the number of ZDC and UIC in the country, particularly if the 42 priority districts are prioritized for these investments.

With regards to the reasons as to why these children and their communities are frequently missed by immunization services, leveraging the WHO BeSD framework helped to uncover non-traditional barriers to vaccination in settings with consistently low vaccination coverages as anticipated by the WHO Working Group on the BeSD framwork[67]. Although, there is paucity of data on the use of BeSD to determine drivers and barriers to childhood routine immunization, it's critical role in unpacking barriers to immunization is well aligned with studies conducted to assess the drivers and barriers to uptake of COVID-19 vaccines during the pandemic[76 77].

Using the BeSD framework, the project unveiled that the role of vaccines in disease prevention was well-known among caregivers, and that there was a real appetite to vaccinate their children. These finding concords well with that from a cross-sectional study in Cameroon, where the authors reported a higher vaccine acceptance rate than hesitancy[78]. Despite this, the project unveiled that distrust in several health system variables, including vaccine quality, standards of health facilities, and capacity of healthcare providers, negatively influences the attitudes of caregivers to get their children vaccinated. This finding, coupled with deep respect and trust for family, friends, the elderly, and religious and community leaders, further worsens vaccine hesitancy. This is similar to the findings in a study conducted by Norwak *et al*. that strongly suggested a significant increase in hesitancy where there is trust among friends and distrust for healthcare providers[79]. To counter this, the EPI and her partners should capacitate district managers on how to set up a trust-worthy and culturally savvy

vaccination teams in their districts. Efforts should also be made to continuously assess and ameliorate the quality of PHC services that are being dispensed in facilities that are sometimes used by missed communities. Furthermore, the EPI will need to expand its sensitization activities to other groups, such as community and religious leaders, that might require meaningfully to spur interest in public health activities with their respective jurisdictions. Another important finding from the qualitative interviews is that a sizeable proportion of some communities, especially in urban settings, prefer private health facilities, many of which do not offer vaccination services. This preference contributes to missed opportunities for vaccination, which by extension pre-empt the population from reaping the benefit from vaccination. To address this, the EPI and her partners need to figure out how to better support private facilities to provide immunization services, particularly in urban areas, where over 90% of existing facilities are privately owned.

Timing, frequency, and duration of vaccination sessions in vaccinating health facilities were considered unfavorable by the participants. This resonates well with other studies in Sub-Saharan Africa[80,81]. This is, therefore, a wake-up call to extend vaccination service delivery to include private health facilities and other non-vaccinating clinics; to improve access to vaccination services. In addition, remodeling vaccination sessions to fit the schedules of caregivers and the realities of the location population will be of tremendous benefit in vaccinating ZDC and UIC.

Among other things, the impact of gender-related issues on vaccine uptake was glaring in this study and these issues vary greatly across the different ethnocultural zones. For example, in the Northern part of the country, women required permission from their husbands to get their children vaccinated. In addition, the gender of the vaccinator or healthcare worker greatly influenced vaccine uptake, with preference tilted toward the female gender. Moreso, the movement of women are restricted, which might limit the probability of them taking their children to facilities for vaccination. On the other hand, in the Southern part of the country, women overwhelming have multiple duties, making them to easily miss vaccination appointments or not prioritize childhood vaccination at all. Overall, the findings from this project align well with those reported by Siddiqi *et al.,* who also found significant gender disparities in vaccination in Pakistan[82]. The findings also suggest the need for our EPI to develop context-specify policies and strategies that consider these gender realities in vaccine and PHC service delivery.

With regards to COVID-19, the project revealed the unparallel effect the pandemic has had on country's immunization system, with a whopping 10% and 14% increase in ZDC and UIC, respectively when compared to the pre-pandemic period. This increase was driven by significant drops in access (40%) and 40% in utilization (40%) of immunization services, which all resulted from drops in the number of fixed-post (33%) and outreach (14%) immunization sessions organized at the surveyed facilities (Table 13). These finding are in line with those reported from several settings, including Lebanon, Pakistan, and Ethiopia[83–86] and the third pulse survey. According to the latter, over 70% of countries reported serious and continuous disruptions of essential health services, reversing past efforts to improve health indicators[83]. The findings are also in agreement with finding from recent studies in different settings in Cameroon, which all reported significant drops in coverage for DTP- containing vaccines [16] [21,22]. The ultimate result of this decline is that many children have missed out on their vaccines and as result remain susceptible to deadly vaccine preventable diseases.

The significant drop in vaccination coverage unveiled by this project can be explained by several factors. First, being novel, the COVID-19 pandemic encountered an unprepared and weak health system that faced grave challenges in meeting the demands of pandemic control. This led to task shifting in favor of the pandemic, creating an unintended negative impact on essential health services, such as routine immunization. Additionally, sub-optimal training of clinicians regarding routine patient care, including vaccination amid the pandemic, created, the fear of contracting COVID-19 when offering health services. This fear was worsened by inadequate personal protective equipment and standards of operation to keep the disease in check in a clinical setting. Delays in COVID-19 confirmatory diagnosis due to limited test kits and diagnostics targeted every patient presenting in a clinical setting with upper or lower respiratory tract symptoms as a suspected case, leading to poor care, even for patients presenting with other ailments. This complexity and uncertainty associated with contracting the COVID-19 infection may have created a spillover effect of COVID-19 stigma

and hesitancy toward other routine essential health care services, including immunization services. Another challenge was the unprecedented disruption of global supply chain systems, which affected timely availability of vaccines and other commodities. This was further compounded by lockdowns and other strict government control measures that negatively impacted in-country distribution systems for health commodities, which by extension affected vaccine stock availability at facility levels.

A noteworthy contribution of this thesis project is the development of an Excel-based tool that health systems can use to assess the impact of an emergency on vaccination. Its use case can be extended to other disease areas and can help identify root causes, guide quick decision making, facilitate the design of a recovery plan and provide analytic monitoring and evaluation support during the implementation of priority actions. Indeed, the tool has enabled the government to develop a national policy and guidance for catch-up vaccination in Cameroon, with a sole focus of providing immunization shots to children who missed their vaccination schedules due to COVID-19[87].

The tool further emphasizes the need for a real-time assessment tool to be used at the different tiers of vaccination service delivery, including health facilities. This is important because aggregated data at higher administrative levels may mask prevailing low performance at lower operational levels. The role of such a tool in data-driven decision making at all levels is invaluable. In a country such as Cameroon, with limited health resources, this piece of information may be helpful to prioritize regions and districts with higher decline in RI indicators, as this may guide the development of a post-COVID-19 recovery plan to reverse the impact of the pandemic on key RI indicators. This finding can also be employed in informing policy on future pandemic management.

The third specific objective of the project was **to assess the effect of the ongoing armed conflict in the NW and SW region on key immunization outcomes in Cameroon**. Overall, the findings suggest a dramatic decline in coverage rates for tracer vaccines, in both regions, with declines for

almost all antigens ranging between 20% and 41% during the study period (Figure 19). Overall, the findings from this project are in line with those reported from several conflict settings including, Syria[88], Yemen[89], Afghanistan[90], and the Democratic Republic of Congo[91] amongst others.

The observed decline in coverage and equity reported by this project can be attributed to the direct effect of the conflict on the immunization system. Indeed, the number of facilities offering immunization services dramatically declined as the conflict intensifies. For example, by November 2019, the number of facilities offering immunization in the NW and SW declined by 53 and 30%, respectively. This decline was a direct consequence of facilities closing because of the rising level of insecurity, which caused many healthcare workers to flee from their duty stations. In a handful of cases, facilities were openly burnt down, destroyed, or looted by arm groups[92]. The functioning health facilities, on the other hand, were confronted with complex realities, including the prevailing security challenge, which impacted all basic immunization service delivery like replenishing of basic immunization inputs, as well as planning and conducting fix and outreach immunization sessions. In addition, fierce fighting in many areas instilled fear in parents, rendering them hesitant to take their infants to health facilities or outreach sites for vaccination. The project also unveiled a dramatic decline in the percentages of fix-post and outreach immunization sessions, which respectively felled by 46 and 27% in SW and NW. The later decline is problematic because outreaches account for about 30% of all immunizations in both regions[93]. With a quasi-cessation of this strategy in both regions, almost 21,730 children will be left unimmunized and thus unprotected against VPD. The challenge of immunizing infants from these two regions extends beyond reaching infants in the conflict regions. As mentioned previously, the conflict has created a mass of internally displaced people, the majority of whom are women and children. Although official reports indicate that half a million people from these regions have fled to neighboring regions, there is limited clarity on the specific destination of these population sub-groups. This leaves open the question on the geographic denominator to which they will now belong. It is highly possible that these displaced populations are not being adequately

included in population denominators in their new locations, which in turn would mean that coverage figures in other regions could be lower than currently reported. This challenge highlights the need to sensitize facilities and healthcare workers in districts where these populations are likely to be found so that these displaced individuals and their children are properly captured into the health system in their new locations.

In this project, the reported violence against health facilities and health staff has been devastating. Burning down, destroying, and looting of facilities, coupled with fatal attacks on health staff, undermine the effectiveness of life-savings public health program, including immunization. As seen in this conflict, these actions clearly disrupt service delivery and engender a demoralized workforce. Although there is a global consensus on "zero tolerance" of violence against health facilities and workforce during conflicts[94,95] mechanisms to translate this global principle into practice seem to be limited in Cameroon. With basically all funding diverted to contain the security situation, limited resources are available to apply the WHO guideline on making "hospitals safe in emergencies"[95]. As a result, there is a need for all stakeholders, including government and non-governmental organizations as well as community and religious leaders, to emphasize on the protection of facilities and health staff to counteract any negative impact on the immunization system. This momentum is necessary to ensure continuous provision of essential health care services to the populations of these two regions. By so doing, homage would be paid to the courageous health workers who lost their lives serving the needy, while also instilling hope in an already despaired population. Restoring hope among the population will also require crafting strategies and mobilizing the necessary resources to immunize the unimmunized in the conflict zones as well as the internally displaced. It will also require mobilizing the necessary stakeholders and resources to rebuild the destroyed society. To protect vulnerable populations from VPD in these two regions of Cameroon, proven strategies for delivering RI services would need to be implemented. This later assumption was piloted during this project.

The fourth specific objective of the project was to evaluated impact of procurement and financial bottlenecks on stock availability and vaccination coverage. In fact, availability of sufficient quantities of quality vaccines at the right time and at the right place is needed to successfully run an immunization program. This fact has resulted into a well-established slogan in the immunization space, which reads "No product, no program"[96]. But for vaccines products to be available in any country, particularly countries in SSA, a complex process must be followed. This process, which is unknown to many, begins with forecasting of vaccines need for a country, then converting this forecast into a dollar amount, mobilizing the funds, and collaborating with procurement agencies such as Unicef SD to purchase and import the vaccine. Until now, no information was available regarding the vaccine procurement and financing process in Cameroon. This information gap motivated the author to explore this space, with a hypothesis that the bottlenecks associated with the process are a major contributor to stockout of vaccines, which invariable impedes vaccine service delivery at facilities and, by extension impacts immunization coverage. To this end, the thesis project used mixed-methods approach, to map the vaccine procurement and financing processes in Cameroon between 2015 and 2020.Additionally, it identified the bottlenecks that exist within these processes, analyzed its effect on stock performance, and gathered recommendations for improvement from key stakeholders.

Overall, the findings from the desk review revealed that the EPI faced a funding deficit of US$ 4 million for vaccine procurement between 2016 and 2019. Consequently, the program was unable to purchase 20 million vaccine doses on time, leading to 41 months of stockout of at least one antigen., poor data use and misalignments between forecasted, allocated and mobilized funds.

Regarding the overall procurement process, the findings of this study revealed an extremely lengthy and complex process, involves multiple stakeholders from different government departments. This lengthy procurement process is further complicated by poor coordination among stakeholders and

low prioritization of disbursement for vaccine procurement, resulting in inefficiencies and delays. These findings are concordant to reports from a study in Mozambique reporting lengthy processes and procedures as a major bottle neck in vaccine procurement[97]. In this study, the observed complexities, were to a greater extent, driven by lack of coordination, conflicting priorities, and poor public financial management systems. The impact of these shortcomings on reducing the impact and benefits of vaccination programs have been well documented[98] and these complexities can render a vaccination system vulnerable to disruptions as seen with the COVID-19 pandemic[99]. This highlights the need for streamlining the procurement process and strengthening coordination and collaboration among stakeholders involved.

Another impact finding from this project is the fact that funding allocated for vaccine procurement in Cameroon is often less than what was forecasted, and the funding mobilized is generally lower than the allocated amount due to extremely low mobilization rates. These complex challenges, coupled with lengthy lead times for mobilization of funds, invariably contributed to the country defaulting on its co-financing commitments in 2018. The findings emanating from this study aligns well with those from a baseline survey of immunization bottlenecks in the Democratic Republic of the Congo, which identified disbursement delays and commitment shortfalls from the state budget as contributing factors to vaccine shortages across the country[100]. Similarly, in Mozambique, procurement and fund disbursement lead times, of up to 18 months, were reported[97].

With regards to percentage forecast fulfilment (PFF), it was apparent that the PFF for traditional vaccines was lower than for co-financed vaccines. This was most likely because the country did not disburse any funds for the procurement of traditional vaccines between 2015 and 2020. And when funds are released, the volume procured are often consistently lower compared to the forecasted needs. For instance, the volumes of traditional vaccines procured consistently fell below 50% of the forecasted volumes, except for 2018 where prolonged stockout of these vaccines led to a public outcry, which caused the presidency to request for immediate disbursement of US$2 million for

vaccine procurement. This action explains why PFF for these traditional vaccines appeared to be high in 2018.

The findings from this PhD project also suggests that Cameroon's inability to meet all funding requirements for both traditional and co-financed vaccines may have contributed to the regular vaccine stockouts experienced between 2016 and 2019. In tandem with the findings, a systematic review assessing vaccine availability in 47 African countries found that 50% of the participating countries experienced vaccine stock-outs for at least one month at national and district levels[101]. Furthermore, an analysis of vaccination indicators from the WHO-UNICEF Joint Reporting Form (JRF) and UNICEF's forecasting tool from 2011 to 2015 showed that 39% of national level stockouts were attributable to government funding delays, while 23% were caused by delays in the procurement processes[102]. These complexities in procurement can result into vaccine stockouts at service delivery points, which by extension can lead to missed opportunities for vaccination, erode public trust in the health system, leading to vaccine hesitancy and ultimately reduce immunization uptake [22].

One of the key bottlenecks to vaccine procurement and financing highlighted by stakeholders in our study was poor data use for forecasting and quantification of vaccines. Indeed, data obtained from KII provided insights into the existence of this problem, beginning with poor use of data for quantification and forecasting, inefficient processes allocating funding and delays in mobilizing the allocated funds for vaccine procurement. These procurement and financing challenges have been recognized by both Gavi and Unicef as fundamental issues affecting vaccine stock performance in many countries[103]. Aside lending support to findings from Gavi, most of the findings reported in this project are aligned with a report by Lydon *et al,* who also found that poor forecasting and stock management were major contributors to vaccine stockouts at central level[102]. This finding re-enforces one key recommendation to immunization programs to prioritize 'using data to drive action on the quality of immunization services'[104] and it further allude to one of the core principles of IA 2030, notably using a 'data-guided' approach to immunization decision making[105]. The shortcoming

observed in this study, alongside recommendations from WHO, highlights the importance of generating high quality data to inform all components of immunization programs, including procurement. To solve the funding and procurement puzzle, study participants made the following three cored recommendations, including setting up a TWG for vaccine financing and procurement, appointing a focal person, would be responsible for following up on government's commitment and establish and executing a fractionated payment plan.

These recommendations are currently being implemented and they have started to yield positive results, including enabling Cameroon to meet its co-financing requirements for 2022 and purchasing the required quantify of traditional vaccines. The country is also on track to complete its vaccine payment for 2023. Given this earlier success, the author would like to recommend Gavi and other global organizations to implement a similar approach in other countries. Already, Gavi has pledged to fund the TWG in Cameroon in 2023, and this may be the beginning of helping Cameroon to successfully transition from Gavi support, which will be due in 2027. Given its promise, this approach can help other countries to successfully transition from Gavi support and provide long term sustainability for the financing of their immunization programs. The concept can also be applied to other vertical programs, including HIV, Malaria and tuberculosis programs funded by Global fund.

The last specific objective of this project was **to develop and test a package of scalable interventions for each of the above specific objectives** for addressing barriers to optimal immunization coverage and equity in Cameroon and other SSA settings. In this project, three interventions were designed and tested, namely, i) strategies for improving RI coverage for ZDC and UIC in missed communities; ii) strategies for improving RI coverage in a conflict setting during a pandemic and iii) strategies for improving procurement and financing process for vaccines.

With regards to improving RI coverage for ZDC and UIC, the approach presented in Figure 11 was designed and tested and this enabled the vaccination of 8,326 ZDC in 20 priority health areas. This

result has motivated the EPI to leverage the approach and apply for funding from Gavi, via its Equity Accelerator funding platform, to target ZDC in areas identified during this project. Other countries, including Benin, Nigeria are also adapting the approach to their different contexts and the PhD candidate has already provided them with support to develop funding proposals to implement the model.

With regards to improving RI in a conflict setting amidst the COVID-19 pandemic, the project has shown that it is possible to leverage local intelligence, local health works, local transportation means to vaccinate children in crises zone. But this implementation phase must be proceeded by advocacy at national level to establish a business case for the intervention, leverage the business case to mobilize the necessary resources and collaborate with affected communities to roll out PIRIs. This approach enabled the EPI team in the SW region to organize three rounds of PIRI, leading to the vaccination 37,407 children, thus raising DTP-3 coverage by 28%, increasing from 43% in 2019 to 71% in 2020. The approach has also enabled the EPI to raise coverage for basically all antigens. We have also shown that following security protocols and COVID-19 safety measures can pre-empt HCW from being harmed by fighters or from contracting covid during campaigns.

Last, but not least, the project has shown, via a pilot, that is possible to improve the efficiency and efficacy of in-country vaccine procurement and financing processes. Mapping the process to understand the pain points and the leveraging on the findings to establish a multi-sectorial working group with clear terms of references and regular meeting schedules can improve the amount of funds allocated for vaccination and the timeliness for mobilizing and transferring these funds to Unicef for coordinated procurement. This approach can redress recurrent and prolonged stockout of vaccines, which in turn can improve on service delivery and immunization coverage.

7. Conclusions

The overall goal of this project was to assess barriers to optimal immunization coverage and equity in Cameroon to leverage the findings to develop scalable strategies and interventions that can be used to improve coverage not only in Cameroon but also in similar settings in Sub-Saharan Africa. Overall, findings for the project suggest that there is an estimated 130,000 ZDC and over 180,000 under immunized children in Cameroon, who are dispersed in several health within the country. Given the limitation in resources, the analysis suggests that the country and her development partners should prioritize reaching ZDC and UIC in 42 districts across the nation. Doing so, may result in to immunizing over 50% of these children. A model that could be leveraged to deliver immunization services to these communities has been proposed. This model has been tested in the Amazon as well as in Manuka health district in Cameroon[2].

The second important factor is the unparallel effect of COVID-19 pandemic on key immunization indicators in Cameroon. Indeed, the study revealed a remarkable decrease in vaccination access and utilization in Cameroon, which were driven by a dramatic decline in facility-based and outreach immunization sessions. Therefore, there is a resounding need to develop and implement recovery and catch-up immunization strategies to mitigate the impact of the pandemic on routine childhood immunization in these regions. To ensure the continuity of childhood routine immunization in future pandemics, there is need to set up a system that will drive the early detection of the impact of the pandemic on immunization services. Moreover, a digital tool that would evaluate the impact of the pandemic at all operational levels in real-time will be of great value. This will help unveil the pandemic's true impact and support data-driven decision making. Additionally, the study findings can be leveraged to inform policies on sustaining immunization services during future pandemics in Cameroon.

Next, the ongoing armed conflict in the NW and SW regions of the country has also impacted key immunization indicators in the two regions as well as Cameroon. The impact of the conflict o the system indicates that implies that many infants in the region miss out on their basic vaccines, a handicap which would continue to render them susceptible to VPDs. Failure to reach children in these regions with vaccination services is already putting the nation at an increased risk of VPD, as evident by the ongoing measles outbreaks. The results from this project, which have already been presented, denote a call to action to rapidly immunize children from these regions, both those residing in conflict zones and the internally displaced. In the short term, there is the need to identify effective strategies and mobilize resources for reaching these children and protecting health facilities and health workers from violence. In the long term, there is the need to rebuild the infrastructure that was destroyed and to re-establish the systems and the supply lines that have been disrupted. Above all, peace needs to return to these regions to ensure permanent improvement in immunization coverage and prevention of deaths from vaccine-preventable diseases.

Finally, the not so obvious procurement and financing bottlenecks are important barriers, with a far-reaching consequence on vaccine availability and adequacy. The findings of this study shed light on some of the major bottlenecks in vaccine procurement and financing in Cameroon, including delayed fund mobilization, lengthy and inefficient procurement processes, and poor data use for forecasting. These factors contributed to a significant funding deficit of US$ 4 million for vaccine procurement between 2016 and 2019, preventing the EPI from purchasing 20 million vaccine doses in a timely manner and leading to 41 months of stockout of at least one antigen. Addressing these challenges will require concerted efforts from all stakeholders to improve the efficiency and effectiveness of vaccine procurement and financing to ensure sustainable vaccine access in Cameroon.

Finally, three set of interventions can be deployed to improve RI coverage and equity in Cameroon. These include, leveraging on existing data sources to identify and characterize hard-to-reach

communities and harnessing the information to design and deliver context specific and operationally feasibility interventions to deliver immunization services to these so-called missed communities. Second, leverage PIRIs to raise coverage in crises zones and third, establish a TWG to improve the procurement and financing processes for vaccines.

8. Recommendations

Basing on the objectives and findings, the results from the project suggest that to improve immunization coverage and equity in any facility, administrative, health area, district, regional and national level in Cameroon or other similar settings, the government and other stakeholders should aim at implementing the following:

1. **To reach ZDC, UIC and missed communities, government and her stakeholders should:**

   1.1. Use data analytics, leveraging various existing data sources to identify the distribution of ZDC, UIC and missed communities at health area, district, regional and national levels.

   1.2. Leverage WHO BeSD tool to explored both demand and supply barriers on why these children miss out on basic primary healthcare services, including vaccination.

   1.3. Leverage the information emanating from 1.1 and 1.2 to develop- context specific strategies to reach these children in their respective settings be it in crisis zone, remote enclaved zones, urban slums, or fluvial communities.

   1.4. Mobilize resources through targeted advocacy.

   1.5. Pilot interventions in selected settings, document successes and failures and review and validate the pilots before leveraging them to prepare scaleup plans.

   1.6. Engage the government to develop a national policy on reaching the unreached ND coordinate with them to create a budget line for this as well as engage their development partners, multilateral and bilateral donors to support them in the implementation of the policy.

2. **To mitigate impact of a public health emergency on key health indicator, government and other interested stakeholders are recommended to:**

   2.1. Use basic resources to develop analytical tools that could be used to measure and track impact of the emergency on key health indicators.

   2.2. Leverage to tool capture data from existing data sources to create analytics that could be used for quick decision making, guide actions and monitor progress.

   2.3. Support governments to develop recovery plans, highlighting areas that should be targeted for catch ups and well as the strategies to use.

3. **To improve RI coverage in conflict zones, government and other interested stakeholders are recommended to:**

   3.1. Leverage existing data to study trends to establish impact of the crises on key health indicators, including immunization.

   3.2. Develop context specific strategies on how to reach target populations in these areas with health interventions Leverage existing local resources (including trusted people in the community, local transportation means etc.) to get the necessary logistics to the target sites.

   3.3. Collaborate with the local stakeholders to rollout campaigns, such as PIRIs and target reaching the maximum of the target population, including internally displaced persons and refugees.

   3.4. Set up data systems to capture and transmit data emanating from the campaigns.

4. **To mitigate the impact of sub-funding fund allocation and mobilization for the procurement of vaccines or other health commodities, government and other interested stakeholders are recommended to:**

   4.1. Map its current procurement and financing processes to gain insights into the various pinpoints and bottlenecks.

   4.2. Assess impact of key bottlenecks on key health indicators, such as vaccine stockouts and their association of coverage and disease outbreaks

   4.3. Establish a multi-sectorial technical working group with clear terms of reference and provide them with the necessary resources to perform their duties.

   4.4. Use data to conduct accurate forecasting of vaccine needs and translate that into dollar amount.

   4.5. Establish a disbursement plan, which splits the amounts paid into small installments for easy approvals, mobilization, and disbursements.

   4.6. Establish a monitoring and evaluation system, which will enable the tracking of key performance indicators, document lessons-be them positive or negative-, put in place plans to mitigate risks and implement corrective actions when problems arise.

9. Annexes

Annex 1:Ethical and Administrative approval

MINSTERE DE LA SANTE PUBLIQUE
SECRETARIAT GENERAL
DIRECTION DE LA SANTE FAMILIALE
PROGRAMME ELARGI DE VACCINATION

MINISTRY OF PUBLIC HEALTH
SECRETARIAT GENERAL
DEPARTMENT OF FAMILY HEALTH
EXPANDED PROGRAM ON IMMUNIZATION

N°____/AA/MINSANTE/SG/DSF/GTC-PEV/SPSV/UAVR.-

Yaoundé, le 11 JUIN 2019

LE MINISTRE

A

MONSIEUR LE DIRECTEUR-PAYS DE
Clinton Health Access Initiative (CHAI)

Objet : Evaluation des barrières à la couverture optimale de la vaccination dans neuf districts de sante cibles au Cameroun

Monsieur Le Directeur-Pays,

J'ai l'honneur de marquer mon accord pour l'autorisation d'une collecte des données relative à l'étude de l'«*Evaluation des barrières à l'atteinte des objectifs de couverture optimale de la vaccination dans neuf districts de sante sous performants au Cameroun* » dans le cadre du renforcement de la vaccination de routine.

Toutefois, je vous saurai gré de soumettre le protocole de cette étude à l'appréciation du Comité National d'Ethique pour l'obtention d'une clairance éthique.

Veuillez agréer, Monsieur Le Directeur-Pays, l'assurance de ma parfaite considération. /-

Pour le Ministre de la Santé Publique
Le Secrétaire d'Etat à la Santé Publique Chargé
de la Lutte Contre les Epidémies
et les Pandémies

ALIM HAYATOU

Ampliations :

- DROS/MINSANTE
- DSF
- CNERSH

Annex 2: Informed Consent- Assessment of the demand and supply-side barriers to vaccination access and utilization in missed communities in Cameroon

Informed Consent

All informed consent forms will be issued in the first language of the participant.

Informed Consent Form

Category of Participant (circle as relevant):

- Caregiver
- HCW/Health Official
- Community Leader

I, the undersigned _____ (Full Name)

Have agreed to participate in the following study: *« Assessment of the demand and supply-side barriers to vaccination access and utilization in missed communities in Cameroon ».*

Conducted by the following investigator: Dr. Yauba Saidu, of Y-Building, 3rd Floor, Rue 1775 Nouvelle Route de Bastos P.O. Box 5241 Yaoundé, email: ysaidu@clintonhealthaccess.org

I have read and I fully understand the participant information notice concerning this study or the participant information notice for this study has been read and explained to me fully;

- I have fully understood the objectives of this study;
- I have received answers to all the questions I have about the study;
- The risks and benefits of participating in this study have been fully explained to me;
- I understand that I can accept or decline to participate in this study and I can decide to withdraw my participation at any time,
- My consent to participate in the study does not disengage the researcher from his ethical obligations; I reserve all my rights according to the law.
- I agree to voluntarily participate in this research according to the stipulations of the information notice by:
    - Responding to interview questions where comfortable and having the interview recorded
    - Answering a questionnaire
    - Participating in a focus group discussion

Done in (location) _____ On (Date) _____

Principal Investigator:
Dr. Yauba Saidu
P.O. Box 5241, Yaoundé
Tel: +237650828451

Study Participant:

Annex 3: Interview guide- « Assessment of the demand and supply-side barriers to vaccination access and utilization in missed communities in Cameroon ».

1.4.1. Interview guide – Care givers

Date	
Name of interviewer	
Interviewee ID/ designation	
District name	
Health area	
Interview start time	
Interview end time	

S/N	Question/[Instruction]	Optional probes
	Introduction: Hello, I am [INTERVIEWER'S NAME]. We are interviewing people to help improve uptake of vaccination services in Cameroon. The interview is expected to take 45 minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me?] Would you be happy for me to record our conversation?	
1	**Tell me a little about yourself and your family.**	- How old are you? [note the gender. It may be perceived as offensive if asked in this context] and what do you do? - Who lives in your household with you? - How old is your child/are your children? - How many children do you have? - Are your children up to date with their vaccines?
2	**Motivation** Thinking back to the first time you had your child vaccinated, tell me why you decided that you would go ahead with it**.**	[If first vaccine was administered at birth, ask about the first time they took their child back for their next set of scheduled vaccines.] - Did anyone suggest it? - Who decided that you should take your child to be vaccinated? - Who usually takes your child(ren) to have their vaccines? If the child has not received any other vaccines after the ones administered at birth or did not

S/N	Question/[Instruction]	Optional probes
		receive the ones at birth, then skip Q2 and go to Q3
3	**Thinking and feeling about vaccines** What are your thoughts about vaccines?	- Cameroon has a schedule of recommended vaccines for children. Do you want your child to get none of these vaccines, some of these vaccines or all of these vaccines? Why? - How important do you think vaccines are for your child's health? Any worries about an unvaccinated child getting childhood infections? - Do you think vaccines are safe? - Any issues about your local healthcare workers that currently deters you from vaccinating your child? [if yes] What are they?
4	**Social processes** **Do you talk about vaccination with anyone else?**	- Is it common for people to vaccinate their children in your community? Why or why not? - Are there any cultural or religious views for or against vaccination - Who do you talk to about vaccination and other health related matters? - What do they say?
	Are there any family, community or religious cultures that may affect vaccine use?	- Do you think most of your close family, friends, community and religious leaders wants you to vaccinate your child? [Why or why not?] - What do they do to either encourage or discourage you from vaccinating your child(ren)

S/N	Question/[Instruction]	Optional probes
5.a	**Practical issues** Exploring gender issues - Does being male or female care giver affect whether or not you can vaccinate your child?	- How far is the closest vaccinating facility? [if far] Do you find it difficult to take your child there? - Do you work? [if yes] Do you feel you can afford to take your child for vaccination or you need to depend on another person's support? - Who takes the final decision (husband or wife or other family member) on whether the child should be vaccinated or not? [if your spouse] what happens if you override the decision? - Does the decision to vaccinate a child depends on the sex of the child? - During vaccination campaigns and outreaches are you or your spouse comfortable with your child being vaccinated by healthcare workers of any gender? - Who takes the child for vaccination? [if a specific spouse] why? [security issues, distance, culture…etc] - Are you allowed to move out of the compound beyond a certain distance? [security issues, distance, culture…etc] Do you always need express permission?
5b	**Thinking back to the first time you took your child to be vaccinated, tell me how you knew it was time to do so?**	- What kind of reminders do you use?
5c	**Let's talk about vaccination days, what happens before you leave home?**	- Do you know where to go to get your child vaccinated? - What do you need to do to prepare before you leave home?
5d	**Once you arrive at the vaccination place, tell me what happens next.**	- Are you attended to on time? Do you have to wait on a queue and for how long? - Do you need to pay a fee? - Are other health checks done while you're there? - What do the health workers talk to you about while you're vaccinating your

S/N	Question/[Instruction]	Optional probes
		child ? How do you feel when you talk with them? - Are you satisfied with their services at the clinic?
5e	**What do you or don't you like about what happens on vaccination day?**	- [If there is something identified that they like] Why do you like it? - Are there things/activities you would like to see happen more often at the facility? - Is there anything you find difficult or unsatisfactory? Why? - Is there any support you think community/community leaders can provide to make vaccination easier?
6	**Is there anything else you'd like to say?**	

1.4.2. Interview guide – Healthcare workers

Date	
Name of interviewer	
Name of facility	
Interviewee ID/ designation (e.g In-charge, EPI personnel etc)	
District name	
Health area	
Interview start time	
Interview end time	

S/N	Question/[Instruction]	Optional probes
	Introduction: Hello, I am [INTERVIEWER'S NAME] with CHAI. We are interviewing people to help improve vaccination services in Cameroon.	

S/N	Question/[Instruction]	Optional probes
	The interview is expected to take 45 minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? Would you be happy for me to record our conversation?	
1a	**Introduction** **Tell me a little about yourself and what you do.**	- How old are you? [note the gender. It may be perceived as offensive if asked in this context] - What are your responsible for? - How long have you been involved in this role? - Where do you perform your duties?
1b	**To what extent does your role involve immunization?**	- What parts of your job involve immunization? - Can you tell me more about that?
2	**I'd like to understand the process you follow to immunize a child.**	- Does it involve work for you even before the family arrives at the centre for vaccination? What kind of work? - On average, how many children are vaccinated during fixed and outreach sessions respectively? - Can you summarize the procedure of immunization in around five steps, starting once a family arrives at the centre for vaccination? *[Note: Adjust this question for non-clinic settings if required.]* - Are there follow-ups or steps involved once they leave the centre? *[Note: Other probes, such as ongoing door to door, systems of recording vaccinations, making vaccination cards and so on, could be added as required.]*
3	**What challenges do you face with administering vaccines to children?**	- Are the vaccines and other relevant supplies usually available in time for RI sessions?

S/N	Question/[Instruction]	Optional probes
		- Are there challenges with logistics and CCE required for seamless RI sessions to happen? - Are there enough staff to help with coordination, service delivery and data management? - Are caregivers charged a fee to receive vaccination. Why or why not?
4	**What challenges do you face getting families to vaccinate their children?**	- Are there any family, social or religious norms that are conflicting with vaccination uptake in this community? - are there pockets of people who have certain challenges with accessing RI? Who are they and what challenges do they face? - Can you give some examples of reasons that people give for refusing vaccines for their children? - Do you think gender has a role to play in childhood immunization in this community? Does your gender as a healthcare worker influence caregivers' decision to accept or refuse vaccines for the children? - How do you identify cases of missed opportunities for vaccination and get them vaccinated? - Do you track zero-dose children? If yes, how do you identify and vaccinate them? *IF CHW, ask the following in addition* - What challenges do you face with mobilizing the community? - Are there populations that usually aren't reached with fixed or outreach strategies in this community? if yes, why?

S/N	Question/[Instruction]	Optional probes
5	**What do you find works in helping families stay up to date with immunization?**	- What helps them not miss doses or appointments? - Are there cases of hesitancies? If yes, how do you resolve the issue and get the children vaccinated?
6	**If you had the chance, what would you do to improve immunization services in your area?**	

1.4.3. Interview guide – Community leader

Date	
Name of interviewer	
Interviewee ID/ designation	
District name	
Health area	
Interview start time	
Interview end time	
Question/[Instruction]	**Optional probes**
Introduction: Hello, I am [INTERVIEWER'S NAME] with CHAI. We are interviewing people to help improve vaccination services in Cameroon. The interview is expected to take 45 minutes. Your articipation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? Would you be happy for me to record our conversation?	
Tell me a little about yourself and your role here in the community.	- How old are you? [note the gender. It may be perceived as offensive if asked in this context] - What is your role in this community? - To what extent does your work involve promoting health? - Can you tell me more about that? Does it also include vaccination? Why [or why not?]

	- Who do you work with to do that work?
Are there any family, community or religious cultures that may affect vaccine use?	- Is it common for people to vaccinate their children in your community? Why or why not? - Are there any cultural or religious views for or against vaccination - Who decides whether the child should be vaccinated or not? - Do community leaders (religious leaders, traditional leaders, etc), influence child vaccination? If yes, how? Any specific examples?
Does gender affect childhood immunization in your community?	- How does the community receive information about vaccination? Does this differ for women and men? - Who makes decisions about children's immunization in the household? - Does the community prefer to vaccinate only girl or male children? If yes, why? - What resources do women and men need to be able to ensure their child is immunized (e.g., information, money, time, transportation)? Who has access to and control over these resources? Who takes the lead to ensure the child is vaccinated [by taking the child to a vaccinating facility]? - In specific neighborhoods or communities, who can access households to immunize children where house-to-house campaigns take place? Are there areas where only female health workers are permitted to enter households? How does access (or lack of it) impact planning for frontline workers, such as social mobilizers and vaccinators?
Can you take me through the process you follow when you work in a community? [focus here is on the role in health promotion]	- -What approach or opportunities or forums do you use to influence vaccination uptake? - -What are your key messages? - -Do you participate in vaccination outreaches and campaigns? What role do you play? - -Do you follow up with the families afterward? How do you do that?
What do you find works in helping families stay up to date with their children's immunizations?	- What helps them not miss doses or appointments? *[Note: This is to probe for practical issues.]* - What helps those who are hesitant about getting their children vaccinated?
What makes it difficult for families stay up to	- Do you think gender have a role to play in childhood immunization in this community?

date with immunization?	- Are there any family, social or religious norms that are conflicting with vaccination uptake? - Can you give some examples of reasons people give when their child has fallen behind the vaccination schedule? - Can you give some examples of reasons that people give for refusing vaccnes for their children? - Are you able to contribute in overcoming these challenges? How?
If you had the chance, what would you do to improve immunization services in your area?	

Annex 4: List of Key informants for the vaccine procurement and financing process

No	Entity	Sub Entity		Number of Key Informants
GOVERNMENT CENTRAL LEVEL				
1	Ministry of Public Health	Cabinet (MPH)		1
		Cabinet (State Secretary in charge of outbreaks and pandemics)		1
		Service Coordination (SG)		1
		Department of Finance and Property	budget service	1
			planning service	1
			financial controller	1
		Division of Cooperation	Head of division,	1
			head of international partnership cell	1
		Department of Family Health, Subdivision of immunization		1
2	Ministry of Finance	Health Desk		1
		Treasury		1
3	Ministry of Economy	Department of cooperation: Director		**1**
4	The Expanded programme on Immunization	Logistics Section		2
		Administration and Finance		2
		Management		1
5	Autonomous Sinking Fund (CAA)	Deputy Director		1
		Payment department		1
TECHNICAL AND FINANCIAL PARTNERS				
6	GAVI	Country Support Team		**1**
7	UNICEF	Immunization Section – Country Office		1
		Supply Division - Copenhagen		1
8	WHO	Immunization Section - Country office		1
9	WORLD BANK	Health program		1
10	PLAN International	Immunization programme		1
11	French Cooperation	Health Counsellor		1
REGIONAL AND PERIPHERAL LEVEL				
17	Regional and peripheral level	Delegate		3
		EPI Coordinator		3
		Logistician		3
		District Medical Officer		3
TOTAL				**41**

Annex 5: Key Informant's Interview Guide

Guide d'entretien avec les informateurs clés
Le Ministre de la Santé Publique
Le Secrétaire d'Etat à la Santé en charge des Epidémies et des Pandémies.

INTRODUCTION

Bonjour Monsieur le Ministre.
Je m'appelle …… ; Je suis accompagné de mon collègue ……
Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers.
Avez-vous des questions pour nous Monsieur le Ministre ?
Pouvons-nous commencer Monsieur le Ministre? Oui/Non

Le sexe de l'interviewé : ☐ F ☐ Date interview___/___ /____
Nom de l'interviewé : ----------
Fonction de l'interviewé : _____
Nombre d'années dans cette fonction : _____
Lieu de l'entretien_____
Heure de début : _____ Heure de fin : _____

L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	Questions de relance (Ne doit pas être oui / non, mais s'appesantir sur le pourquoi)
Ministre de la Santé Publique, Processus d'élaboration, d'engament et de mobilisation du budget de l'Etat : Pourquoi l'Etat ne couvre-t-il pas entièrement le financement de la vaccination à travers le PEV?	a- Financement du PEV par l'Etat - Quelle est votre appréciation du financement du PEV par l'Etat ? (Suffisante, mobilisé à temps, difficultés.) - Quelles sont les difficultés rencontrées par le Ministre pour la mise à disposition à temps, des fonds prévus pour l'acquisition des vaccins du PEV ? - Y –aurait-il des solutions à ces difficultés ? Lesquelles ?
Le Cameroun cessera d'être éligible aux financement de GAVI en fin 2027.	b- Plan de transition - Comment envisagez-vous la fin des ruptures de stocks de vaccins telles que connues en 2017 et en 2018?

- Comment le Ministère de la Santé Publique se prépare-t-il pour l'acquisition des vaccins du PEV dans l'optique du retrait progressif de GAVI ?
- Comment pensez-vous combler les gaps financiers du PEV et améliorer la couverture vaccinale ? (Y aurait-il plus de budget pour le MINSANTE ? le MINSANTE augmentera-t-il la proportion accordée au PEV dans tous les cas ?

Notre entretien est terminé Monsieur le Ministre,
Auriez-vous des questions à nous poser ?
Nous tenons une fois de plus à vous remercier pour le temps que vous nous avez accordé.
Le rapport de cette étude sera soumis à votre validation avant sa publication.

Guide d'entretien avec des informateurs clés

Chef de Division Coopération
Chef de la Cellule du Partenariat International MINSANTE

INTRODUCTION

Bonjour Monsieur.

Je m'appelle …… Je suis accompagné de mon collègue ….

Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout, vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes, pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers.

Avez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

Le sexe de l'interviewé : ☐ F ☐ Date interview___/___ /____

Nom de l'interviewé : ----------

Fonction de l'interviewé : _____

Nombre d'années dans cette fonction :_____

Lieu de l'entretien_____

Heure de début : _____ Heure de fin : _____

L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	Questions de relance (Ne doit pas être oui / non, mais s'appesantir sur le pourquoi et le comment)
Chef de Division de la Coopération ou Chef de la Cellule du Partenariat International, Processus d'élaboration, d'engament et de mobilisation des financements extérieurs du PEV: Dans le cadre du programme élargi de vaccination Comment les contributions des partenaires Techniques et Financiers sont-elles obtenues ? Le Cameroun cessera d'être éligible aux financement de GAVI en fin 2027. Comment le Ministère de la Santé Publique se prépare-t-il à couvrir les gaps de financement de GAVI?	c- Contribution des PTF dans le budget - Comment les financements des PTF pour le PEV parviennent-ils au MINSANTE? - Comment ces contributions sont-elles prises en compte dans la préparation du budget de l'ETAT pour les exercices 2020 et autres? d- Plan de transition - Comment seront couverts les gaps au cas où le budget du MINSANTE ne le permettrait pas ?

Notre entretien est terminé Monsieur.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
Une copie du rapport de cette étude vous sera remis après son adoption dans le cadre d'un atelier de validation dans lequel vous serez convié.

Guide d'entretien avec des informateurs clés
PEV – SECTION LOGISTIQUE

INTRODUCTION

Bonjour Monsieur.

Je m'appelle …… Je suis accompagné de mon collègue ….

Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout, vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes, pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers.

Avez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

Le sexe de l'interviewé : ☐ **F** ☐ **Date interview**___/___ /____

Nom de l'interviewé : ----------

Fonction de l'interviewé : _____

Nombre d'années dans cette fonction :_____

Lieu de l'entretien_____

Heure de début : _____ Heure de fin : _____

Obtention du consentement écrit de l'interviewé : /___ / Oui /___ /Non

L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	Questions de relance (Ne doit pas être oui / non, mais s'appesantir sur le pourquoi)
Logistique, Processus d'acquisition des vaccins : Dans le cadre de l'approvisionnement en vaccins pour le PEV, quelles en sont les différentes étapes ?	e- Quantification - Comment se déroule le processus de quantification et quels sont les différents acteurs qui y interviennent ? - Quel est votre appréciation de ce processus ? - Comment pensez-vous améliorer le fonctionnement du processus d'expression des besoins ? - Comment déterminez-vous la quantité de vaccins à commander ? (Besoins réels ou le budget ?)

- Quelles sont les obstacles que vous rencontrez pour l'expression de la quantité nécessaire de vaccins à commander ?
- Que pensez-vous de la formation du personnel impliqué dans la quantification ?
- Quelles solutions à votre avis devraient être apportées pour se débarrasser de ces obstacles ?

f- Phase post quantification

- Comment faites-vous pour obtenir les vaccins après l'étape d'expression de besoins?
- Comment appréciez-vous l'approvisionnement en vaccins ? (Livré à temps, en quantités suffisantes, de bonne qualité …)
- Quelles suggestions pouvez-vous faire pour améliorer l'approvisionnement en vaccins ?

Notre entretien est terminé Monsieur.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
Une copie du rapport de cette étude vous sera remis après son adoption dans le cadre d'un atelier de validation dans lequel vous serez convié.

Guide d'entretien des informateurs clés

PEV – Section Administration et Finance

INTRODUCTION

Bonjour Mademoiselle, Madame ou Monsieur.

Je m'appelle …… Je suis accompagné de mon collègue ….

Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout, vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes, pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers.

Avez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

Nom de l'interviewé : ----------

Sexe de l'interviewé : M ☐ F ☐ Date interview___/___ /____

Fonction de l'interviewé : _____

Nombre d'années dans cette fonction:_____

Lieu de l'entretien_____

Heure de début : _____ Heure de fin : _____

Obtention du consentement écrit de l'interviewé : /___ / Oui /___ /Non

L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	Questions de relance (Ne doit pas être oui / non, mais s'appesantir sur le pourquoi)
Administration et Finance : Dans le cadre de l'approvisionnement en vaccins pour le PEV, quels rôles la section Administration et Finance joue-t-elle ?	- Connaissances et pratiques sur l'approvisionnement des vaccins - Quelle est votre appréciation du rôle de la SAF dans l'approvisionnement en vaccins au PEV ? - Comment le budget du PEV en général et celui de l'acquisition des vaccins en particulier est-il élaboré ? Quelles en sont les étapes ? - Après la budgétisation, comment se fait la mobilisation des fonds pour le fonctionnement du PEV et l'acquisition des vaccins ? b- Mobilisation des fonds

- Quelles sont les étapes pour mobiliser les fonds ?
- Quels sont les obstacles rencontrés lors de la mobilisation des fonds ?
- Quel délai faut-il pour mobiliser les fonds ?
- Qu'est ce qui peut expliquer ces délais selon vous ?
- Quelles suggestions pouvez-vous faire pour améliorer le financement de l'approvisionnement en vaccins ?

Notre entretien est terminé Monsieur.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
Une copie du rapport de cette étude vous sera remis après son adoption dans le cadre d'un atelier de validation dans lequel vous serez convié.

Guide d'entretien des informateurs clés
PEV - Secrétaire

INTRODUCTION

Bonjour Madame.

Je m'appelle …… Je suis accompagné de mon collègue ….

Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout, vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes, pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers. Vous avez été choisie pour vos fonctions et l'influence que vous avez dans le processus de quantification des besoins, de commande ou de mobilisation des ressources pour la passation de marchés d'acquisition des vaccins ou encore de mobilisation des PTF pour leur appui au PEV.

Avez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	Questions de relance (Ne doit pas être oui / non, mais s'appesantir sur le pourquoi)
Secrétaire Permanent du Groupe Technique Central du PEV: Quels rôles le Secrétariat Permanent du PEV joue-t-il dans l'approvisionnement des vaccins au Cameroun ?	a- Quantification - Comment se déroule le processus de quantification et quels sont les différents acteurs qui y interviennent ? - Quel est votre appréciation de ce processus ? - Comment déterminez-vous la quantité de vaccins à commander ? (Besoins réels ou le budget ?)

- Avez-vous des solutions pour surmonter les difficultés que vous rencontrez dans la détermination des besoins en vaccins?

b- Phase post quantification

- Comment faites-vous pour obtenir les vaccins après l'étape d'expression de besoins?
- Quels sont les obstacles rencontrés à la phase post quantification ?
- Comment envisagez-vous les résoudre ?

c- Budgétisation et mobilisation des fonds

- Comment se fait la budgétisation des activités du PEV ?
- Comment la Direction du PEV s'assure-t-elle que le budget élaboré respecte les canons du CDMT et de la finance publique ?
- Comment se fait la mobilisation des fonds alloués ? (Quels en sont les délais?)
- Quels sont les obstacles rencontrés dans tout ce processus : budgétisation – mobilisation des fonds ?
- Quelles solutions à votre avis, pourraient améliorer ce processus ?

d- Approvisionnement en vaccins

- Comment appréciez-vous l'approvisionnement en vaccins ? (Quels délais ? livré à temps, en quantités suffisantes, de bonne qualité …)
- De façon générale quels sont les obstacles à l'acquisition des vaccins ?
- Quelles sont les solutions, selon vous, qui pourraient améliorer ce processus ?
- Que fait le SP PEV pour éviter les ruptures de stocks de vaccins tels que celles survenues en 2017 et en 2018 ?
- Que pensez-vous des approvisionnements pendant la transition et après graduation du Cameroun ?

Notre entretien est terminé Madame.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
Une copie du rapport de cette étude vous sera remis après son adoption dans le cadre d'un atelier de validation dans lequel vous serez convié.

Guide d'entretien avec les informateurs clés :
MINSANTE/DRFP

INTRODUCTION

Bonjour Monsieur.

Je m'appelle …… Je suis accompagné de mon collègue ….

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Avez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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L'achat des vaccins au Cameroun obéit à deux mécanismes : le financement de l'Etat pour les vaccins traditionnels (BCG, VPO, Tétanos & Diphtérie et Rougeole & Rubéole) et le cofinancement GAVI – Etat pour l'achat de nouveaux et des vaccins peu utilisés. Du cofinancement Etat du Cameroun - GAVI, il a été de 15% et 85% en 2016, il sera de 60% et 40% en 2024 respectivement et l'Etat devra l'assumer entièrement en 2027 après le retrait de GAVI. Le PEV a connu en 2017, une rupture de stocks du BCG de 60 jours. Une autre rupture de stocks de 30 jours du vaccin anti tétanique et du vaccin contre la rougeole et la rubéole est survenue en 2018. Ces ruptures de stocks sont en lien avec les retards de mise à disposition de fonds par le gouvernement, qui ont affecté également le cofinancement avec GAVI, toute chose pouvant faire craindre les mêmes causes, si les fonds du partenaire ne jouaient l'effet tampon.

Questions pour l'entretien (sujet)	**Questions optionnelles**
MINSANTE/DRFP : Quels rôles la DRFP joue-t-elle dans l'approvisionnement en vaccins du PEV au Cameroun ?	a- Appréciation du rôle de la DRFP - Quelle est votre appréciation du rôle de la DRFP dans l'approvisionnement en vaccin au PEV ? - Comment et dans quelle mesure votre rôle pourrait-il impacter l'acquisition des vaccins pour le PEV d'une manière ou d'une autre ? - Comment appuyez-vous le PEV et ses partenaires pour l'acquisition à temps des vaccins ?

	- Comment pourrait-on améliorer votre rôle pour un PEV performant et efficient ? **b- Budgétisation et mobilisation des fonds** - Comment se fait la budgétisation des activités du PEV ? - Comment la DRFP s'assure-t-elle que le budget élaboré respecte les canons du CDMT et de la finance publique ? - Comment se fait la mobilisation des fonds alloués ? (quels en sont les étapes et les délais) - Comment à votre avis pourrait-on éviter les ruptures de stocks en lien avec la non mobilisation à temps des finances publiques allouées au PEV ?

Notre entretien est terminé Monsieur.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
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Guide d'entretien avec les informateurs clés
MINFI/Direction du Trésor

INTRODUCTION

Bonjour Monsieur.

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Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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Questions pour l'entretien (sujet)	Questions optionnelles
Direction du Trésor : Mobilisation des fonds pour l'acquisition des vaccins : Comment la Direction du Trésor s'implique-t-elle pour mettre des fonds à disposition du PEV pour l'acquisition des vaccins ?	**a- Mobilisation des fonds aux Finances** - Comment la Direction du Trésor est-elle impliquée pour mettre les fonds pour l'acquisition des vaccins ? - Qui décide du moment de la mise à disposition des fonds ? - Qui décide du montant à mettre à disposition ? - Quel est le délai pour mettre les fonds à disposition du PEV pour l'acquisition des vaccins ?

	- La mise à disposition des fonds se fait-elle selon une priorité ? Si oui, comment s'établit la priorité et qui en décide? - Qu'est ce qui à votre avis pourrait expliquer les retards de la mise à disposition des fonds, source des ruptures de stocks de vaccins ? - Comment pourrait-on éviter que cela n'arrive plus?

Notre entretien est terminé Monsieur.
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Guide d'entretien des informateurs clés
MINEPAT/Direction de la programmation des investissements publics

INTRODUCTION

Bonjour Mademoiselle, Madame ou Monsieur.

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Questions pour l'entretien (sujet)	Questions optionnelles
Programmation du budget pour l'acquisition des vaccins :	- Comment se fait l'allocation du budget d'investissement dans votre direction ? - Comment détermine-t-on le montant à allouer à un Ministère ou à un organisme public quelconque ? - Comment à titre d'exemple se fait l'allocation du budget d'achat des vaccins demandé par le MINSANTE/PEV ? - Qu'est ce qui à votre avis peut expliquer les ruptures de stocks de vaccins dues à des retards de mise à disponibilité des fonds publics?

- Quelles sont, selon vous, les solutions pour éviter ces situations préjudiciables pour la santé des enfants et des adultes?

Notre entretien est terminé Monsieur.
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Guide d'entretien des informateurs clés
CAA : Directeur Adjoint et Service de paiement

INTRODUCTION

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Auriez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?

Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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Questions pour l'entretien (sujet)	**Questions optionnelles**
Mobilisation des fonds pour l'acquisition des vaccins : Quels rôles la CAA joue-t-elle dans la mise à disposition des fonds publics destinés à l'acquisition des vaccins ?	- Quelle est votre appréciation du rôle de la CAA dans la mobilisation des fonds publics destinés à l'achat des vaccins ? - Comment appréciez-vous les procédures actuellement en cours pour mobiliser ces fonds ? - Que pensez-vous des délais pour cette mobilisation ? - Quelles sont les difficultés que vous rencontrez pour mettre à disposition et à temps fonds nécessaires à l'acquisition des vaccins?

	- Qu'est ce qui à votre avis peut expliquer les ruptures de stocks de vaccins dues à des retards de mise à disponibilité des fonds publics? - Quelles sont, selon vous, les solutions pour éviter ces situations préjudiciables pour la santé des enfants et des adultes?

Notre entretien est terminé Monsieur.
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Guide d'entretien des informateurs clés
UNICEF : BUREAU CAMEROUN ET COPENHAGEN

INTRODUCTION

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Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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Questions pour l'entretien (sujet)	**Questions optionnelles**
Mobilisation des fonds pour l'acquisition des vaccins : Quels rôles joue l'UNICEF dans l'acquisition des vaccins ?	- Quelle est votre appréciation de l'approvisionnement des vaccins au Cameroun ? - Quels sont les problèmes rencontrés pour livrer les vaccins au Cameroun selon les besoins et les délais ? - Quelles sont, selon vous, les solutions pour améliorer le processus ?

Notre entretien est terminé Monsieur.

Auriez-vous des questions à me poser ?

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Guide d'entretien avec les informateurs clés
GAVI

INTRODUCTION

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Nous travaillons pour Clinton Health Access Initiative (CHAI) à Yaoundé, un des partenaires Techniques et Financiers du Gouvernement du Cameroun et du Ministère de la Santé Publique. Nous voulons avant tout, vous remercier de nous avoir accordé un peu de votre temps et d'accepter cet entretien qui intervient dans le cadre de la présente enquête visant à décrire le processus d'approvisionnement et de financement des vaccins au Cameroun, en vue de faire du PEV un Programme performant et efficient. Nous souhaitons avec votre permission, enregistrer notre entretien d'une vingtaine de minutes, pour les besoins d'étude et de bonne exploitation des réponses que vous nous donnerez. Celles-ci ne seront utilisées que dans le cadre de la présente étude et ne seront en aucun cas communiquées à un tiers. Vous avez été choisi pour vos fonctions et l'influence que vous avez dans le processus de mobilisation des ressources pour la passation de marchés d'acquisition des vaccins du PEV.
Auriez-vous des questions pour nous Monsieur le Chef de Division/ Monsieur le Chef de la Cellule du Partenariat International?
Pouvons-nous commencer Monsieur le Chef de Division/ Chef de la Cellule de Partenariat International ? Oui/Non

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Questions pour l'entretien (sujet)	**Questions optionnelles**
Acquisition des vaccins : Que fait GAVI pour aider l'Etat à garantir la disponibilité des vaccins ?	- Quelle est votre appréciation de l'approvisionnement des vaccins au Cameroun ? - Quels sont les problèmes identifiés dans le système d'approvisionnement des vaccins du Cameroun - Quelles sont, selon vous, les solutions pour améliorer le processus ? - Que se passerait-il si le Cameroun ne trouvait pas de financement en 2020 pour combler les gaps croissants d'année en année du fait du programme de graduation ou de ses difficultés de trésorerie?

- Que deviendraient donc les résultats jusqu'ici atteints ?

Notre entretien est terminé Monsieur.
Auriez-vous des questions à me poser ?
Je tiens à vous remercier pour le temps que vous nous avez accordé.
Une copie du rapport de cette étude vous sera remis après son adoption dans le cadre d'un atelier de validation dans lequel vous serez convié.

Annex 6: List and roles of Responsibilities of key informants for objective #4

Key Informant	Roles and Responsibilities
The Ministry of Public Health (MoH):	○ Department of finance resources and property (DRFP), responsible for preparing all financial documents required for obtaining government allocated funds for the ministry, ○ Division of Cooperation and its international partnership cell, responsible of cooperation with the ministries of financial, Economy, and technical partners. ○ Department of Family Health and its sub-division of immunization, responsible for overseeing the EPI functions
The Ministry of Finance (MINFI):	○ Public Treasury: The Public Treasury is responsible for releasing funds to the Ministry of Public Health for the procurement of vaccines
The Ministry of Economy and Planning (MINEPAT):	○ Division of Cooperation. This department is responsible for yearly budgetary planning for counterpart funds used by the country to complement funding from international donors.
The Autonomous Sinking Fund (AAF/CAA),	○ Responsible for transferring state funds for the procurement of vaccines to UNICEF Supply Division or any other partner according to bilateral or multilateral conventions.
The Expanded Program on Immunization (EPI)	○ The EPI is responsible for coordinating the procurement, distribution, and use of vaccines across the country.
Regional Delegations, districts, and facility level	○ Responsible for collecting and sending consumption data to central level
Global Alliance for Vaccines and Immunization (GAVI):	○ Funds over 54% of EPI vaccines needs- for both routine vaccination activities and for procurement of new and underutilised vaccines, such as Pentavalent, Inactivated Polio Vaccine, Rotavirus, Pneumococcal vaccine, and yellow fever.
United Nations International Children Emergency Fund	○ Support the EPI to procure vaccines using its pooled procurement mechanism.
World Health Organization (WHO)	○ Support in country in decision making on all aspects of immunization and in the management of the vaccine supply chain
French Cooperation	○ Support in funding some of the country's vaccines needs
World Bank.	○ Support in financing many health projects
Clinton Health Access Initiative	○ Support EPI with Vaccine forecasting, management, and distribution in-country

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