IVCC
Building Partnerships
Creating Solutions
Saving Lives

Vector Control in the Indo-Pacific: Market Access Landscape

Country Report

Cambodia

INNOVATIVE VECTOR CONTROL CONSORTIUM

November 2019

Contents

List of Tables

List of Figures

Abbreviations

ADB	Asian Development Bank
ATSB	Attractive toxic sugar baits
BCC	Behaviour change communication
BMGF	Bill & Melinda Gates Foundation
Bti	*Bacillus thuringiensis israelensis*
CDC IAA	U.S. Centers for Disease Control and Prevention Interagency Agreement
CMEP	Cambodia Malaria Elimination Project
CMS	The Central Medical Store
CNM	The National Center for Malaria Control, Parasitology and Entomology
CRC	The Cambodian Red Cross
CSO	Civil Society Organization
ESP	Education Strategic Plan
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GHSC-PSM	The Global Health Supply Chain Program – Procurement Supply Management
GMS	Greater Mekong Subregion
HSP	Health Strategic Plan
IRS	Indoor Residual Spray
ITN	Insecticide-treated net
IVM	Integrated Vector Management
JE	Japanese encephalitis
KOL	Key Opinion Leaders
LLIHN	Long-lasting insecticide-treated hammock net
LLINs	Long lasting insecticidal nets
LMIS	Logistics management information system
MCC	Malaria Control in Cambodia
MEAF	Malaria Elimination Action Framework
MIS	Malaria Information System
MMWs	Mobile Malaria Workers
MoEYS	Ministry of Education, Youth and Sport
MoH	Ministry of Health
NDCP	National Dengue Control Program
NFM	New Funding Model
NMCP	The National Malaria Control Program
NSP	National Strategic Plan
OD	Operational district
PHDs	Provincial Health Departments
PMI	President's Malaria Initiative
PNG	Papua New Guinea
PQ	Prequalification
PSK	Population Services Khmer
RAI	Regional Artemisinin Initiative
RAI2E	Regional Artemisinin-resistance Initiative 2 Elimination
RDTs	Rapid diagnostic tests
SEA	South-East Asia
UNOPS	The United Nations Office for Project Services
URC	University Research Co. LLC
USAID	United States Agency for International Development
USF	University of South Florida
VBD	Vector-borne Disease
VC	Vector control
VMW	Village Malaria Workers
WHO	World Health Organization
WTP	Willingness-to-pay

1. Executive Summary

Dengue and malaria are the most prevalent vector-borne diseases in Cambodia

Cambodia is one of the countries in the Greater Mekong sub-region and has a high prevalence of malaria and dengue, amongst other vector-borne diseases (VBDs). It has low coverage for many essential services such as safe drinking water, sanitation, and healthcare services as compared to other South-East Asian countries.

Considerable progress has been made in malaria control in the last decade. Despite the success, Cambodia's malaria burden continues to be disproportionately borne by mobile, migrant, ethnic and cross-border populations and minority groups, representing a huge challenge for its control and elimination. Geographically, malaria is endemic in ~84% of provinces with the highest incidence in north-eastern parts of Cambodia. Moreover, due to the spread of artemisinin drug resistance identified in multiple sites in Cambodia (including the Thai-Cambodia border), malaria incidence is increasing and posing challenges for the achievement of the national elimination goals.

The Global Fund is the main donor for malaria control in the country since 2005

In order to reduce the malaria burden in Cambodia, various organizations are supporting and funding malaria control and elimination activities. Funding is the main activity helping VBD control in the country. The main donors in Cambodia are The Global Fund, PMI, BMGF, and the Asian Development Bank (ADB). The Global Fund has been the major donor for malaria control since 2005. There are two Global Fund mechanisms in Cambodia: Both the Regional Artemisinin Initiative (RAI) and the New Funding Model (NFM) ended in December 2017. The United Nations Office for Project Services (UNOPS) serves as the principal recipient for both the RAI and the NFM grants.

PMI is the second largest donor supporting malaria control and elimination activities in Cambodia. PMI plays a key coordinating role directly engaging each of the main donors to coordinate activities and leverage funding to more efficiently support the CNM's (National Centre for Parasitology, Entomology, and Malaria) control and elimination activities.

Large global donors are engaged in the mass distribution of long-lasting insecticide-treated nets (LLINs) and long-lasting insecticide-treated hammock nets (LLIHNs)

The procurement channels for vector control products in Cambodia include the traditional donor channels and the retail channels. Large global donors are active in the country and are the primary source of donor-driven vector control products, such as LLINs and LLIHNs. According to the PMI Cambodia Malaria Operational Plan FY 2018, 594,650 LLINs and 183,000 LLIHNs were distributed through continuous distribution systems in 2016. Retail products such as insecticide coils, electric insecticides, and spray/aerosols and others are available with the grocery store, supermarket, convenience store, hypermarket, e-commerce, general store, and hawkers.

Lack of significant funds for dengue control in the country is leading to an increase in cases

Various vector control (VC) products [donor products (ITNs, and LLINs), and retail products (topical repellents, coils, sprays/aerosol, and others)] are used in the region to help prevent and control malaria. Insecticide-treated bed nets (ITNs/LLIN) were introduced as an effective means of preventing mosquito bites and malaria transmission. Most of the funding used by the government related to vector-borne diseases is concentrated towards malaria control. Most of the funds are provided for malaria control, whereas no significant funds are granted for dengue.

The majority of the retail market is driven by direct purchase by the end users

The Cambodian retail market for vector control products was USD ~26 million in 2018. The retail market in Cambodia consists of various consumer products such as coils, vaporizing mats, aerosols, and repellents (lotions and wipes), with Off, RID, and Bushman are the leading brands used in Cambodia. The majority of the products used in the retail market are imported; only a few players in the spatial repellent market are present in Cambodia. Manufacturers from neighbouring countries sell their stock to the regional wholesalers, who further distribute to the retailers, grocery stores, etc.

The growing use of digital tools and increase in awareness campaigns are anticipated to boost vector control activities in Cambodia

In order to improve the situation for vector-borne diseases (VBD) in Cambodia, various national and international organizations are actively participating and taking the initiative to eliminate VBDs from the country. Various activities in the vector control market are helping to achieve VBD control and elimination goals, such as the mass distribution of ITNs/LLINs/LLIHNs in high endemic regions; increasing awareness among the population; increase in use of digitals tools building up epidemiological data; utilizing a range of different vector control products (such as IRS, space spraying, and larvicides); and building up strategies for malaria control and elimination at the national level.

However, the slow implementation of vector control activities is a major concern

It is necessary to increase awareness among the population about protective measures for vector control. Effective integrated vector management and implementation strategies are necessary in the country. Similarly, new products should be introduced in the market as drug resistance is high in Cambodia as compared to other Asian countries.

2. Introduction

Objective of the study

- To study the vector control market, and market access landscape, by type of market, vector control implementing organizations, and consumers, including an understanding of regulatory pathways.
- To map and provide a better understanding of procurement channels for vector control products and their barriers.
- To perform a detailed market study for 6 countries in the Indo-Pacific region, namely, Indonesia, Myanmar, Cambodia, Vietnam, Malaysia, and Papua New Guinea (PNG).

2.1 Country Overview

Cambodia is a Southeast Asian country whose landscape spans low-lying plains, the Mekong Delta, mountains and Gulf of Thailand coastline.

2.1.1 Geography

Cambodia is part of the Greater Mekong Sub-region (GMS) with extensive forest cover

Cambodia is a South East Asian country in the Great Mekong sub-region bordered by Vietnam, Thailand, and Laos, with a total land of 181,035 square kilometres.[1] Most of the land in Cambodia is rolling plains from north to south of which only 20% of the land is used for agriculture. The country is heavily forested, covered with rice paddies, fields of dry crops such as corn (maize) and tobacco, tracts of tall grass and reeds, and thinly wooded areas.[2]

Cambodia has a tropical climate with two distinct seasons: the cool, dry north-eastern monsoon brings little rain from November to February, and the south-western monsoon carries strong winds, high humidity, and heavy rainfall from May to October. The mean annual temperature for Phnom Penh (the capital city) is 27°C.[3]

---

1 Cambodia (Confidence level of source [CL]: Medium)

2 Britannica (CL: Medium)

3 Demographic and Health Survey, Cambodia, 2014 (CL: High)

2.1.2 Demographics

The country has a population of 16 million, of which ~80% resides in rural areas

With a population of ~16.4 million in 2018, Cambodia ranks as the 69th most populated country in the world. It is a home for various ethnic groups such as Khmer (97.6%), Cham (1.2%), Chinese (0.1%), Vietnamese (0.1%), and others (0.9%).

The country is composed of 25 provinces, out of which three have relatively short maritime boundaries, 2 municipalities, 172 districts, and 1,547 communities.

FIGURE 1: HIGH POPULATION PROVINCES[4]

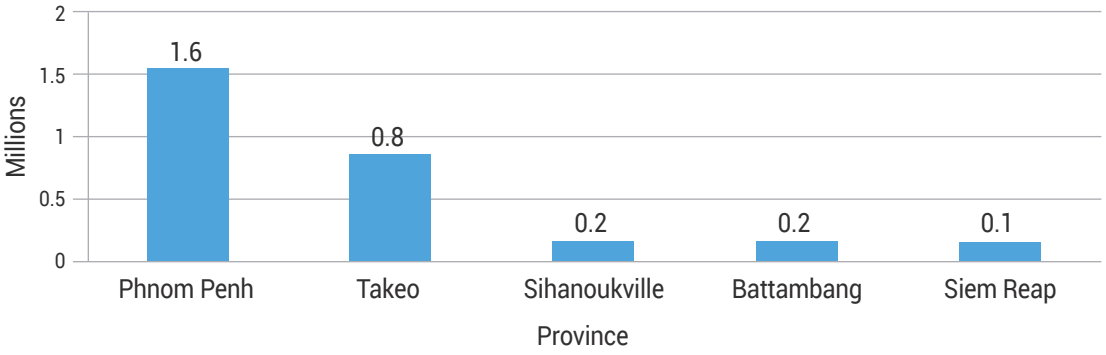
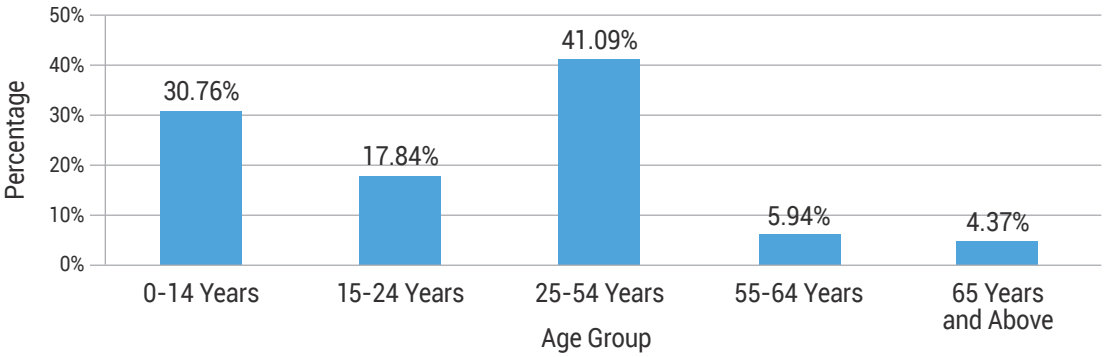


TABLE 1: AGE STRUCTURE (2018)[5]

Age Group	Number of Males (millions)	Number of Females (millions)
0-14 years	2.56	2.50
15-24 years	1.45	1.48
25-54 years	3.31	3.45
55-64 years	0.41	0.57
65 years and above	0.27	0.45

The gender ratio in the country was 0.95 male(s)/female in 2018. The productive age (25-54 years) in the country is the maximum i.e. 41.09% of the total population.

FIGURE 2: AGE STRUCTURE[6]



[4] The World Bank (CL: Medium)

[5] Central Intelligence Agency (CL: Medium)

[6] Central Intelligence Agency (CL: Medium)

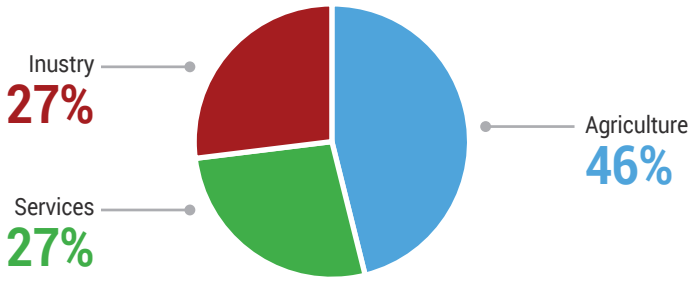
2.1.3 Economic Situation

Cambodia is the sixth fastest growing economy in the world and is classified as a lower middle-income country by the World Bank.[7] The growth of the country's economy is propelled by garment production, construction, and the services sector. High out-of-pocket expenditure (~60%) in Cambodia remains a challenge in the health sector, and there is relatively low coverage of many essential services, when compared to other Asia Pacific countries.

2.1.3.1 Employment

In Cambodia, residence has an effect on type of occupation. In urban areas, women and men are more likely to hold jobs in the professional, technical, managerial, clerical, and sales and services sectors than those in rural areas. Rural populations are more likely to be engaged in agricultural work.

FIGURE 3: EMPLOYMENT SHARE (2017)[8]



2.1.3.2 Others (Internet usage, Education, etc.)

Internet usage:

The country's economic growth has contributed to boost up the living standards of the people, enabling them to afford and access new smartphones and technology. The use of internet among the Cambodian population is increasing. The Socio-Economic Survey of 2010 shows that 64% of total Cambodian households had television, while 41% had radio sets, and about 20% used the Internet and Facebook. As expected, the percentage of urban residents who use the Internet is much higher than that of rural residents (48% vs 31%).[9]

TABLE 2: NUMBER OF INTERNET USERS (IN MILLION)[10]

Years	2013	2014	2015	2016	2017	2018
Number of internet users	4.33	6.93	11.09	13.41	16.23	19.64

Education:

The education sector plays an important role in the national development, and Cambodia aspires to reach the status of an upper-middle income country by 2030, and a high-income country by 2050. In order to achieve this, the Education Strategic Plan (ESP) 2014-2018 was designed by the Ministry of Education, Youth and Sport (MoEYS) in Cambodia. The ESP 2014-2018 had an increasing focus on the expansion of early childhood education, bolstering access to quality secondary and post-secondary education and non-formal education, technical and vocational education.[11,12]

---

7 World Bank (CL: Medium)

8 Statista (CL: Medium)

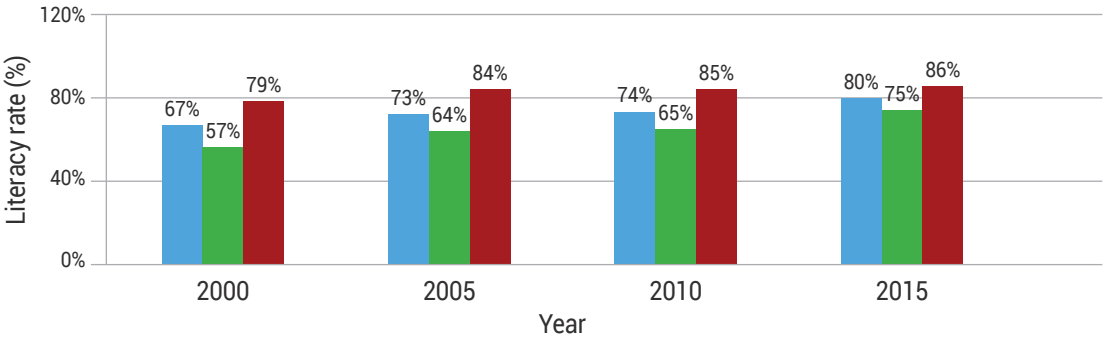
9 Cambodia Research Study (CL: High)

10 National Strategic Development Plan 2014-2018 (CL: High)

11 MOEYS.GOV (CL: High)

12 EDUCATION STRATEGIC PLAN 2014-2018 (CL: High)

FIGURE 4: LITERACY RATE IN CAMBODIA (%)[13]



The literacy rate in Cambodia was highest among women and men in the age group 15-24 years. The literacy rate among men was higher in all ages, except in the age groups of 6-14 and 15-24 where the it was higher among women. The difference between women and men was small in the younger ages and larger in the older ages.

TABLE 3: LITERACY BY AGE GROUP AND SEX, 2016 (%)[14]

Age group	Women	Men	Both sexes
6+	78.4	86.3	82.3
6-14	74.9	73.3	74.1
15-24	95.9	95.0	95.4
25-34	87.5	91.0	89.2
35-44	76.4	86.8	81.4
45-54	67.1	85.8	75.8
55-64	65.1	85.9	73.5
65+	39.8	81.3	56.3

2.1.4 Health Status

2.1.4.1 Health Indicators

Health outcomes have improved in Cambodia since 2010. The infant mortality rate has decreased from 45 per 1,000 live births in 2010 to 27 per 1,000 live births in 2014. Similarly, the under-5 mortality rate decreased from 54 per 1,000 live births to 35 per 1,000 live births in the same period. Life expectancy at birth is 67.1 years for males and 70.1 years for females[15] (NIS, 2013). General government expenditures on health per capita increased from USD8 in 2008 to USD11 in 2010, USD 13 in 2012, and USD16 in 2014[16] (MoH, 2015).

Listed below are some of the key health indicators.

TABLE 4: KEY HEALTH INDICATORS[17]

Population (2018)	16.4 Million
Urban population	21.9% of total population
Gender ratio	96.7/100 Males/Females
Life expectancy at birth (years) (2016)	67.3 (Male) 71.2 (Female) 69.0 (Both)
Neonatal mortality rate (per 1000 live births) (2017)	14.9 (Both sexes)

The health status of the Cambodian people has steadily improved in a number of key areas.

[13] NIS.Gov (CL: High)
[14] Socio-Economic Survey (CL: High)
[15] UNFPA (CL: High)
[16] UNFPA.org (CL: High)
[17] WHO (CL: High)

2.1.4.2 Living Conditions (Lifestyle)

Water and sanitation:

In Cambodia approximately four million (~25%) people out of the total population lack access to safe water, and ~6 million (~35%) lack access to improved sanitation. Moreover, ~80 percent of Cambodians live in rural areas, where they are excessively affected by poor access to safe water and sanitation. Although Cambodia has one the fastest growing economies in Asia, the GDP per capita still remains low compared to neighbouring countries; access to affordable financing for water and sanitation remains a barrier for families in need of securing water connections and toilets for their homes.

TABLE 5: MAIN SOURCES OF DRINKING WATER BY SEASON AND GEOGRAPHICAL DOMAIN, 2016 (%)[18]

Water sources	Cambodia	Phnom Penh	Other urban	Other rural
Piped in dwelling or on premises	29.5	99.7	56.8	15.5
Public tap	0.3	-	1.0	0.3
Tube/piped well or borehole	26.0	-	18.0	30.9
Protected dug well	4.8	-	3.0	5.8
Improved rainwater collection	0.5	-	0.1	0.6
Unprotected dug well	9.4	-	4.9	11.4
Pond, river or stream	13.3	0.1	5.1	16.3
Unimproved rainwater collection	4.0	-	1.9	4.9
Vendor-provided water / Tanker truck provision of water	11.5	-	4.9	14.1
Bottled water	0.6	0.3	4.2	0.2
Other	0.1	-	0.1	0.1
Number of households	3,390,000	385,000	367,000	2,638,000

The definition of "improved sanitation facility" includes three types of toilets namely: "pour flush/flush toilet connected to sewerage", "pour flush/flush toilet connected to septic tank", and "pit latrine with slab".

TABLE 6: TOILET FACILITIES BY GEOGRAPHICAL DOMAIN, 2016 (%)[19]

Water sources	Cambodia	Phnom Penh	Other urban	Other rural
Improved toilets	72.9	99.9	87.9	66.9
Unimproved toilets	27.0	0.1	12.1	33.0

[18] Cambodia Socio-Economic Survey 2016 (CL: High)

[19] Cambodia Socio-Economic Survey 2016 (CL: High)

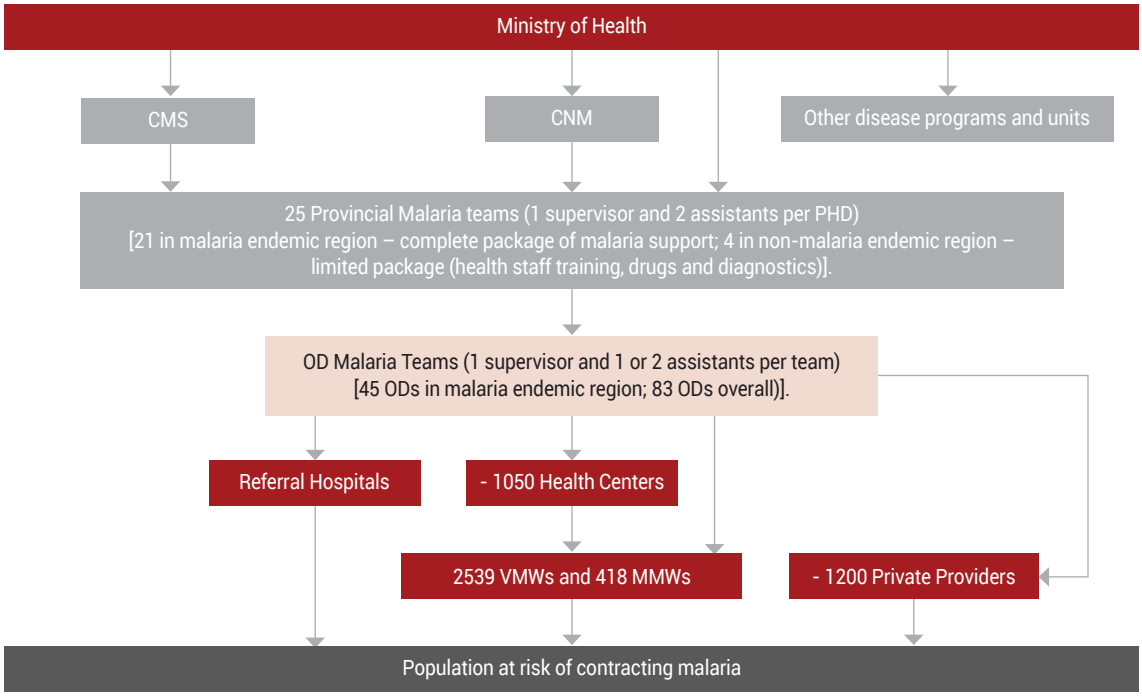
2.1.4.3 Healthcare Structure

Cambodia has a mixed health system comprising numerous service providers and with various funding sources. The Ministry of Health (MoH) is solely responsible for the organization and delivery of government health services, through 24 MoH Provincial Health Departments, 81 health Operational Districts each with a Referral Hospital delivering a Complementary Package of Activities, and a number of Health Centres providing a Minimum Package of Activities. Significant efforts have also been taken in the rebuilding of the health system through an extended health reform beginning in the 1990s. Health status has substantially improved since 1993. Mortality rates significantly dropped and life expectancy at birth was 62.5 years in 2010, a 1.6-fold increase from 1980. Cambodia is on track to achieve the Millennium Development Goal targets.[20]

National Malaria Program, Ministry of Health

- The Centre for Parasitology, Entomology, and Malaria is a part of the Ministry of Health
- The leadership for malaria control activities within Cambodia rests at the central level
- With the decentralization of the MoH, Provincial Health Department (PHD) and operational district (OD) malaria supervisors are involved in planning and implementing activities
- **Availability of malaria services**
- Mobile Malaria Workers (MMWs)
- Local authorities
- Village Malaria Workers (VMWs)
- **Accessibility of malaria services**
- Long-lasting insecticide-treated net (LLIN) distribution
- Early diagnosis and treatment
- Malaria health education

FIGURE 5: STRUCTURE OF THE NATIONAL MALARIA PROGRAM WITHIN THE MINISTRY OF HEALTH, CAMBODIA[21]



[20] Cambodia Health System (CL: Medium)

[21] PMI Cambodia 2018 (CL: High)

2.1.4.4 Healthcare Spending

Over the past decade, Cambodia has been receiving a significant proportion of financial support from the international community, including support for the health sector.

Health care expenditure

- Cambodia spends ~6% of the GDP for healthcare (as of 2015), and its health expenditure per capita is ~USD69 (as of 2015).
- The Third Health Strategic Plan 2016-2020 (HSP3) is Cambodia MoH's "strategic management tool" which is utilized for effective use of resources in healthcare.
- The five-year cost of the HSP3 is estimated to be USD3,317 million, increasing from USD592 million in 2016 to USD753 million in 2020.
- About half (53%) of the HSP3 costs are for strategic objective 1, which include the costs of commodities and program management for health programs.
- The largest five-year health program costs are for HIV (27%), maternal and neonatal health (19%), and child health and immunization (11%) programs.
- Human resources for health costs increase from USD67 million in 2016 to USD132 million in 2020; ~75% of this cost is utilized for the salaries of the health workers.

Low healthcare expenditure from the government imposes a burden on out-of-pocket expenditure which is ~60% of total health expenditure.[22,23]

- The limitation with the Cambodian healthcare system is the lack in the quality of assured services.
- Although the country's annual growth rate is 7.1%, inadequate funding from the government in the healthcare sector results in high out-of-pocket expenditure.
- Regulations in health services are poor, resulting in low-quality private and public services.

TABLE 7: FINANCIAL PERFORMANCE[24]

Year	Annual GDP (USD Mn)	GDP Growth %	Health Expenditure (% of GDP)	Health Expenditure per capital by Govt. (USD)	Out-of-pocket expenditure per capita (USD)	% of Out-of-pocket expenditure
2017	22,158	7.10	-	-	-	-
2016	20,017	6.86	-	-	-	-
2015	18,050	7.03	5.98	69.58	41.30	59.35
2014	16,703	7.14	6.17	67.86	42.71	62.93
2013	15,228	7.35	6.90	70.09	43.79	62.45

[22] WHO Cambodia (CL: High)

[23] The World Bank Group (CL: Medium)

[24] WHO Cambodia (CL: High)

3. Vector Control Market Overview

Vector control tools used by different end users

TABLE 8: VECTOR CONTROL TOOLS AND END USERS

Vector Control Tools	End Users
LLINs	• Households residents • Forest workers and miners • Cross border travellers • Eastern provinces • Women and children
Fogging	• Government agencies • Private pest control operators
Indoor Residual Spray (IRS)	• Hospitals • Academic Institutions • Corporate & Government Offices • Factories • Households
Larval Control	• Households residents • Hospitals
LLIHNs	• Forest workers and miners • Cross border travellers

3.1 Vector Control Overview

Geographically, malaria is endemic in 21 out of 25 provinces in Cambodia. The incidence is highest in the north-eastern parts of the country and lower in the western provinces. Highest malaria transmission is between the months of July and November which is the period from the hot to the rainy season. Of all VBDs, malaria and dengue are the most prevalent in Cambodia. The country is trying to eliminate malaria, however, undertaking various actions.

Malaria Elimination Action Framework (MEAF) 2016 – 2020: Phase of malaria control and elimination

CNM in collaboration with its donor partners has developed MEAF 2016-2020, with a vision to eliminate malaria from Cambodia. The goal of the MEAF is to reduce the incidence of malaria to <1 per 1,000 people at risk in each operational district (OD) and eliminate *Plasmodium falciparum* malaria including multidrug resistance by 2020.

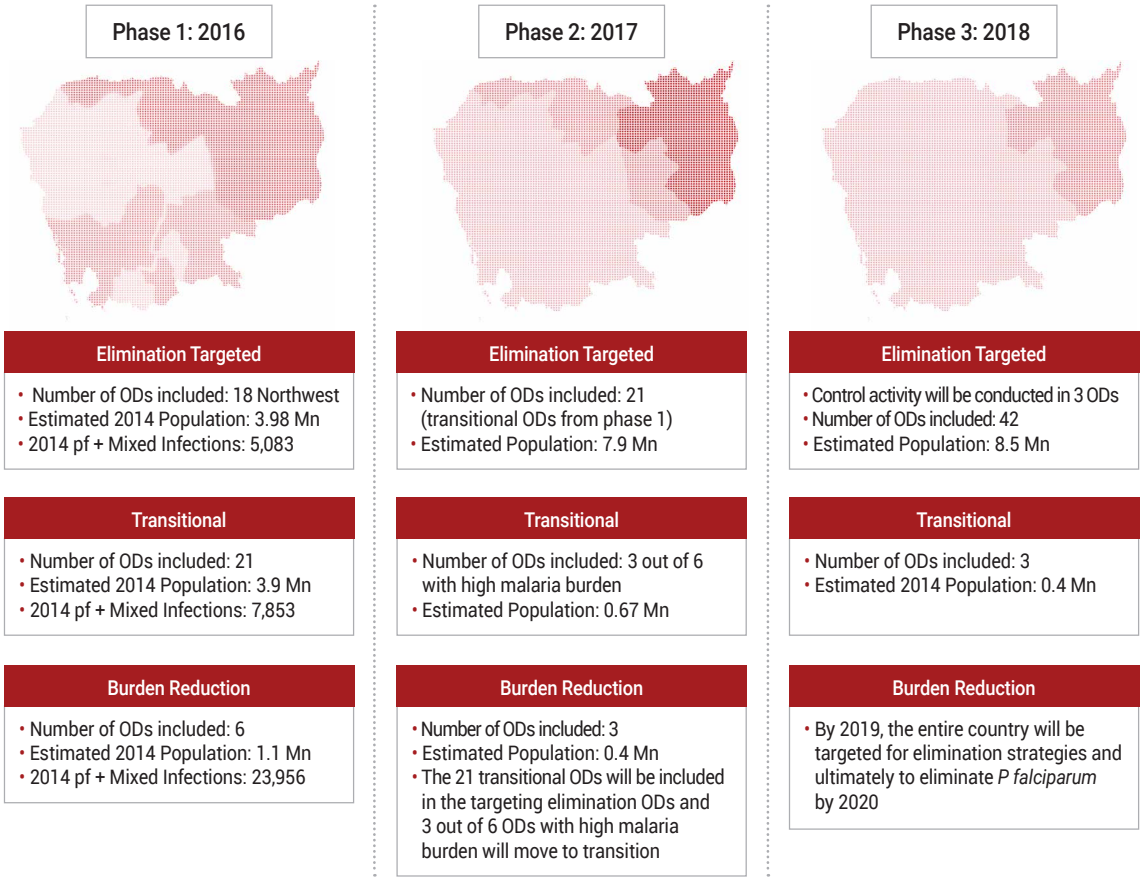
The MEAF includes the following specific objectives:

- Provide effective program management and coordination at all levels by 2017 to efficiently deliver a combination of targeted interventions for malaria elimination.
- Achieve universal coverage of case management services by 2016 to ensure 100% parasitological diagnosis of all suspected cases and effective treatment of all confirmed cases.
- Protect at least 90% of all populations at risk of malaria with an appropriate vector control intervention by 2017.
- Enhance the surveillance system to detect, immediately notify, investigate, classify, and respond to all cases and foci by 2017 to move toward malaria elimination.
- Implement comprehensive information, education, communication/behaviour change communication (BCC) approach, that facilitates at least 90% of people seeking treatment for fever within 24 hours at a health facility or qualified care provider.

TABLE 9: MALARIA ELIMINATION ACTION FRAMEWORK (MEAF) 2016 – 2020[25,26]

Sr. No.	Malaria elimination phase	Population	No. of Provincial Health Departments (PHDs)	No. of Operational Districts (ODs)	Global Fund supported PHDs	Global Fund Supported ODs
1	2018	3.8 Mn	6	18	5	14
2	2019	3.5 Mn	9	26	8	22
3	2020	1.2 Mn	6	9	6	9

FIGURE 6: MALARIA ELIMINATION ACTION FRAMEWORK (MEAF) 2016 – 2020: PHASE OF MALARIA CONTROL AND ELIMINATION[25,26]



[25] PMI Cambodia 2018 (CL: High)

[26] PMI Cambodia 2019 (CL: High)

3.1.1 Vector Borne Disease Trends

Mosquito-borne viruses continue to cause significant global morbidity and mortality, particularly in Southeast Asia. The major vector-borne diseases (VBDs) in the South-East Asia (SEA) region are malaria, lymphatic filariasis, dengue, Chikungunya, and Japanese encephalitis.

- **Use of LLINs/ITNs:** Cambodia has a strong "net culture". Long lasting insecticidal nets (LLINs) are being promoted by WHO and Roll Back Malaria partners as a cost effective and sustainable method for protection against malaria.[27] Various organizations are aggressively distributing LLINs/ITNs in the high-risk areas, in particular amongst young children and pregnant women. In Cambodia, 97% of households owned at least one mosquito net and 80% owned two. Moreover, 88% of family members had slept under a mosquito net (any type); similarly, 92% of children under age five also slept under a mosquito net.[28]
- **Indoor residual spraying (IRS):** IRS is the application of long-acting insecticides to the walls and ceilings of houses and animal sheds in order to kill adult vector mosquitoes that land and rest on these surfaces. In addition to nets, The National Center for Malaria Control, Parasitology and Entomology (CNM) plans to conduct IRS in response to outbreaks and active transmission foci in order to quickly reduce vector numbers and minimize transmission. USD2.5 million has been allocated for this IRS under RAI2E for three years. PMI has allocated USD1,192,000 for IRS in the country.[29] However, IRS is not used extensively in the country.
- **Fogging:** To reduce the disease burden of dengue, fogging activities were enhanced in Cambodia. Space spraying of insecticides or fogging activities involved the application of small volumes of insecticide into the air in the form of hundreds of millions of tiny droplets, with volume median diameters ranging from 1-30 µm, in an attempt to kill adult mosquitoes. Generally, thermal fogs and cold fogs have been commonly used for *Ae. aegypti* control, where both can be dispensed by vehicle-mounted or hand-operated machines. Early application of space sprays on a sufficiently large scale may reduce the intensity of dengue haemorrhagic fever transmission in an epidemic.[30]

Limitations of using fogging:

- Expensive as it must be repeated several times at short intervals (3 to 4 times in a week)
- Needs special equipment
- *Aedes* adults re-infest
- Not effective on its own, needs IVM (e.g. larvicides, non-essential water container control)[31]

FIGURE 7: MOSQUITO FOGGING OPERATIONS IN FLOOD AFFECTED COMMUNITY BY WHO[32]

Vector Borne Disease Control Program staff conducting mosquito fogging operations in a flood-affected community.

---

27 Malaria Consortium (CL: High)

28 URC (CL: High)

29 PMI CAMBODIA Malaria Operational Plan FY 2018 (CL: High)

30 Yee L Y et al., (2016) (CL: Medium)

31 Implementing Integrated Vector Management in humanitarian emergencies (2016) (CL: Medium)

32 WHO Mosquito Fogging Operations (CL: High)

- Larval control: Use of larval control methods for dengue vector control is highly effective in Cambodia. Larviciding has also been used to control dengue in various parts of Cambodia. A variety of larvicides have been used for malaria control, including oils, chemical insecticides, insect growth regulators, guppy fish and microbial insecticides. For instance, a study was conducted in Kampong Cham province, Cambodia, targeting *Aedes* mosquito larvae through introducing guppy fish.

FIGURE 8: INSPECTION OF THE NUMBER AND CONDITION OF GUPPY FISH IN WATER JARS[33]

There are various other vector control tools or methods previously used and or clinically tested in Cambodia. Enlisted below are few VC tools/methods clinically tested in Cambodia for dengue control.

TABLE 10: VECTOR CONTROL TOOLS TESTED IN CAMBODIA[34]

Tool Used	When	Where	Results/Challenges
Temephos (Temephos is a non-systemic organophosphorus insecticide, mainly used as a larvicide to control mosquitoes, including in domestic water containers and those used for storing drinking-water.)	Ongoing distribution	Country wide	Larval Resistance
Thermal Fogging	Ongoing	OD staff Private Sector	Resistance to Permethrin/ Deltamethrin
Mesocyclops (Mesocyclops is a genus of crustacean in the Cyclopidae family. It preys on mosquito larvae and is used as a nontoxic, inexpensive form of biological mosquito control)	2003-2004	Kratie	Low acceptance/ low efficacy
Treated Covers (Insecticide treated water jar covers)	2008	Kampong Cham	Short efficacy on medium term
Guppy Fish	2008	Kampong Speu	79% less larvae in targeted containers
	2010/2011	Kampong Cham	CI/PPP in intervention significantly lower than in control
Bacillus thuringiensis israelensis (Bti)	2007 2016	Phnom Penh	Reduction in pupae for 10-13 weeks
Pyriproxyfen	2006 2008	Phnom Penh Phnom Penh	IE > 95% IE > 80% for 34 weeks

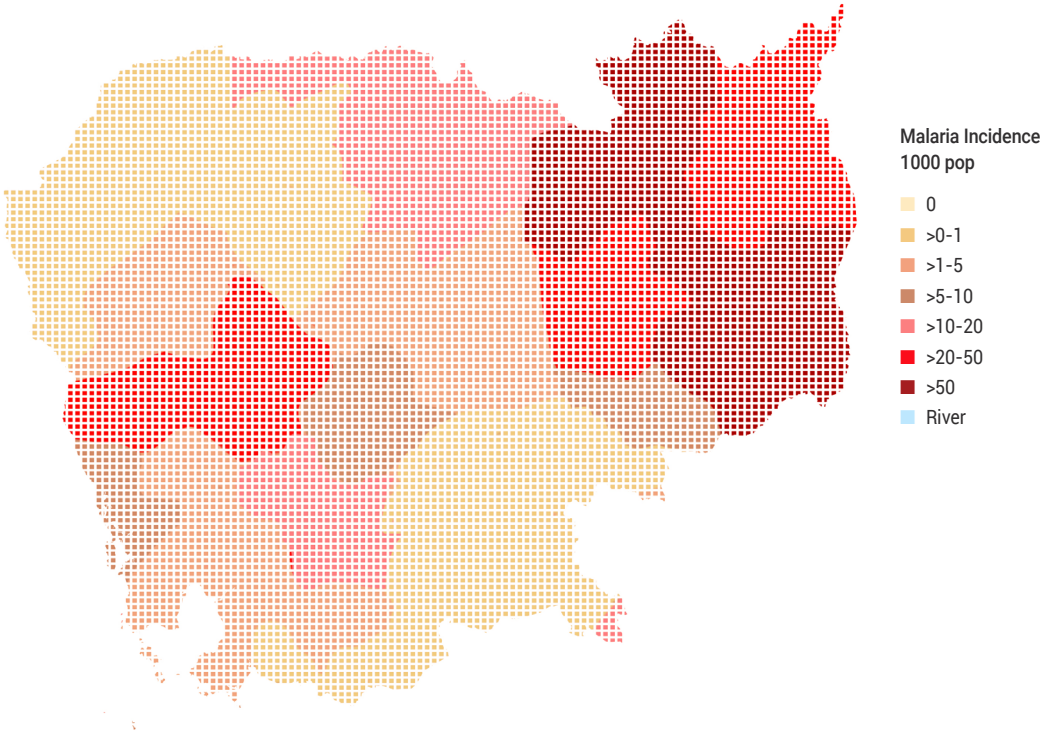
[33] WHO Integrated Vector Management in Cambodia (CL: High)

[34] Malaria Consortium (CL: High)

3.1.2 Burden of Disease

Malaria: Geographically, malaria is endemic in ~84% of provinces with highest incidence in north-eastern parts. Malaria incidence decreased drastically in the last decade from 5.2/1,000 in 2009 to 1.5/1,000 in 2016. However, case reports nearly doubled in 2017 when compared to 2016. The increase in incidence was attributable to interruption of malaria control activities in the higher burden provinces, resulting from delays in implementation of the Global Fund RAI grant.[35]

FIGURE 9: MALARIA INCIDENCE BY OPERATIONAL DISTRICTS (ODS) IN CAMBODIA—2017[35]



Malaria transmission is high between July-November which is a transition period from summer to rainy season. Malaria predominantly impacts males from 15-49 years of age while only 3.7% of cases are in children <5 years of age. Incidence rates in adult males are five times higher than adult females. The affected population are majorly mobile male workers who move from low to high transmission areas. Mobile/migrant workers lack access to malaria services and education making them vulnerable.

Dengue: Dengue remains a major public health problem in Cambodia, with fourteen thousand cases annually. Epidemics occur at intervals of 5 to 7 years. As of December 2018, a total of 9,885 suspected dengue cases have been reported in Cambodia. Dengue has spread to rural areas, increasing the population at risk from 3.5 million to almost 11 million. The worst outbreak on record occurred in 2007 when 39,851 cases and 407 deaths were reported. A number of factors have contributed to the rapid growth of dengue, including urbanization, globalization and climate change as well as a lack of effective mosquito control.

Zika Virus: Zika virus is also transmitted by infected *Aedes* mosquitoes. It causes a self-limiting illness with symptoms lasting 2–7 days, including mild fever, skin rash, conjunctivitis, muscle and joint pain, malaise and headaches. Zika virus was first detected in August 2010. Only 5/2,400 (0.2%) were found to be positive in a retrospective study on 2,400 acute serum samples from dengue patients between 2007 and 2016.[36]

Chikungunya: Chikungunya was reintroduced into Cambodia in 2011, and a large outbreak occurred in south-eastern Cambodia in March 2012.

---

[35] PMI Cambodia 2019 (CL: High)

[36] Lim SK, et al. 2017, PMC5500276 (CL: High)

Schistosomiasis: *Schistosoma mekongi* is present in Stung Treng District (Stung Treng Province) and Kratié Province. Cambodia has implemented a plan to control and eliminate schistosomiasis in affected regions, which has resulted in the reduced prevalence of the disease.[37]

Japanese Encephalitis (JE): JE is considered endemic throughout Cambodia. Transmission occurs year-round, but peaks during the rainy season from May to October. One case was reported in 2010 in a traveller who visited Phnom Penh.[38]

Filariasis: In 2017, WHO certified Cambodia for eliminating lymphatic filariasis.[39]

3.1.3 Economic Burden of VBD

Understanding the economic burden of a disease is one of the important steps to grasp a full scope of vaccination benefits from the social perspective. The cost of illness (COI) or economic burden included three major cost components: direct medical costs (DMC), direct non-medical costs (DNMC), and indirect costs (IC).

Dengue: Dengue fever is a vector-borne disease and transmitted by *Aedes* mosquitoes, and is a major public health concern in many parts of South-East Asia including Cambodia. According to a study "A multi-country study of the economic burden of dengue fever based on patient-specific field surveys in Burkina Faso, Kenya, and Cambodia", the cost of illness for dengue fever is significant in these countries.

TABLE 11: AVERAGE ECONOMIC BURDEN OF DENGUE FEVER PER EPISODE (USD IN 2016)[40]

Cost	Inpatient (n = 254)
Direct Medical Cost (DMC)	46
Direct Non-Medical Cost (DNMC)	41
Indirect Cost (IC)	73
Total Cost	152
Total Cost per Day	17

3.1.4 Measures/Initiatives for Vector Control

Different campaigns for increasing level of awareness and promoting the use of mosquito nets and other vector control measures are being conducted.

TABLE 12: VECTOR CONTROL AND PREVENTION CAMPAIGNS

Name of the Campaign	Time Period	Target Disease	Coverage	Organization	Digital Campaign
COMBI	Ongoing	Dengue, Zika and Chikungunya	Countrywide	The Cambodian Red Cross (CRC)	No
No larvae – No mosquito – No dengue	Ongoing	Dengue	Pailin province	Malaria Consortium	No

[37] World Schistosomiasis (CL: Medium)

[38] CDC Yellow Book 2018 Chapter-3 (CL: High)

[39] Lymphatic Filariasis (CL: Medium)

[40] Lee JS, et al., PLoS Negl Trop Dis. 2019 (CL: High)

Net lending scheme[41]

The net lending program is an initiative of the Malaria Control in Cambodia (MCC) Project, implemented by University Research Co. LLC (URC) in collaboration with CNM. A lot of mobile farm workers come from low endemic areas and are not aware of the risk of mosquito bites. One LLIN per person and one LLIHN per family is provided to the owner of the farm, who will distribute these nets to the workers and collect it back when they leave. A buffer stock of these commodities is maintained at VMW, health centres and ODs.

No larvae – No mosquito – No dengue[42]

FIGURE 10: PARTICIPATION OF STAKEHOLDERS IN DENGUE CAMPAIGN[46]

- In Pailin province, the Malaria Consortium supported the dengue control programme. It was involved particularly in education campaigns and larvicide (Abate) distribution under the supervision of the village malaria workers (VMWs).
- The VMW system was originally established for malaria education, free diagnostics and malaria treatment for villagers.
- The VMWs have been encouraged and trained to provide broader health services, especially for dengue control.
- Primary roles of the VMWs include the distribution of Abate and guppy fish in water jars, and also the cleaning up of nearby areas to encourage others to engage in similar activities to help prevent dengue.

---

42 Malaria Consortium Cambodia (CL: High)

43 A road to resilience in SEAR (CL: Medium)

COMBI[43]

FIGURE 11: EDUCATION TO CHILDREN ABOUT VBD THROUGH COMIC BOOK[47]

Effective environmental sanitation encouraged in COMBI activities can reduce incidence of enteric diseases, vector-borne diseases and create healthier environments.

Purpose:

- An awareness program is being run under the Strategy 2011-2020 by the Cambodian Red Cross (CRC).
- The comic book is a children-friendly tool to raise awareness and prevention of mosquito-borne diseases.
- It educates children about the VBDs such as dengue, Zika and Chikungunya, with the key messages: **clean up, cover up and keep it up**.

National Dengue Control Programme (NDCP)[44]

FIGURE 12: IMPLEMENTATION OF IVM FOR DENGUE CONTROL IN CAMBODIA[48]

The program is focused on two main interventions for vector control

- Use of Abate: A larvicide used in water jars for controlling the *Aedes* mosquito population; however, Abate has proven to be prone to resistance.
- Use of Bt: A group of bacteria used as a biological control agent, but its use is expensive unless the outside funding is provided.

Hence the need for alternative larval control methods has emerged:

- One of the alternatives for large water storage containers, the use of guppy fish (*Poecilia reticulata*) to reduce dengue vector populations has shown promise.
- Guppy fish are a low-cost, sustainable and effective approach to reduce dengue vector populations.
- Some biological control methods can be used for smaller containers as guppy fish do effectively live or breed well in a container less than 50 litres.

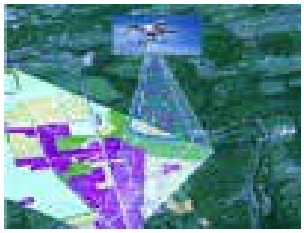
---

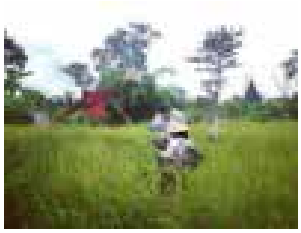
[43] A road to resilience in SEAR (CL: Medium)

[44] Malaria Consortium: community perception and policy development (CL: High)

Larval habitat identification by using drones[45]

FIGURE 13: GRAPHIC HIGHLIGHTING HOW DRONES ASSIST IN LOCATING THE MOSQUITO AQUATIC HABITATS[49]





- Drone technology is under the research of Dr. Robert Novak of the USF (University of South Florida) College of Public Health, which captures the larval habitat with the help of a spectrophotometer.
- The technology research is funded by Gates Foundation and aims to help reduce the risk of transmission.
- The first step is to capture unique "spectral signatures" i.e., pictures of mosquito larvae in an aquatic environment which are then uploaded to the drones for capturing a broader area of surveillance.
- Using a handheld device called a spectrophotometer, a 30 cm square image of what a mosquito aquatic habitat looks like at ground level is used as a baseline.
- This spectral signature is then uploaded to the drone which allows the team to find and identify all similar aquatic habitats producing mosquitoes.
- Once the drones have identified all the potential mosquito larvae in a given area, the next phase will be to use satellites to capture an image of a larger region and then treat them.

Primary Insights

" In Cambodia I have seen with the use of drones and spectral signatures we can find every mosquito breeding site in an area and we can also use drones to treat those areas " KOL-4

3.1.5 Challenges

Mobile population and increasing insecticide resistance are the major challenges in vector control

Funding:

- Total health expenditure for year 2020 will be ~$2 Billion and in the same year funding for malaria and dengue will be $23.6 Million.
- Most government funding related to vector-borne diseases is concentrated towards malaria control.
- The Malaria Consortium is working on dengue vector control with government help, but the funding gap remains.

Population at risk:

- In Cambodia ~11 million people are at risk of malaria, and among those, ~7 million people are at high risk.
- Dengue, which was previously confined to urban areas, is now transmitted in the villages as well. This trend is further increasing the number of people at risk.
- The government of Cambodia is targeting the high endemic areas in the north-western part of the country where the annual parasite incidence >5.
- There is a need to improve awareness about the use of LLINs in rural populations.

[45] USF Health (CL: High)

Mobile population:

- A majority of the people in high risk areas are farm or forest workers, and hence mobile, which is a challenge when using conventional bed nets to prevent mosquito bites.
- Hence, there is a need for distribution of LLIHNs along with LLINs.
- Under the mass distribution, 1 LLIN is provided per 1.8 people and one hammock net is provided per family.
- The major procurer of these nets is The Global Fund and the remaining gap is filled by the procurement from PMI.
- The first instance of insecticide resistance was detected in Cambodia.
- This condition is further exacerbated by drug resistance in some malaria vectors.
- Need of dual-treated LLINs arises as the resistance to the existing chemical increases.

4. Market Analysis

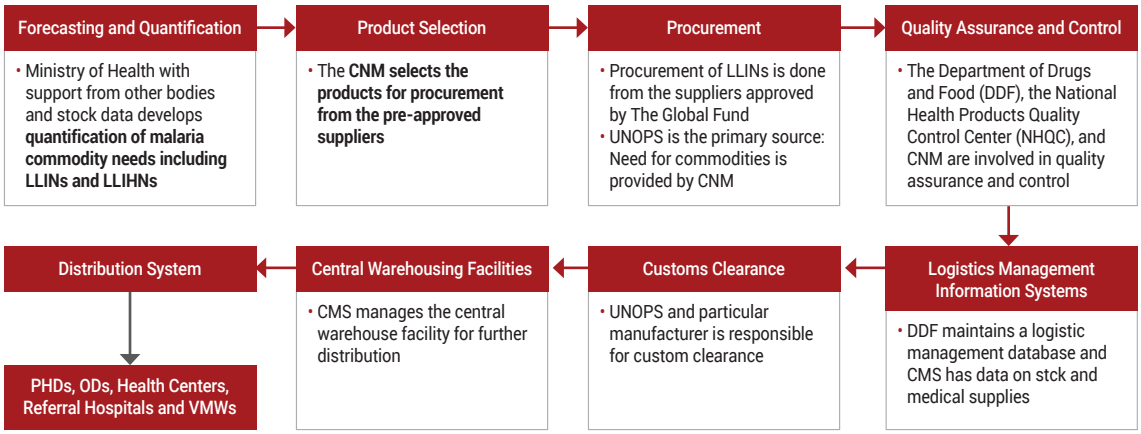
4.1 Procurement Channels

The procurement channels for vector control products in Cambodia include the traditional donor channels and the retail channels. Large global donors are active in the country and are the primary source of donor-driven vector control products, such as long-lasting insecticide treated nets (LLINs) and long-lasting insecticide treated hammock nets (LLIHNs).

4.1.1 Overview of Procurement Channels

Ministry of Health (MoH), with support from UNOPS, does the quantification of malaria commodity needs including LLINs and LLIHNs.

FIGURE 14: PROCUREMENT AND SUPPLY CHAIN MANAGEMENT IN CAMBODIA[46]

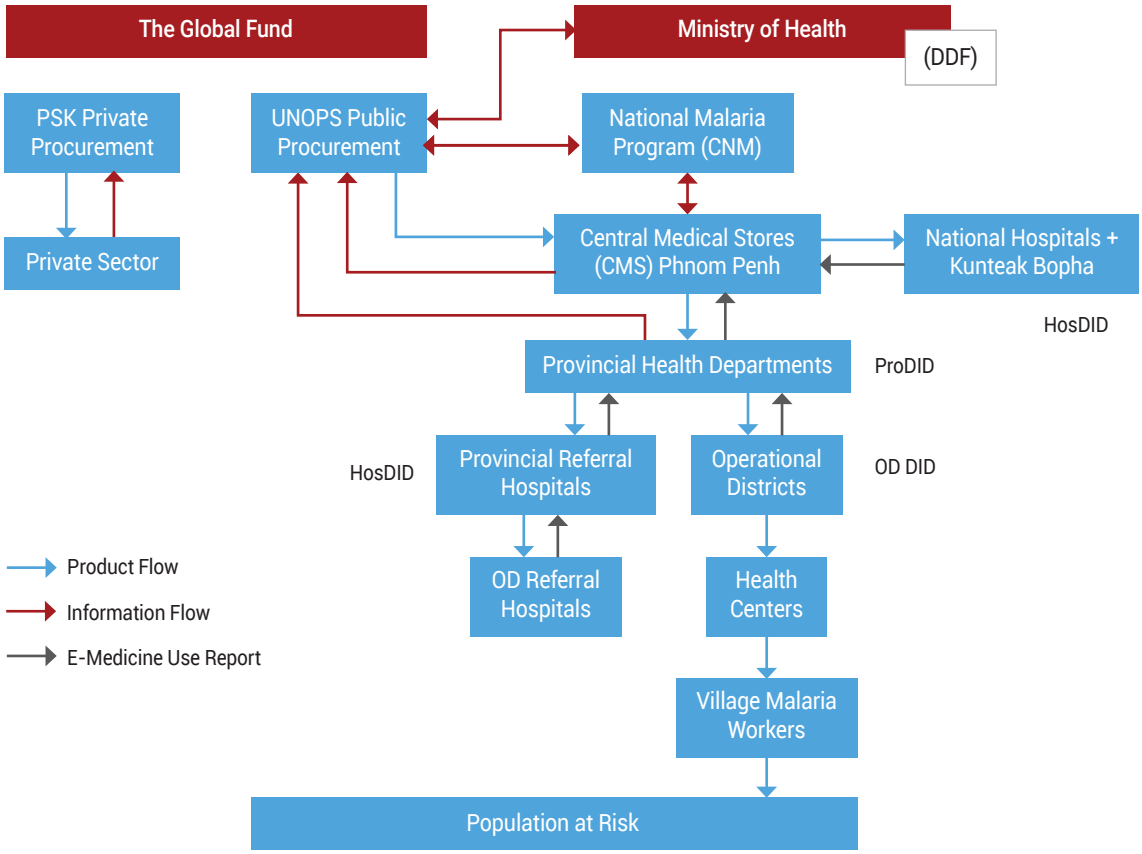


[46] WHO IRIS Report (CL: High)

The United Nations Office for Project Services (UNOPS) is the principal recipient of The Global Fund, which procures required commodities with the help of the Ministry of Health.

- Departments involved in the forecasting and procurement of the anti-malarial commodities are at the central level in the Ministry of Health.
- UNOPS serves as the principal recipient for Global Fund grants for malaria.
- The Central Medical Store (CMS) is responsible for distributing essential medicines and medical commodities to PHDs and ODs on a **quarterly basis**.
- Health facilities re-stock their commodities using a "pull" system from OD warehouses, and on overstocking they may exercise a "push" mechanism.
- The CNM sits within the MoH, which is a responsible body for all the vector control disease programs.
- The decentralization of the MoH, allows the Provincial Health Department (PHD) and operational district (OD) malaria supervisors to plan and implement vector control activities.
- Malaria diagnosis and treatment, LLIN distribution, and malaria health education is looked after by VMWs, Mobile Malaria Workers (MMWs), and local authorities.
- In 2011, Cambodia launched the National Strategic Plan (NSP) for the elimination of malaria by 2025.
- To align the program with GMS region MEAF 2016 -2020 was launched and updated to eliminate malaria from the region by 2030.

FIGURE 15: PROCUREMENT CHANNELS[47]



[47] PMI Cambodia 2018 (CL: High)

TABLE 13: PRIVATE SECTOR AND EXTERNAL FUNDING IN CAMBODIA[48]

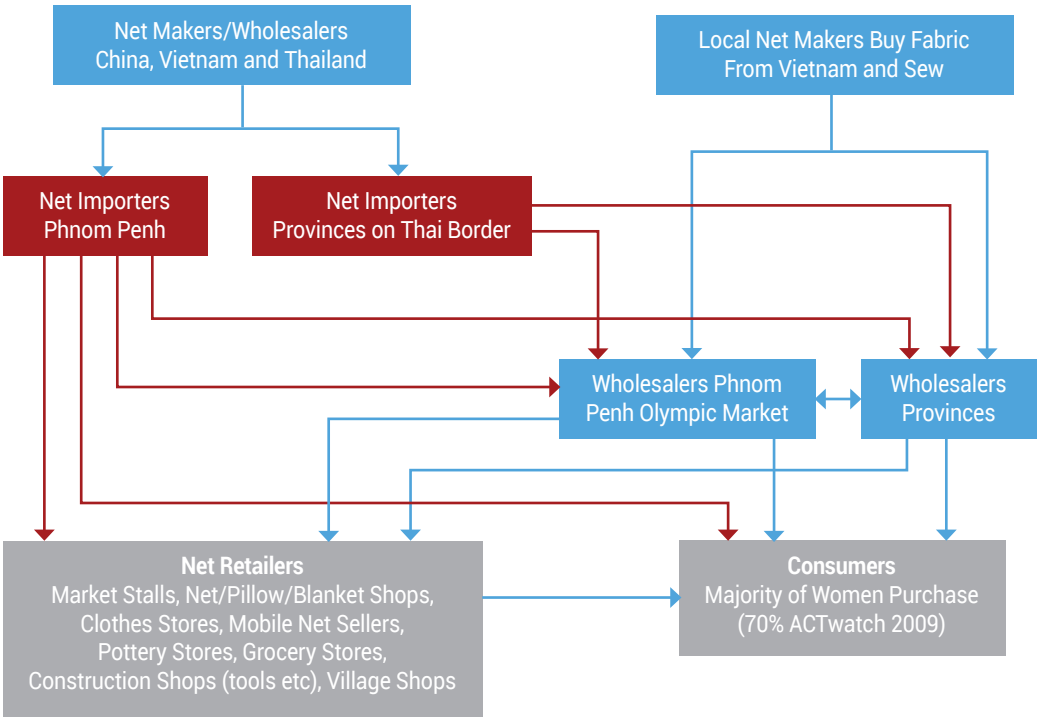
Private sector share of antimalarial market	60%
Public-private partnerships	Yes
Main source of funding	PMI/USAID
Other key sources of funding	GFATM WHO

TABLE 14: AGENCIES RESPONSIBLE FOR PROCUREMENT AND SUPPLY CHAIN MANAGEMENT IN CAMBODIA[52]

Forecasting	National Center for Parasitology, Entomology and Malaria Control
Product selection	National Center for Parasitology, Entomology and Malaria Control
Procurement	United Nations Office for Project Services
Warehousing	Central Medical Store
Logistics Management Information System (LMIS)	Department of Drugs and Food/Central Medical Store
QA/QC	Department of Drugs and Food/United Nations Office for Project Services

Private Sector distribution activities in Cambodia:

FIGURE 16: NET DISTRIBUTION CHAIN AND STRATEGY IN CAMBODIA

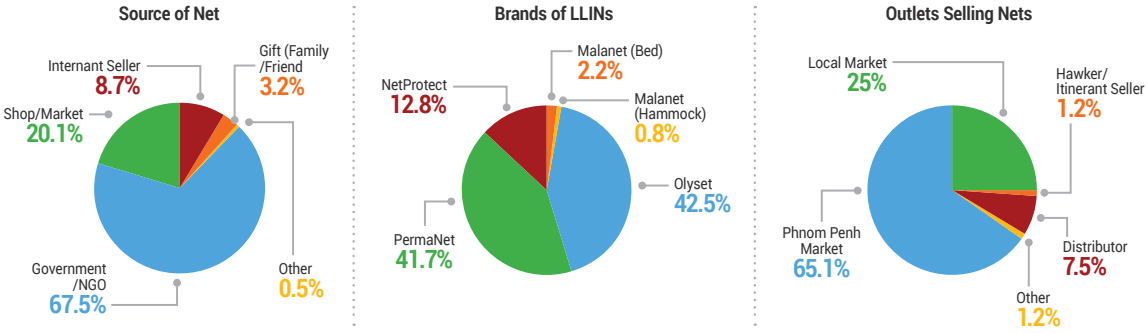


Note: The nests are treated by the purchaser.

[48] WHO Western Pacific Region: Malaria Supply Chain (CL: High)

Most of the LLINs are distributed via mass campaigns by the government or the NGOs. Below are the sources of nets, brands of LLINs available in market and outlets selling nets in Cambodia:

FIGURE 17: SOURCES, BRAND, AND OUTLETS SELLING LLINS[49]



Some locally available untreated or treated nets are purchased by locals from Phnom Penh market

4.1.2 Stakeholders

Key Stakeholders

4.1.3 Procurement Channels – Gap Analysis

Demand and Supply Gap:

In Cambodia, malaria is endemic in 21 of the 25 provinces in Cambodia with an estimated at-risk population of approximately 3 million. Needs of LLINs and LLIHNs for mass distribution are estimated at 2.35 million for 2018. For the 2018 mass campaign, a total of 2.3 million nets are needed to cover the entire at-risk population of approximately 3 million people. There was a demand-supply gap for LLINs in Cambodia for 2018.

[49] Cambodia Malaria Survey (2013) (CL: High)

FIGURE 18: SMALL GAP LIES IN NEED VS. AVAILABILITY OF THE LLINS IN CAMBODIA[50]

Calendar Year	2017	2018	2019
Total targeted population	2.7 million	3.02 million	3.06 million
Continuous Distribution needs			
Channel #1: VMWs and worksites to reach MMPs	0.214 million	0.117 million	0.153 million
Mass Distribution Needs			
2018 mass distribution campaign*	0	2.23 million	0.264 million
Total calculated need: Continuous and campaign	0.214 million	2.35 million	0.417 million
Partner Contributions			
ITNs carried over the previous year	0.432 million	2.53 million	0.18 million
ITNs from Government	0	0	0
ITNs from Global Fund (NFM)	2.31 million	0	0
ITNs from other donors	0	0	0 using conventional bed nets
ITNs planned with PMI funding**	0	0	0.15 million
Total ITNs Available	**2.74 million**	**2.53 million**	**0.33 million**
Total ITN Surplus (Gap)	**2.58 million**	**0.18 million**	**-0.087 million**

* Includes LLINs and LLIHNs for MMPs

** PMI plans to procure small quantities of rapid diagnostic tests (RDTs) in 2017 and 2018 to fill gaps and conduct top-up activities in PMI-supported areas on an as needed basis.

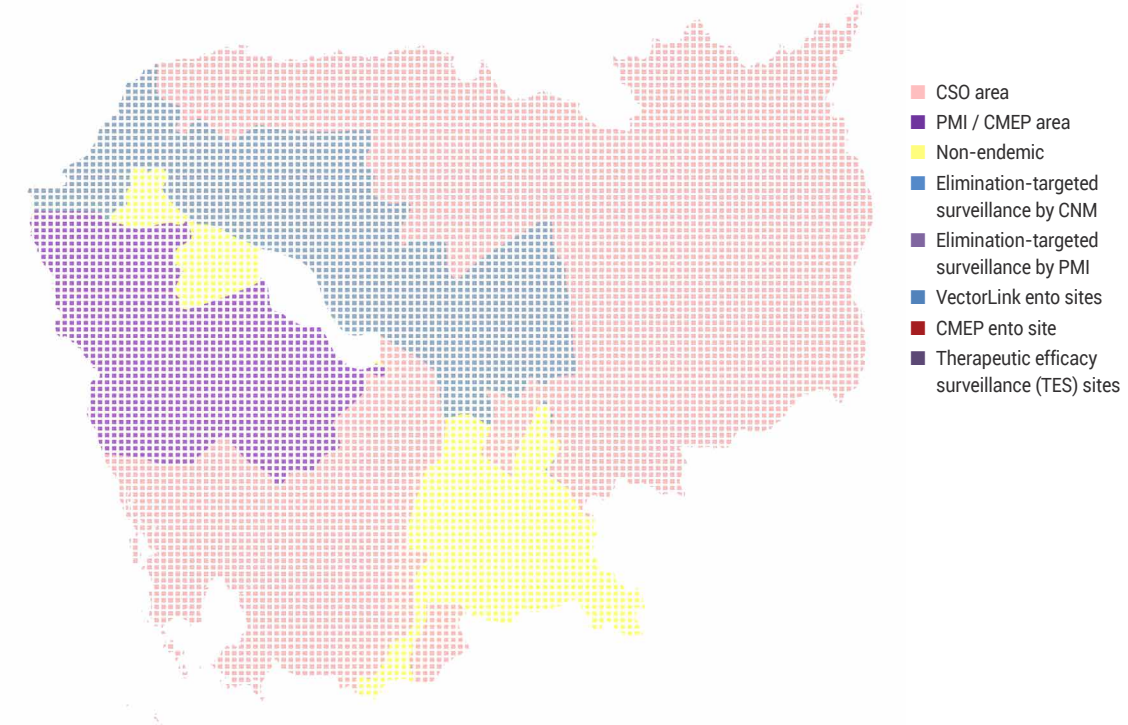
Logistics: Controlling outdoor transmission of malaria is of particular importance in Cambodia, especially in high-risk population such as ethnic minorities, migrants and mobile populations in remote locations near forested areas. Thus, it is important to develop interventions, vector control measures, and distribution strategies that are acceptable, feasible, and sustainable to use amongst these population groups.

4.2 Sponsors & Payers

The main donor in Cambodia are Global Fund, PMI, and Bill & Melinda Gates Foundation (BMGF); other donors include Asian Development Bank (ADB).

[50] PMI Cambodia 2018 (CL: High)

FIGURE 19: GEOGRAPHIC DISTRIBUTION OF MALARIA PARTNERS IN CAMBODIA 2018-2020[51]



- A new Regional Artemisinin-resistance Initiative 2 Elimination (RAI2e) grant for 2018–2020 has been initiated by The Global Fund, with the UNOPS being the principal recipient.
- The Global Fund-supported activities have been divided geographically into five clusters; four of these are controlled by civil society organizations, which includes local bodies, local NGOs, etc.
- In the fifth cluster which is being targeted for malaria elimination, activities are to be implemented by the National Malaria Center (CNM), with technical assistance from the BMFG.
- In Western Cambodia, PMI will support the Cambodia Malaria Elimination Project (CMEP); in other areas PMI will continue routine entomological monitoring in three high-burden provinces (Mondulkiri, Stung Treng, and Kampong Spou).

- Activities by The Global Fund are divided into:
    - **Core Intervention Packages:** Which includes scaling up of LLIN and the VMW network.
    - **Elimination Package:** Includes activities of intervention packages and implementation of surveillance for elimination including individual case reporting, investigation, and follow-up.

- The Global Fund controls 19 elimination and 19 intervention packages; whereas PMI has 3 intervention and 2 elimination packages.

PMI is the second largest donor supporting malaria control and elimination activities in Cambodia. It plays a key role in directly engaging each of the main donors to coordinate activities and leverage funding to more efficiently support CNM's control and elimination activities.

The BMGF supports CNM through technical assistance and capacity building on surveillance, monitoring and evaluation. The German Federal Ministry for Economic Cooperation and Development (BMZ) has supported Cambodia since 1994 in rural development and development of the Health Sector.

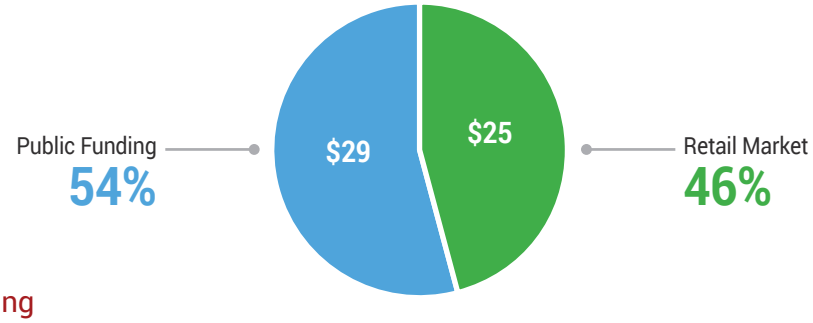
[51] PMI Cambodia 2019 (CL: High)

4.3 Vector Control Related Spending

Vector control related spending[52,53,54,55]

LLINs and LLIHNs are the primary measures for vector control in malaria-endemic areas of Cambodia, which are provided either free of cost or loaned. A small payment of 1000 riels (USD0.25) or less was often given as a voluntary, informal contribution to show appreciation and gratitude to the VMWs. Nets which are purchased from the private sector cost in a range of USD3.7 to 16.2. Dengue vector control programs rely on field staff (VMWs) who check homes and surrounding premises for mosquito larvae and pupae, in water-holding containers. The cost of mobilization, communication, and education activities is ~USD5 per person and USD24 per household. The cost for the guppy fish breeding and distribution systems is USD0.25 per person and USD1.27 per household. Other means of vector control are mosquito repellents (sprays, coils, etc.) which on average cost ~USD5 per unit. Most of the villages use traditional methods for vector control, such as burning leaves and incense, cleaning vegetation, etc.

FIGURE 20: SHARE OF VECTOR CONTROL MARKET SPENDING ($MN), 2017-18[56]



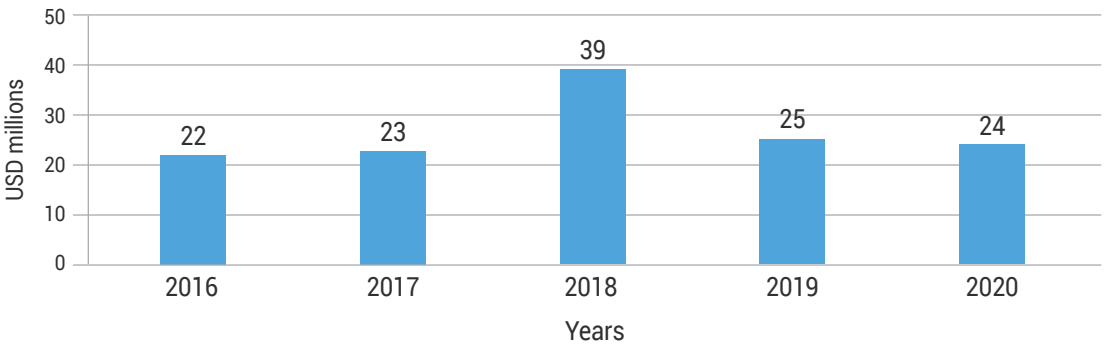
4.3.1 Funding

The main donors in Cambodia are The Global Fund, PMI, BMGF, and the Asian Development Bank (ADB). The Global Fund has been the major donor for malaria control since 2005. There are two Global Fund mechanisms in Cambodia: Both the Regional Artemisinin Initiative (RAI) and the New Funding Model (NFM) ended in December 2017. The United Nations Office for Project Services (UNOPS) serves as the principal recipient for both the RAI and the NFM grants. Similarly, PMI is the second largest donor supporting malaria control and elimination activities in Cambodia. PMI plays a key coordinating role directly engaging each of the main donors to coordinate activities and leverage funding to more efficiently support the CNM's (National Centre for Parasitology, Entomology, and Malaria) control and elimination activities.

4.3.1.1 National Funding

A total of USD132 million budget has been allocated for dengue and malaria control by MoH through the Health Strategic Plan (HSP3) during 2016-2020.

FIGURE 21: COSTS BY HSP3 STRATEGIC OBJECTIVE FOR MALARIA AND DENGUE (USD MILLION)[41,43]



52 Health Strategic Plan 2016 – 2020 (CL: High)

53 Liverani M. et al. Malar J (2017) (CL: High)

54 Managing regional public goods for health: Community-based dengue vector control (2013) (CL: High)

55 World Bank (CL: High)

56 FB Analysis

TABLE 15: NATIONAL/DOMESTIC MALARIA FUNDING FOR CAMBODIA[57]

Funding	Total Budget in USD (Funds Disbursed)	Duration	Key Implementing Partners	Key Activities
Domestic	3.4 million	–	–	Treatment services for Cambodian citizens (2012 funding)

4.3.1.2 International Funding

The majority of the funding for malaria control and prevention in Cambodia is from The Global Fund under the RAI and NFM grants.

TABLE 16: ACTIVE GRANTS BY THE GLOBAL FUND IN CAMBODIA

Sr. No	Grant Title	Partner	Total Budget (US$ millions)	Budget (USD)	%
1	Regional Artemisinin Initiative 2 Elimination (RAI2E)	Malaria Consortium (MC)	0.34	2018	NA
2	Field study on the relation between Long Lasting Insecticide Treated Nets (LLIN) material and LLIN usage in Myanmar and Cambodia	Population Services International (PSI)	0.26	2018	1. To assess the relationship between LLIN material and LLIN usage in Myanmar and Cambodia. 2. To determine the level of population use of polyester and polyethylene LLINs among households with at least one LLIN, in areas covered by recent distribution campaigns (by NMCPs and/or partner organizations). 3. To assess the association between LLIN use and LLIN material (polyester and polyethylene). 4. To describe differences in the above outcomes and associations between Myanmar and Cambodia.
3	RAI2E	Ministry of Interior - Health (MoIH)	0.11	2018-2020	NA
4	RAI2E	Central Medical Store (CMS)	0.05	2018-2020	NA
5	RAI2E	World Health Organization (WHO)	1.47	2018-2020	NA
6	RAI2E	Ministry of National Defense (MoND)	0.45	2018-2020	NA
7	RAI2E	Department of Drugs and Food (DDF)	0.19	2018-2020	NA
8	Regional Artemisinin Initiative 2 Elimination (RAI2E) - RSSH	Ministry of Health (MoH)	6.00	2018-2020	NA
9	RAI Regional Steering Committee Secretariat & Independent Monitoring Panel	WHO Independent Monitoring Panel and RSC	1.27	2018-2020	NA

[57] PMI Cambodia 2018

10	Monitoring antimalarial drug efficacy and resistance in the Greater Mekong Subregion (GMS)	WHO Therapeutic Efficacy Surveillance Regional	1.89	2018-2020	1. Develop and implement new Integrated Drug Efficacy Surveillance (iDES) protocol in the low endemic areas. 2. Consultation, orientation & planning meeting for efficacy monitoring in low endemic areas. 3. Training of health staff at local level on the drug efficacy monitoring protocol for low endemic areas. 4. Supportive supervision visits by district level staff to the TES sites. 5. Annual sub-regional level drug efficacy meeting with GMS countries. 6. Regional monitoring of molecular markers of drug resistance and production of interactive maps. 7. Conduct expert review group meetings to review and give recommendations on monitoring and response to resistance. 8. Support for continual online sharing of findings in monitoring of molecular marker of drug resistance.
11	RAI2E regional component: Supporting a Regional CSO platform and Malaria CSOs work to address access to services to the community in the GMS region)	American Refugee Committee (ARC)	0.92	2018-2020	1. Production of integrated disease training manual. 2. Conduct national and regional CSO consultations. 3. Development of advocacy plan and strategy for CSO activities. 4. Development of CSO platform website that informs the activities of CSOs and related reports. 5. Mentorship training to build future community leader in malaria advocacy. 6. Community network building at national level. 7. Information and advocacy material development. 8. Cross learning field visit. 9. Platform and project evaluation.
12	Malaria Elimination Database (MEDB) for the Greater Mekong subregion (GMS)	WHO Mekong Malaria Elimination Database Regional	1.01	2018-2020	1. Training for National Program on surveillance for elimination and application of the District Health Information Software (DHIS) 2 and other relevant tools. 2. Hiring Technical Assistance (TA) for system development, implementation and installation and aligning to country malaria SOP in Laos, Myanmar and Vietnam. 3. Consultancy work to readjust the DHIS Tracker (field-testing) and introducing platform in Cambodia. 4. Field-testing of DHIS 2 Tracker in Laos, Myanmar and Vietnam. 5. Consultancy work in each country to conduct the assessment based on standard tool. 6. Annual (rotating) regional surveillance meeting for GMS countries. 7. Developing DHIS 2 National program data repository. 8. Hiring of consultant to analyse data and develop surveillance bulletin for the RDSP to be based in HQ.
13	Strengthening Pharmaceutical Systems in the Greater Mekong Subregion (GMS)	WHO Pharma Regional	0.91	2018-2020	1. Regional advocacy, coordination and information sharing meeting on the issues of quality of anti - malaria drugs (including substandard and falsified drugs). 2. Need assessment missions to GMS countries by Pharma RAI2E component focal person. 3. Inter-country collaboration, cooperation and capacity building at local cross-border provinces. 4. Develop country-specific national plan on prevention, detection and response to Substandard and falsified medical products. 5. Develop advocacy materials for National Malaria Week in all GMS countries related to SF and drug resistance.

TABLE 17: INTERNATIONAL MALARIA FUNDING FOR CAMBODIA[56]

Sr. No	Funding	Total Budget in USD (Funds Disbursed)	Duration	Key Implementing Partners	Key Activities
1	Global Fund SSF	50,953,325 (USD37,370,392)	2013-2015	CNM, UNOPS (Principal recipient)	Pre-elimination
2	Global Fund RAI	15,000,000	2014-2016	CNM, UNOPS (Principal recipient)	Artemisinin resistance containment
3	Global Fund NFM	30,000,000	2015-2017	UNOPS (Principal recipient)	Malaria control and prevention
4	ADB Grant	Second GMS Regional Communicable Diseases Control Project (CLV) 9,500,000 for GMS CDC2 CLV 4,000,000 for Cambodia	Jan 2016-30 June 2017	Grant to Departments of Communicable Disease Control, MoH in GMS countries and Cambodia Malaria National Program Centers	Contribute to the containment of Artemisinin resistance and malaria elimination in Preah Vihear Province. Strengthen and harmonize national malaria programs. Enhance regional cooperation in malaria and strengthen focal points for regional cooperation for malaria control in each MoH. Support WHO and the ministries in rolling out regional strategies for malaria control
5	BMGF	GMS specific investment 76,925,595 and investment with GMS component 86,404,751	2013-2020	WHO-ERAR, AFRIMS, CHAI, PSI UCSF, MORU, APLMA	Research and innovative tools to control and eliminate malaria. Support to WHO ERAR Hub and Asia-Pacific Malaria Leaders Alliance. Direct BMGF engagement in Global Fund RAI

TABLE 18: PMI BUDGET IN CAMBODIA, 2018[57]

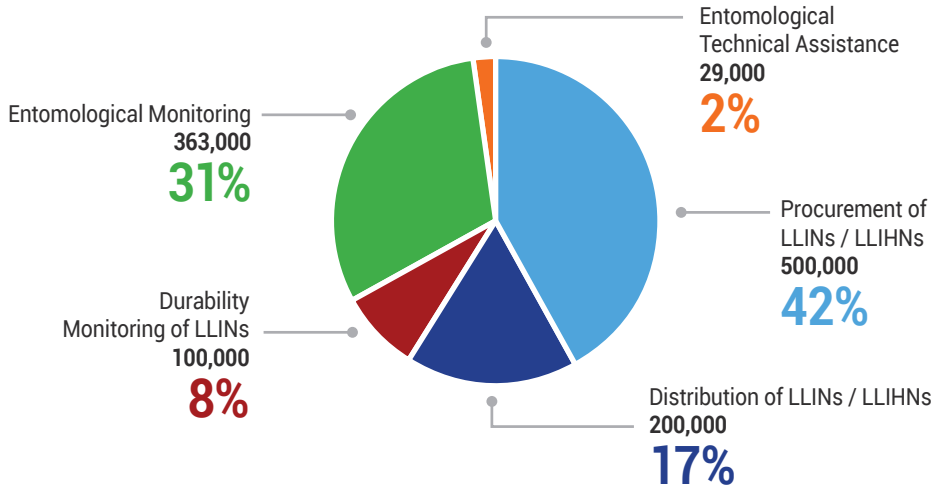
Sr. No	Mechanism	Geographic Area	Activity	Budget (USD)	%
1	CMEP (new bilateral)	8 Operational Districts	Case management at the community level; ITN distribution; capacity building for in-country coordination and support to CNM and PHDs; SBCC community level implementation; national level SM&E strengthening; enhanced surveillance, monitoring & evaluation of elimination in target ODs	5,000,000	56%
2	CDC IAA	National	TDYs for entomology, monitoring and evaluation, and OR studies	69,000	1%
3	TBD (Vector control)	Sentinel sites and residual foci	Entomological monitoring in selected sites	363,000	4%
4	TBD (LLIN durability)	Sentinel sites	LLIN durability monitoring	100,000	1%
5	GHSC-PSM TO2	National	Procurement of LLINs/LLIHNs, RDTs, ACTs to fill gaps in PMI supported areas and supply chain strengthening	1,250,000	14%
6	GHSC-PSM TO1	National	Support LMIS strengthening	200,000	2%
7	WHO umbrella grant	Sentinel sites	TES in sentinel sites	270,000	3%
8	TBD (OR studies)	National	Operational research studies	900,000	10%
9	USAID	National	Staffing, administration, and travel costs	848,000	9%
			Total	**9,000,000**	**100%**

PMI planned budget for vector monitoring & control in 2018 was ~USD1.2 Mn; of which USD0.5 Mn was allocated for procurement of LLINs & LLIHNs.

[56] FB Analysis

[57] PMI Cambodia 2018

FIGURE 22: BUDGET ALLOCATION BY PMI[58]



Entomological monitoring:

- Focus on increasing capacity and range of surveillance for insecticide resistance
- Ad hoc entomological surveys to improve information on malaria transmission risk in particular residual foci and ecosystems (Sentinel Sites)
- Entomological technical assistance is obtained under the U.S. Centers for Disease Control and Prevention interagency agreement

Procurement of LLINs/LLIHNs:

- Support for approximately 150,000 LLINs and LLIHNs for focus areas, filling potential gaps, and targeting migrant/mobile populations.
- The mechanism followed for this procurement is the Global Health Supply Chain Program – Procurement Supply Management (GHSC-PSM).
- Support the distribution of LLINs/LLIHNs in 8 operational districts, under the Cambodia Malaria Elimination Project (CMEP).
- Continued support for durability monitoring of LLINs (physical durability and insecticide content), to inform timing of future LLIN procurements in sentinel sites.

4.3.2 Funding Gap

Total health expenditure for year 2020 will be ~USD2 billion and in the same year funding for malaria and dengue will be USD23.6 Million. Most government funding related to vector-borne diseases is concentrated towards malaria control, whereas, no significant funds are granted for dengue. The Malaria Consortium is working on dengue vector control with government help, but the funding gap remains.

[58] PMI Cambodia 2018 (CL: High)

4.4 Market Description and Analysis

Retail market:[59]

The majority of the retail market is driven by direct purchase by the end users. The majority of the products used in the retail market are imported; only a few players in the spatial repellent market are present in Cambodia. Manufacturers from neighbouring countries sell their stock to the regional wholesalers, who further distribute to the retailers, grocery stores, etc. The retail market in Cambodia consists of various consumer products such as coils, vaporizing mats, aerosols, and repellent (lotions and wipes), with Off, RID, and BushMan as the leading brands used in Cambodia.

In terms of major product types in the market, insecticide coils and sprays/aerosols have comparable market size of ~10-15 USD million each. Electric insecticides are still not used extensively.

Some of the leading players in the vector control retail market in Cambodia[60] are: SC Johnson & Son Inc. (US) [Baygon (liquid electric mosquito repellent machine, spray, peel bait), Radar (repellent liquid), Autan (repellent)], Fumakilla Ltd (Japan) [Beep mat, Fumakiller (insect repellent), Fumakilla A Double Jet (aerosols)], RID Australia (Australia) [RID (outdoor mosquito coils, workforce aerosol)] and Juno Laboratories Pty Ltd (Australia) [Bushman (repellent)].

TABLE 19: VECTOR CONTROL PRODUCT (RETAIL) MARKET SIZE[61]

Product class	Volumes 2016 (Mn)	Volumes 2017 (Mn)	Volumes 2018 (Mn)	Average Unit Price (USD)	Value 2016 (USD Mn)	Value 2017 (USD Mn)	Value 2018 (USD Mn)
Insecticide Coils	150	188	238	0.04	5-10	5-10	10-15
Electric Insecticides	0.05	0.05	0.05	2.1	0.1-0.3	0.1-0.3	0.1-0.3
Spray/ Aerosols	1.9	2.3	2.9	4.8	5-10	11-15	11-15

Cambodia is a donor driven market, as public funding is greater than retail market size.

Manufacturer	Electric Insecticides	Coils	Aerosols
RID Australia		RID 	RID 
SC Johnson & Son Inc	Raid 	Raid 	Raid 
Fumakilla	Vape 	Fumakilla 	Fumakilla 
Bushman			Bushman 
OFF			OFF 

[59] FB analysis

[60] FB analysis

[61] FB Analysis

Donor market:[62]

Long-lasting insecticidal nets are distributed via mass-campaigns in a 3-year cycle. In Cambodia people spend considerable amounts of time away from houses at night, so along with LLINs, hammock nets (LLIHNs) are also distributed via mass-campaigns. This is particularly the case in places where the number of LLINs needed are forecasted and procured by The Global Fund; any lag in this is filled by the USAID. UNOPS acts as the procurer for the government; and the government distributes these commodities to the health centers for further distribution.

> " There is no manufacturing of nets in Cambodia. Vietnam has a factory of nets and Thailand as well " KOL-1

> " Cambodia is a distribution based VC market, as there is very less manufacturing of medical equipment. Hence, the private sector is much unorganized " KOL-2

> " They assume every family has a male adult who goes to forest and they assume one person needs hammock bed net. That's done every year no matter it's a mass distribution or continuous disytribution " KOL-2

TABLE 20: VECTOR CONTROL PRODUCT (DONOR) MARKET SIZE[61]

Product class	Volumes 2016 (Mn)	Volumes 2017 (Mn)	Volumes 2018 (Mn)	Average Unit Price (USD)	Value 2016 (USD Mn)	Value 2017 (USD Mn)	Value 2018 (USD Mn)
LLIN	4.1	2.0	NA	2.25	9.20	4.48	NA
LLIHN	0.594	0.075	NA	2.25	1.34	0.17	NA

FIGURE 23: MARKET SIZE OF VECTOR CONTROL PRODUCTS[63]

[61] FB Analysis
[62] FB analysis
[63] FB analysis

TABLE 21: MALARIA BURDEN, FUNDING, RETAIL MARKET

Parameter	Cambodia
Population at risk 2017	◒
Incidence of malaria (2017)	◒
No. of LLINs distributed (2017)	○
Public funding (2017-18)	◒
Public fund ($)/person at risk	◒
Retail market (2018)	○
Est. funding for LLINs (% of Public Fund)	◒

Note: High ● Medium ◒ Low ○

4.4.1 Level of Awareness and Need for Vector Control Products

In Cambodia, people have high awareness about the use of protective tools against mosquito bites; however, they have a low willingness to pay. Similarly, there is high awareness about malaria transmission and health centres; however, people lack awareness about preventive measures and treatment duration.

Awareness about malaria in Cambodia[64,65,66]

A total of 90 households (N=448) participated in a survey conducted in 2013, that included two villages of high endemic areas of the Mondulkiri province. Most of the population (~99%) was aware of the relation between the mosquito bite and the spread of disease; ~85% of individuals correctly listed the symptoms of malaria. The most common source of information was the nearest health center and local VMWs. Protective methods in the farm or forest consisted of long clothing (67.8%), followed by burning leaves (31.0%), bed nets (17.2%) and hammock nets (12.6%).

Similarly, a survey conducted in >3,000 households all over Cambodia in the year 2013 showed that knowledge of malaria being transmitted through mosquito bites was very high (~98%). Knowledge of mosquito nets and at least one other prevention method was moderate, at 51.2%; less than half of respondents (41.8%) reported that ITNs specifically can be used to prevent malaria. Recall of at least three of the key messages for malaria prevention was very low, at 1.4%. While the majority of respondents reported that mosquito bites caused malaria, there are persistent beliefs that malaria is associated with drinking dirty water or not boiling water; approximately one-third of respondents reported that boiling water was a method to prevent malaria. Fewer than half of respondents could correctly identify the signs of a serious fever, indicating that there may be challenges in identifying potential severe malaria cases in the community. Knowledge of malaria symptoms among individuals interviewed during household surveys was generally good, at 80.3%. Almost all respondents (97%) knew where they could access advice, testing, and treatment from trained providers.

[64] Liverani M. et al. Malar J (2017) (CL: Medium)

[65] Shafique M. Malaria Consortium (CL: High)

[66] Cambodia Malaria Survey (2013) (CL: High)

5. Regulatory Pathways[67]

The registration process in the country is not developed, and though there are registration requirements for pesticides used in Agriculture, there are no clear requirements for the registration of pesticides used in Public Health.

The pesticides that are used in Agriculture are registered and regulated by the Ministry of Agriculture, Forestry and Fisheries (MAFF). However, pesticides that are used for vector control in Public Health are not subjected to any regulatory processes. An import permit allows pesticides to be imported into the country to be used in the household and Public Health, but no registration is required.

Nevertheless, policies including pesticides for use in households as well as public health are also to be brought under the gambit of the Ministry of Agriculture, Fisheries and Food, to regulate and register the pesticides prior to their importation into the country. However, for use in public health pest control, products that are PQ (Pre-Qualified) listed are permitted to be included in vector control programmes.

Import permits are issued by the competent authority for the import of PQ listed pesticides for inclusion in public health programs. The cost of an import permit is US$ 600 for one consignment of pesticides to be imported into the country.

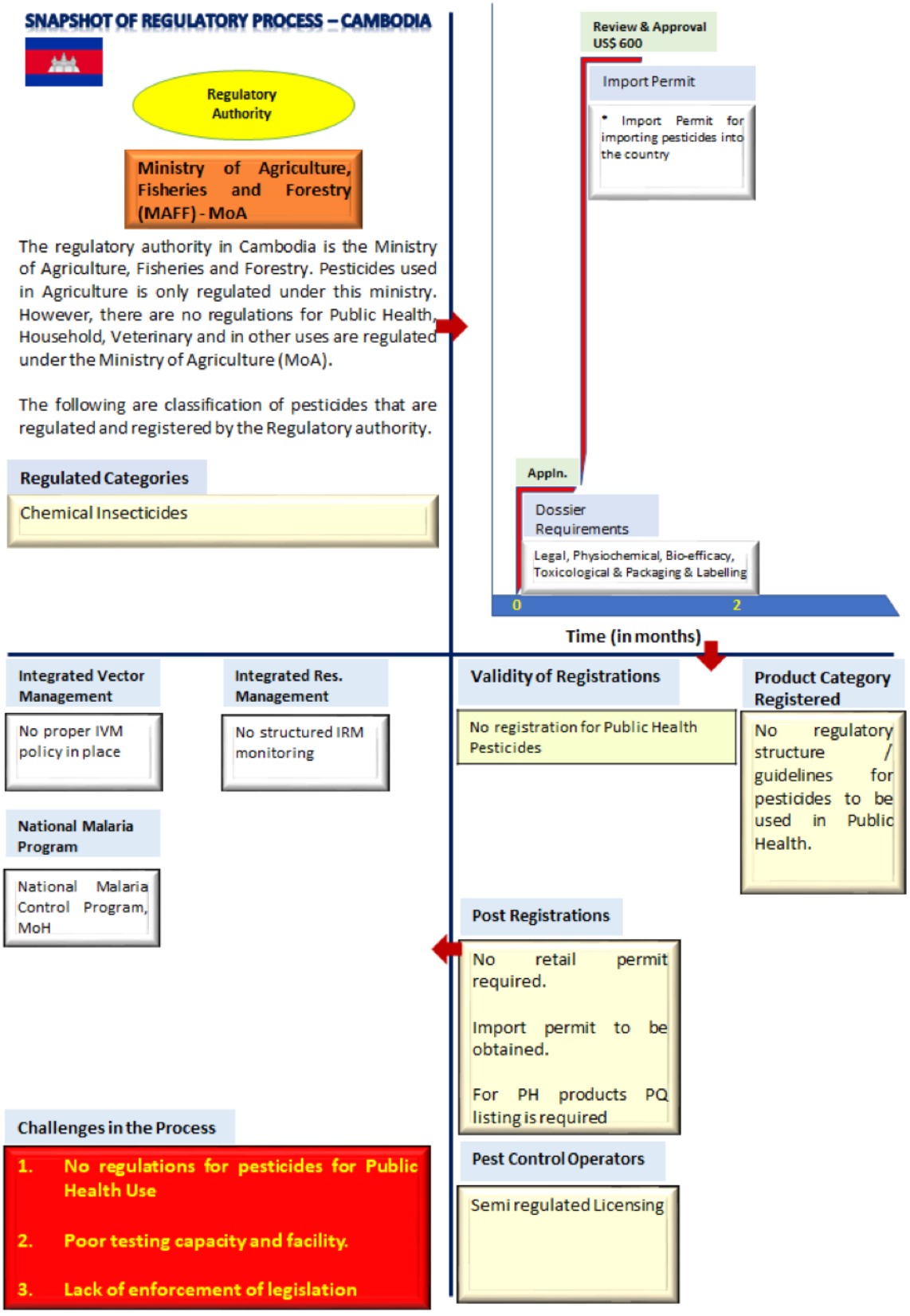
There is no permit required for the retailing of imported pesticides in the country. Since there is no manufacturing capability in Cambodia, all pesticides are imported from various other countries.

Some of the challenges of the registration process in Cambodia are as follows:

1. Lack of guidelines for regulating Public Health pesticides
2. Lack of proper testing capability and capacity in the country.
3. No proper enforcement or monitoring in the country

[67] John Vasanthan Paul (JVP) – Independent Regulatory Consultant (CL: High)

FIGURE 24 SNAPSHOT OF REGULATORY PROCESS[68]



[68] John Vasanthan Paul (JVP) – Independent Regulatory Consultant (CL: High)

6. Market Dynamics

6.1 Market Trends

Increase in use of digitals tools: Cambodia uses digital tools such as MIS to focus the malaria control and elimination activities in endemic areas. For instance, a mobile application called Malaria Case Surveillance App[69] is used for data collection in the Khmer area by Population Services Khmer (PSK). It is well connected with PSI's global DHIS2 database and directly sends patient data, which is aligned with the National Malaria Control Program (NMCP). The application/tool has a user-friendly interface and requires little to no technical knowledge to access it.

This application will help PSI and their partners to:

- Track malaria cases
- Identify malaria outbreaks
- Access real-time malaria-related data
- Re-direct resources (where they are most needed in real time)

Similarly, the Malaria Information System (MIS)[70] is being employed in Cambodia with an aim to provide a tool for district staff to manage their vector control activities, such as mosquito net distribution and stratification at the village level. The MIS tool links malaria information system data (particularly data from the VMW program and mosquito nets) with the national facility-base.

The process for the alert system data flow is as follows:

- In the health centre, the storekeeper records inventory on the stock card and enters information as a message in the mobile
- This message enters the online database and is automatically updated
- The updated stock information is visible on Google Maps by OD/PHD and CNM
- Further appropriate action is taken through approved Ministry of Health mechanisms

The Cambodian national malaria control programme now has a number of innovative mHealth solutions (tools/apps) for its specific real-time data needs.

Awareness campaigns: they are conducted in accordance with government bodies, NGOs and other district or local level organizations. This has helped people to understand the prevention and control measures for malaria and dengue. Various awareness campaigns are conducted in Cambodia:

- No larvae – No mosquito – No dengue
- COMBI

[69] PSI Pulse (CL: High)

[70] Malaria Consortium MIS (CL: High)

6.2 Market Drivers

Increase in incidence of the specific disease: The National Center for Parasitology, Entomology and Malaria Control (CNM) confirmed an increase of malaria cases which started mid-2017. Since the middle of 2017, reported number of cases started to show an increase largely in 10 districts from 8 provinces in the north-east region of the country. The CNM has attributed this increase to a series of possible reasons, including:

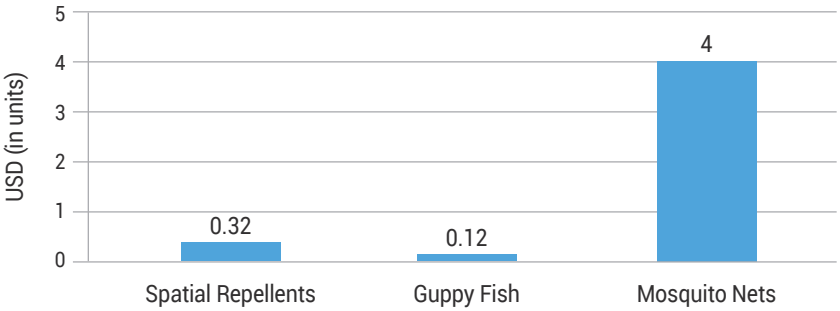
- Interruption of Village Malaria Workers program for two years
- Low use of mosquito nets, distributed in 2015
- Increased movement to and from forest areas
- Abnormal early and heavy rainfalls in 2017

The increased number of malaria cases is driving the vector control market.

The low use of mosquito nets can be attributed to various factors and beliefs among people: long-lasting insecticidal bed nets catch fire,[71] cause claustrophobic feelings, or due to individual preferences for shape, colour, and size of LLINs.

Willingness-to-pay: Willingness-to-pay (WTP) per unit can be defined as the maximum amount a person/ institution is willing to pay for a product or service, or to avoid a loss. Different studies have been undertaken to understand the level of willingness amongst the population in Cambodia to pay for various commodities used in vector control.

FIGURE 25: WILLINGNESS TO PAY (USD)[67,68]



Accordingly,

- In the survey for the spatial repellents; the respondents were willing to pay **USD 0.32** per unit (1268.99 Cambodian riels)[72]
- Socioeconomic status did not have a statistically significant effect on mean scores of willingness to pay, and neither did gender[73]
- There is increased acceptance for the use of guppy fish, and the people are willing to pay **USD 0.12** (200-500 riel/pair) for guppies in the future[74]
- In another survey where farm workers were interviewed, the willingness to pay for the nets was higher in workers who do not own a net, compared to the ones who have a net
- The average amount which the respondents were willing to pay for a mosquito net is USD4, and ranged from as minimum as USD0.5 to as high as USD 12[75]

---

71 Marc Egrot, et al., June 2014 (CL: High)
72 Malaria Journal (CL: Medium)
73 Malaria Journal (CL: Medium)
74 Malaria Consortium (CL: High)
75 Lek D, et al., Infect Dis Poverty. 2018 (CL: High)

Potential drivers for change:

- **Disease Pattern:**
  In Cambodia, malaria is responsible for the highest number of cases amongst VBDs. Geographically, the disease is endemic in ~84% of provinces, with the highest incidence in north-eastern parts. Dengue remains a major public health problem in Cambodia, with 14K cases annually. In 2017 WHO certified and praised Cambodia for successful elimination of Lymphatic Filariasis.
- **Economic Dynamics:**
  The main donors in Cambodia are The Global Fund, PMI, BMGF, and the Asian Development Bank (ADB). The Global Fund has been the major donor for malaria control since 2005. A huge sum of money from The Global Fund goes towards prevention and control activities for VBDs in Cambodia. Domestic funding is available for the maintenance of malaria elimination programs. Out-of-pocket expenditure is ~50% of the total healthcare expenditure.
- **Impact of diseases:**
  Amongst all VBDs, malaria is a high endemic disease, with high transmission between July-November which is a transition period from summer to rainy season. Similarly, as of December 2018, a total of 9,885 suspected dengue cases have been reported in Cambodia. Hence there is huge burden of malaria and dengue amongst all other VBDs.
- **Technology:**
  Increase in the use of digital tools, such as Malaria Case Surveillance App and Malaria Information System (MIS) are helping to create awareness, track down disease cases and monitor the behaviour of clean living; an increase in social marketing has also helped to change health behaviours of the population.
- **Social focus:**
  In Cambodia, village malaria workers (VMWs) are actively working towards eliminating malaria as well as spreading awareness about dengue. The extensive work done by VMWs is helping the country to eliminate vector borne disease. This is a driving factor for the market.

6.3 Success Stories

Cambodia has seen an increase in dengue cases in recent years. With almost 15,000 cases reported in 2015 alone, this VBD has become a serious concern to both public health and economic development in the country. In the absence of a cure or vaccine, the best methods to fight dengue are protection against mosquito bites and vector control; the use of guppy fish, for instance has proven to be successful. In this context, controlling dengue is one of the objectives of Cambodia's health and climate change strategy.

FIGURE 26. USE OF GUPPY FISH AS A SUSTAINABLE AND COST-EFFECTIVE MEASURE AGAINST DENGUE[71]

As mosquitos have become resistant to some of the substances used for vector control, there is a need for a new, more sustainable approach to mosquito reduction. The best vector control method being used against *Aedes* mosquitoes is the guppy fish, a natural and cost-effective alternative. As part of an IVM approach, the CNM and Malaria Consortium established this method of vector control with the support from WHO.

Guppy fish were placed in a large water container near the home, checking twice a month as recommended to see if replacement was needed. Communities were instructed to keep guppies and, and to use other preventive measures like avoiding mosquito bites and cleaning-up of surrounding areas. Flyers, banners and tuk-tuks were used for delivering health messages.

The project has shown that keeping guppy fish in large household water containers is an effective and low-cost dengue control method that is acceptable and sustainable in Cambodia.[76]

7. Market Access Analysis

In order to enter into the Cambodian market, considering the following points is essential.

Partnership: Any organization willing to enter into the Cambodian vector control market should try to build a strategic partnership with the Ministry of Health. Additionally, the organization can also focus on developing multi-organizational partnerships (e.g. pharmacy and medical associations).

Products: The population affected by vector borne diseases is too large to reach. The main activity carried out is mass distribution of LLINs to high endemic regions in order to prevent VBD transmission. Hence, the entry strategy for any new organization is to go for mass distribution campaigns of LLINs, as coils and aerosol sprays are majorly a part of the retail market. Moreover, WHO Prequalification (PQ) is also required for products to be eligible for mass distribution.[77] As evident from Figure 25, retail and public spending contribute equally to the vector control product market. An organization entering the market could target mobile and migrant populations for the distribution of backpacks/forest packs containing an LLIN/LLIHN along with retail products.

Awareness Campaigns: Campaigns emphasized on education about clean environments, preventive measures and basic medical help in case of disease, should be undertaken with the help of local bodies and NGOs in the country.

Geography based on burden of disease: Geographical analysis for high endemic malaria and dengue regions is necessary. In Cambodia, north-eastern provinces (Kampong Cham, Svay Rieng, Mondulkiri, Ratanakiri etc.) and western provinces (Pailin, Pursat) are high endemic regions, with high population at risk.

Implementation Partner: Listed below are key implementation partners responsible for vector control in the country

- Ministry of Health (MoH); CNM
- Malaria Consortium
- UNOPS
- BMGF

Awareness Media:

Media plays an important role in spreading awareness. The communication forms can be radio, television, cinema, magazines, newspapers, and/or Internet websites. Human communication or mouth-to-mouth communication are important sources of media used to increase awareness. However, in Cambodia, local health centers, VMWs, and BBC programs are used to spread awareness about VBD amongst the population.

[77] Primary insight

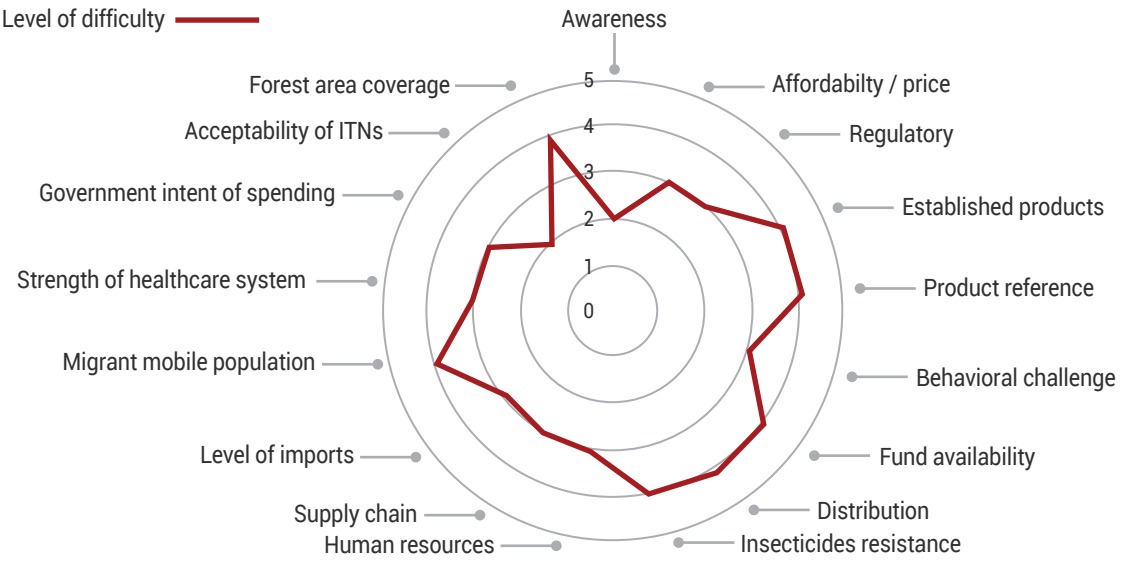
8. First conclusions

There is a strong mosquito net culture in the Asia Pacific region, especially in the GMS, including Cambodia. Nets/LLINs are effective on specific mosquito species, require retreatment, and provide a physical barrier (can be effectively used during sleeping, as daily work hinders the use of nets). Moreover, there are preferences for net colours, designs, and shapes among some ethnic groups in Cambodia, leading to lower usage. This drawback of the nets provides an opportunity to look for new integrated vector management tools.

In addition, it is necessary to observe and understand what information can be gained from mosquito presence and behaviour, in terms of level of cleanliness, geographical barriers, and persistent usage of tools (source: *primary KoL insight*). Combining LLINs with some additional VC tools can be effective. Retail market products such as coils, repellents, spray/aerosols, and insecticides can be products that IVCC consider developing or adapting, that could be bundled along with LLINs as a kit.

In terms of challenges for new VC products in Cambodia, inaccessible forest areas, mobile & migrant population, and strong product preferences are amongst those ranking the highest.

FIGURE 27: CHALLENGES FOR NEW PRODUCTS IN CAMBODIA



In above chart for level of difficulty: 1 – lowest challenge; 5 – highest challenge

9. Referencing

The list of participants in the primary interview research process is listed below.

1. Country Director – Global Donor
2. Independent Consultant and IVM Adviser –World Health Organization
3. Director, Country Support - World Health Organization
4. Managing Principal – Global Manufacturer for Household Insecticides
5. Director – Global Donor Body
6. Vector Control Specialist – Leading Insecticide Manufacturer

10. Appendix

1. Confidence Level for Sources Used in Secondary Research

The following criteria has been used for defining confidence level of secondary sources used in this report:

High:

- Reports published by major funding bodies such as The Global Fund, PMI, WHO, etc.
- Literature published in scientific journals
- Publications from government (MoH)
- Company websites, press releases, annual reports

Medium:

- News articles, blogs, published interviews, etc.
- Conference presentations
- Awareness websites
- University websites

2. Malaria Burden Funding, Retail Market – Rating Criteria

Key Parameters	High	Medium	Low
Population at Risk 2017 (% of total population)	>75	25-75	<25
Incidence of Malaria (Cases/1000) (2017)	>50	5-50	<5
LLINs (Million) (2017)	>10	5-10	<5
Public Funding (USD Million) (2017-2018)	>50	30-50	<30
Public Fund ($)/person at risk	>10	2-10	<2
Retail Market (USD Million) (2018)	>100	50-100	<50
Est. funding for LLINs (% of Public Fund)	>25%	10-25	<10

3. Malaria Burden Funding, Retail Market – Data

Parameter	Cambodia
Population at Risk 2017	11.3
Incidence of Malaria (2017)	13
LLINs (2017)	2.6
Public Funding (2017-18)	29.4
Public Fund (D)/person at risk	$2.6
Retail Market (2018)	25.2
Retail Spending (D)/person at risk	$2.2
Est. funding for LLINs (% of Public Fund)	20%