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Vector Control in the Indo-Pacific: Market Access Landscape

Country Report

Papua New Guinea

INNOVATIVE VECTOR CONTROL CONSORTIUM

November 2019

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Abbreviations

ACT	Artemisinin-based Combination Therapy
AMF	Against Malaria Foundation
APLMA	Asia Pacific Leader Malaria Alliance
CDC	Centers for Disease Control and Prevention
CMCA	Community Mine Continuation Agreement
DENV	Dengue Virus
EDAT	Early Diagnosis and Appropriate Treatment
GFATM	Global Fund to Fight AIDS, Tuberculosis and Malaria
GIS	Geographic Information System
GST	Goods and Service Tax
IRS	Insecticide Residual Spraying
ITN	Insecticide-Treated Nets
LLIN	Long-Lasting Insecticidal Net
MMV	Medicines for Malaria Venture
MHC	Mobile Health Clinic
MoE	Ministry of Environment
MSP	Malaria Strategic Plan
NCD	National Capital District
NDoH	National Department of Health
NHIS	National Health Information System
NICTA	National Information and Communication Technology Authority
PNG	Papua New Guinea
RAM	Rotarians Against Malaria
RHAP	Rural Health Aid Post
RDT	Rapid Diagnostic Test
Swiss TPH	Swiss Tropical and Public Health Institute
VBD	Vector-Borne Diseases
WHO	World Health Organization

1. Executive Summary Vector Control

Papua New Guinea (PNG) includes the eastern half of the world's second biggest island, New Guinea, bordering the Indonesian province of Irian Jaya to the west. The rest of the country is made up of about 600 small islands, the chief of which are the Bismarck Archipelago, the Trobriands, the Louisiade Archipelago, the D'Entrecasteaux Islands, and some of the islands in the Solomons group, including Bougainville. The estimated population is just above 8 million as of 2017, wherein urban population comprises of around 13% and the rural population is about 87%.

Papua New Guinea is gifted with natural resources, but it is inaccessible to most of the population because of rugged terrain and the ever-increasing cost of developing infrastructure. Most people are employed in the agriculture sector which contributes to about 67% as opposed to services at 27%. With an increase in the number of people migrating from rural to urban areas, the living conditions are on the decline as there is a deficit in housing. The National Department of Health and the Church-run facilities are the major provider of healthcare services in the country.

In PNG, 94% of the total population is at risk of Malaria infection

Malaria has been endemic throughout PNG with the exception of highland areas over 1600m of altitude, where low temperatures prevent stable transmission. The prevalence of malaria is about 7.1% as per the 2016-2017 Malaria Indicator Survey; the incidence of malaria is particularly high in children below 5 years of age. As there is a lack of surveillance system for dengue, the cases of this virus are rarely reported in PNG; according to a study published by Senn *et al* (2011), a seroprevalence rate of 8% was found among patients reporting with acute febrile illness in Madang Clinic.

The Global Fund and Australian Government are the major funders for Malaria in PNG

The Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) is the major source of external funding for malaria in PNG. The Global fund has signed an amount of USD38.6 million for the period of January 01, 2018 - December 31, 2020. The next major funding comes from the Australian Government which runs a trilateral malaria project along with China and PNG. The project was designed for a three-year period from 2016 to 2018, with a funding allocation of USD2.8 million. Against Malaria Foundation (AMF) is another funding body which is mostly focused on the distribution of Long-Lasting Insecticidal Nets (LLINs) for the control of vector-borne diseases (VBDs).

Rotarians Against Malaria is the foremost channel for distribution of vector control measures

Rotarians Against Malaria (RAM) is funded by The Global Fund and works together with the National Department of Health and provincial health offices to ensure that every village in PNG receives mosquito nets every three years. To date, they have coordinated the distribution of over 9.6 million LLINs to household level throughout PNG. Together with the household distribution, they have supplied a further 1.3 million nets to vulnerable groups such as pregnant women, boarding schools, and correctional centers.

Retail market in PNG mostly comprises of insecticidal coils owing to their low cost

The retail market for vector control products in Papua New Guinea was ~USD18 million in 2018. It consists of various consumer products such as electric insecticides, insecticide coils, spray/aerosol insecticides, home insecticides, vaporizing mats, and repellents (lotions and wipes); Aerogard, RID, and BushMan are the top retail market products used in the country. It is estimated that ~200 million insecticide coils were sold in 2018, generating a sales value of USD5-10 million due to their low cost.

Logistics and the financial system are the major challenges in PNG

The financial system is the major challenge in PNG, as Inland Revenue wanted to start charging a Goods and Service Tax (GST) on nets for household distribution; because of this, commercial selling of LLIN is currently abandoned. Community involvement is a problem unless there is someone present to supervise the malaria program. Another major challenge in PNG is logistics, i.e., transportation of vector control products is difficult in rural areas because of poor road and transport infrastructure, as many villages are only accessible by air, boat, or long-distance walking.

Major Trends and Drivers

Women development programs and an increase in funding through corporate social responsibility are the current market trends in PNG. An increase in Internet services and the application of mobile services, along with Geographic Information Systems (GIS) technology, can drive the vector control market in PNG.

Role of Advocacy in PNG

The use of medical cargo drones for service delivery of vector control products has to be considered, as transportation is a major drawback in PNG, and some remote villages are only accessible by boat or air. Initiation of newer projects such as 'The Debug Project' by Verily can be initiated in PNG so as to control the female mosquito population which is the major carrier of *Plasmodium* parasites. Various medical campaigns, such as those initiated by MMV, Exxon Mobil and Oil Search are required to monitor and control vector-borne diseases in PNG.

2. Introduction

The objectives of this study are:

- 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

PNG occupies the eastern half of the island of New Guinea and its offshore island in Melanesia, a region of the south-western Pacific Ocean of the north of Australia. The capital city, Port Moresby is located at the south-eastern coast. The western part of New Guinea forms the Indonesian provinces.

2.1.1 Geography

In the list of Pacific Island Nations, PNG is the largest one. It has a large volcanic island and about 600 dispersed islands to the East and North of the Bismarck Archipelago and the Solomon Sea. The land area covered by PNG is over 462,840 square kilometres. PNG has the most rugged topography in the world, with altitudes of over 4000m. The country is spread over 2,082 kms north-northeast to south-southwest and 1,156 kms east-southeast to west-northwest.

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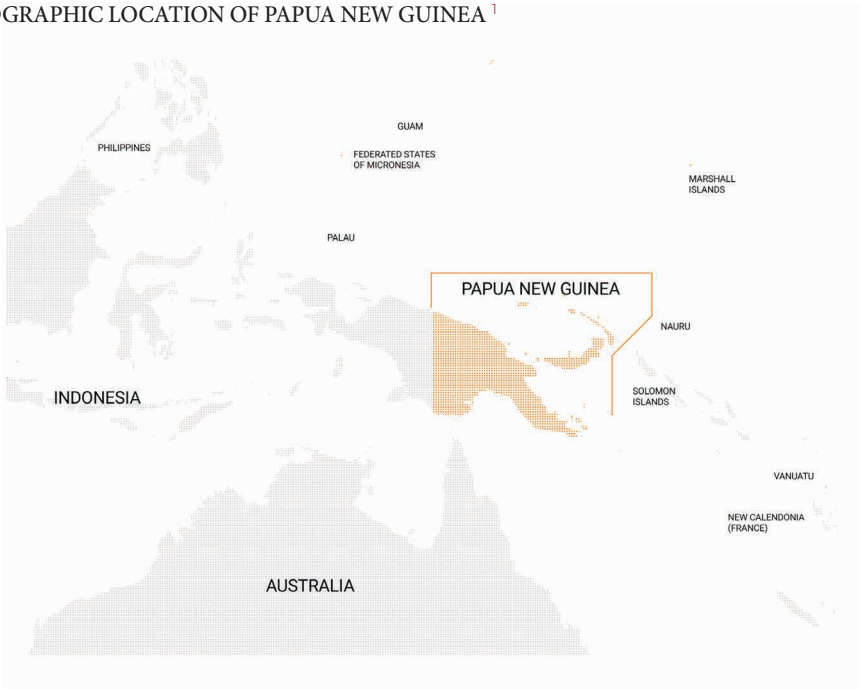
[1] Cambodia (Confidence level of source [CL]: Medium)

[2] Britannica (CL: Medium)

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

FIGURE 1: GEOGRAPHIC LOCATION OF PAPUA NEW GUINEA [1]



Papua New Guinea mostly consists of the main island of New Guinea which is the second largest island in the world along with Irian Jaya, a province of Indonesia. The north side of PNG lies the U.S. Trust Territory of the Pacific Island, towards the east are the Solomon Islands, the west side consists of Irian Jaya, and towards the south lies the closest neighbour country, Australia.[2] The boundary length of PNG is almost 5,972 kms out of which 5,152 kms is the coastline.

2.1.2 Demographics

As per the United Nations, Department of Economic and Social Affairs, Population Division (2017), the population of Papua New Guinea was 8.59 million in 2017. The numbers of males and females are 4.37 million and 4.22 million respectively.[3] The rural population comprises about 87% of the total population, whereas the urban population is around 13%.

2.1.3 Economic Situation

Papua New Guinea is gifted with vast natural resources but these are largely unexploited because of the rugged landscape, issues with land terrain and the increasing cost of developing infrastructure. The nation has a small official sector mostly focused on the export of those natural resources, and an informal sector which employs the bulk of the population. The major sector is agriculture which provides a livelihood to almost 85% of the population in PNG. As there is an ever-increasing demand for commodities in PNG, the global recession levels have a diminished impact here. Natural resources like copper, gold, and oil together comprise two-thirds of the export earnings.

There are various challenges faced by the government, which include providing security to foreign investors and recovering their confidence, reinstating integrity to state institutions, endorsing economic efficiency by privatizing the declining state institution, and continuing a decent relationship with Australia, its formal colonial ruler. Also, the socio-cultural challenges could decline the economy which include the chronic law and order, and land tenancy issues. PNG launched its first-ever national trade policy in August 2017, named PNG Trade Policy 2017-2032. The major aim of the policy is to enhance trade by increasing exports, reducing imports, and promoting foreign direct investment.[4]

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[2] Global Security (CL: Medium)

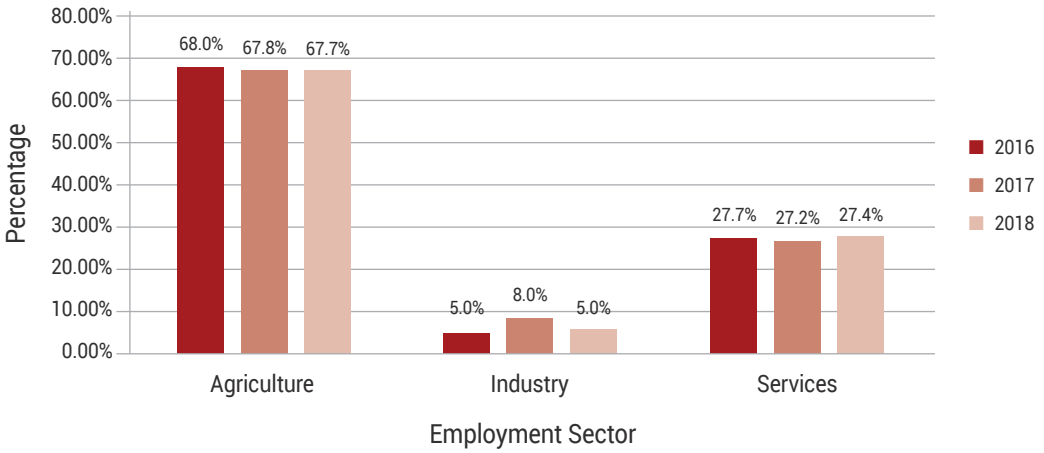
[3] United Nation Population Division (CL: Medium)

[4] Papua New Guinea Economic Indicators (CL: Medium)

2.1.3.1 Employment

The majority of people are employed in agriculture which contributes to about 67% of the total population, as compared to services which is 27%, and other industries at 5-8%.

FIGURE 2: PERCENTAGE OF EMPLOYMENT IN PAPUA NEW GUINEA[6]



2.1.3.2 Others (Internet usage, Education, etc.)

Education:

The education system is on the verge of change in PNG, as the number of children entering the school is higher than ever before, since the government has abolished school fees. Still, almost half of the children eligible for primary schooling cannot benefit from these services due to reasons such as distance from school, safety issues, lack of parental support and the living conditions in their homes. Also, the number of girls attending to school is lower than that of boys. The country's overall enrolment rate is at 63% which is the lowest in the Asia Pacific region. Only one in three children can complete their basic education; there is less probability for children in rural areas to receive education as compared to those living in urban areas.[7]

Internet Usage:

Due to an upsurge in technology, the number of Internet users in PNG has grown to 900,000, and almost 3.3 million people of the total population use a cell phone. This information was provided by the National Information and Communication Technology Authority (NICTA) at the Internet Filtering and Policy workshop in Port Moresby. The Statistics from NICTA have shown that because of an increase in mobile phone networks, 11.76% of the population now has access to the Internet.[8]

[6] Data from World Bank (CL: High)

[7] UNICEF (CL: High)

[8] National Information and Communication Technology Authority (CL: Medium)

2.1.4 Health Status

2.1.4.1 Health Indicators

Life expectancy has increased over the years in Papua New Guinea. In 2016, the life expectancy was 65.9 years (68.3 for women and 63.6 for men).[9]

Listed below are some of the key health indicators.

TABLE 1: KEY HEALTH INDICATORS[10]

Population (2017)	**8.59 million**
Population proportion under 15 (%) (2016)	36.3
Population proportion over 60 (%) (2016)	1.4
Life expectancy at birth (years) (2016)	63.6 (Male), 68.3 (Female), 65.9 (Both)
Neonatal mortality rate (per 1000 live births) (2017)	23.7 (both sexes)

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

2.1.4.2 Living Conditions

The population growth rate of PNG is 3.1% and there is an increase in a number of people migrating from rural to urban areas, adding to urban poverty characterized by poor living conditions and shortfalls in housing. Even the main urban infrastructure and services like roads, drainage systems, water, and sanitation have declined in recent years because of poor maintenance.[11]

All the levels in the government sector are facing stumbling blocks in the development of Papua New Guinea because of the absence of major policy-making in the housing sector, a lack of capacity, poor management, and dysfunctional governance structures.

2.1.5 Healthcare Structure

The Government and church-run facilities are the major providers of healthcare in Papua New Guinea and are also funded by government tax revenues, donors and users. In terms of facilities, there are 1820 aid posts, 508 larger health centres, and 48 urban clinics as of the year 2000. Around 96% of the total population live within the reach of these primary health care centres.

There are government hospitals in all provinces except the central, whose people receive medical services from Port Moresby General Hospital, which is both a teaching and referral hospital. Two small private hospitals are present in the National Capital District (NCD).

The National Department of Health plans and administers health programs that are implemented at the provincial and district levels. However, a devolution exercise has seen the delegation of powers to hospitals, which are more flexible in managing their own human resources and finances.

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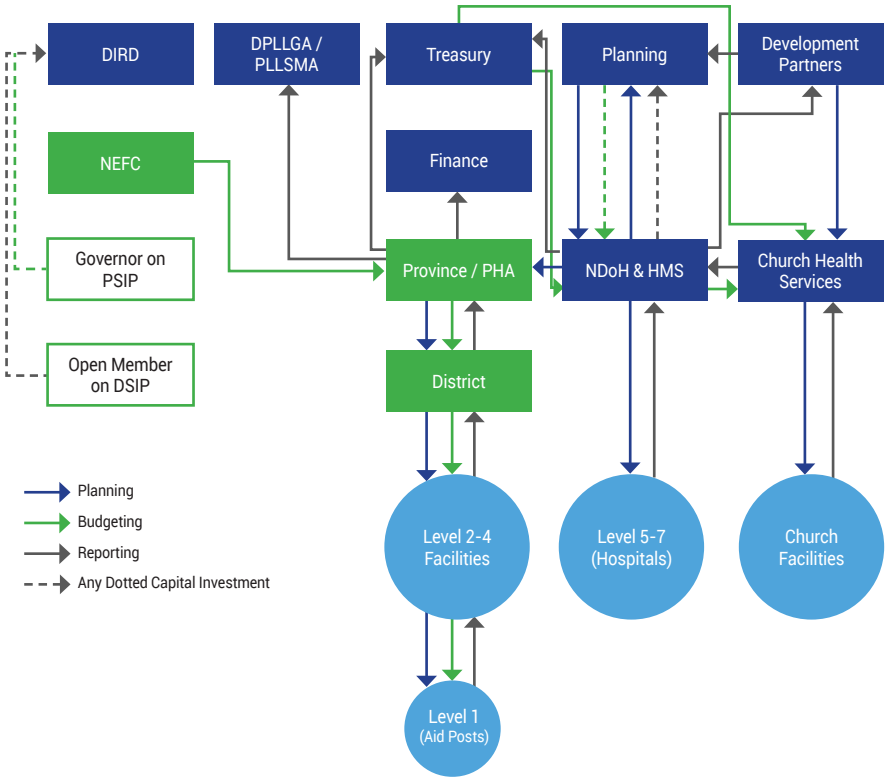
[9] Papua New Guinea – Life Expectancy at birth (CL: Medium)

[10] WHO (CL: High)

[11] United Nations (CL: High)

FIGURE 3: GOVERNANCE STRUCTURE OF THE HEALTH SYSTEM



The governance mechanism in the sector remains convoluted and, in many ways, ineffective. An extensive list of central agencies receives siloed reporting data.[12] These include:

- The Department of Implementation and Rural Development, which receives reports specifically on provincial and district infrastructure out of the Provincial Service Improvement Program and District Service Improvement Program funding.
- The Department for Provincial and Local-Level Government Affairs, which receives reports on provincial health delivery.
- The Department of Finance and Treasury, which budget for, and release operational expenditure, and receive financial reports on budget expenditure and performance from provinces and the National Department of Health (NDoH).
- The Department of Planning which budgets for capital investment component and receives performance reporting on infrastructure projects.
- The National Economic and Fiscal Commission (NEFC) which budgets for rural facilities on provinces but does not receive reports from provinces directly.

2.1.5.1 Healthcare Spending

The Ministry of Treasury in Papua New Guinea has provided the budget estimates for national government departments for the year 2017, 2018 and 2019. The Papua New Guinea health budget has historically remained below 4% of the GDP. Papua New Guinea's government expenditures on health increased from USD40.6 per capita in 2011 to an estimated USD76.2 per capita in 2015.[13]

[12] Health Financing System Assessment: Papua New Guinea (CL: High)

[13] WPRO.WHO (CL: High)

TABLE 2: 2019 BUDGET ESTIMATES FOR NATIONAL GOVERNMENT DEPARTMENTS[14]

Entity	Actual 2017	GDP Growth %	Health Expenditure (% of GDP)
Total Appropriation	7.4	7.0	7.8
Department of Health	1.1	1.6	2.0

Table 2 clearly shows that the Government of Papua New Guinea has been increasing its healthcare spending over the years, and for the year 2019 has estimated it will spend around USD2 million on health care services.

3. Vector Control Market Overview

3.1 Vector Control overview

The vector control market in Papua New Guinea is mostly focused on the distribution of LLINs, which is carried out by Rotarians Against Malaria (RAM) at the country level. To carry out the distribution, RAM is largely funded by the Global Fund.

In the last eight years (2010-2018) RAM has distributed around 9.6 million LLINs at household levels in Phase One and Phase Two to all 89 districts in 22 provinces.

TABLE 3: DISTRIBUTION OF LLIN'S TO HOUSEHOLD LEVEL[15]

Periods	Date	District	Provinces	Nets Delivered
Phase One (2010-2011)	Nov 09-Oct 11	50 Districts	18 Provinces	1,890,448
Year 3 (2012)	Nov 11-Sept 12	27 Districts	10 Provinces	832,671
Year 4 (2013)	Oct 12-Sep 13	28 Districts	12 Provinces	1,210,391
Year 5 (2014)	Oct 13-Sep 14	23 Districts	11 Provinces	1,374,791
Year 5 (2014) No Cost Extension	Oct 14-Dec 14	Okapa, Lufa, Madang, Angoram, Maprik, Yangoru, Saussi, Wewak, Aitape Lumi, Nuku and Vanimo Green	EHP, Madang, East Sepik, Sandaun	454,806
Year 6 (2015)	Jan-Dec 2015	29 Districts	11 Provinces	932, 822
Year 7 (2016)	Jan-Dec 2016	27 Districts	13 Provinces	805,597
Year 8 (2017)	Jan-Dec 2017	36 Districts	13 Provinces	1,543,947
Year Nine	Jan-Mar 2018	Kompiam, Siassi, Mount Hagen, Jimi, Gumine, Kunidawa Gembogi, Sinsina Yongumugl, Nomane	Morobe, Enga, Western Highlands, Jiwaka, Chimbu	272,725
	April – Jun 2018	Asaro, Unggai Benna, Kainantu, Kabwum, Huon, Finschafen, Nawae, Bulolo and Menyamya	Eastern Highlands, Morobe	336,128
Total New Program				**608,853**
New Funding Model (2015-2017)				**3,282,366**
Round Eight (2010-2014)				**5,763,107**
Overall Total Phase One and Phase Two and NFM				**9,654,326**

Distribution of LLINs to vulnerable groups in the last eight years stands at 1.3 million nets, as depicted in Table 4.

[14] 2019 Budget Estimates Of Revenue And Expenditure For National Government Departments (CL:High)

[15] Chasing Malaria in PNG - RAM Conference 2018 (CL:High)

TABLE 4: DISTRIBUTION OF LLIN'S TO VULNERABLE GROUPS[16]

Totals	Antenatal	Schools	Prison	Other	Totals
Phase One	208,602	43,242	4,656	5,158	261,658
Nov – Dec 2011 (Q9)	15,089	4,740	0	507	20,336
2012	154,215	2,290	0	3,051	159,556
2013	119,738	52,365	4,253	3,900	180,256
2014	155,561	23,834	0	2,626	182,021
2015	169,884	400	0	105	170,389
2016	123,366	13,782	2,047	55	139,250
2017	146,771	3,284	0	313	150,368
Jan – Mar 18 (Q1 GFNP)	16,710	0	0	0	16,710
Apr – Jun (Q2 GFNP)	64,500	–	–	300	64,800
Total GFNP	81,210	0	0	300	81,510
R8	653,205	126,471	8,909	15,242	803,827
Total NFM	**440,021**	**17,466**	**2,047**	**473**	**460,007**
Total Programme	**1,174,436**	**143,937**	**10,956**	**16,015**	**1,345,344**

In total, RAM has distributed over 10 million nets to Papua New Guineans over the past eight years.

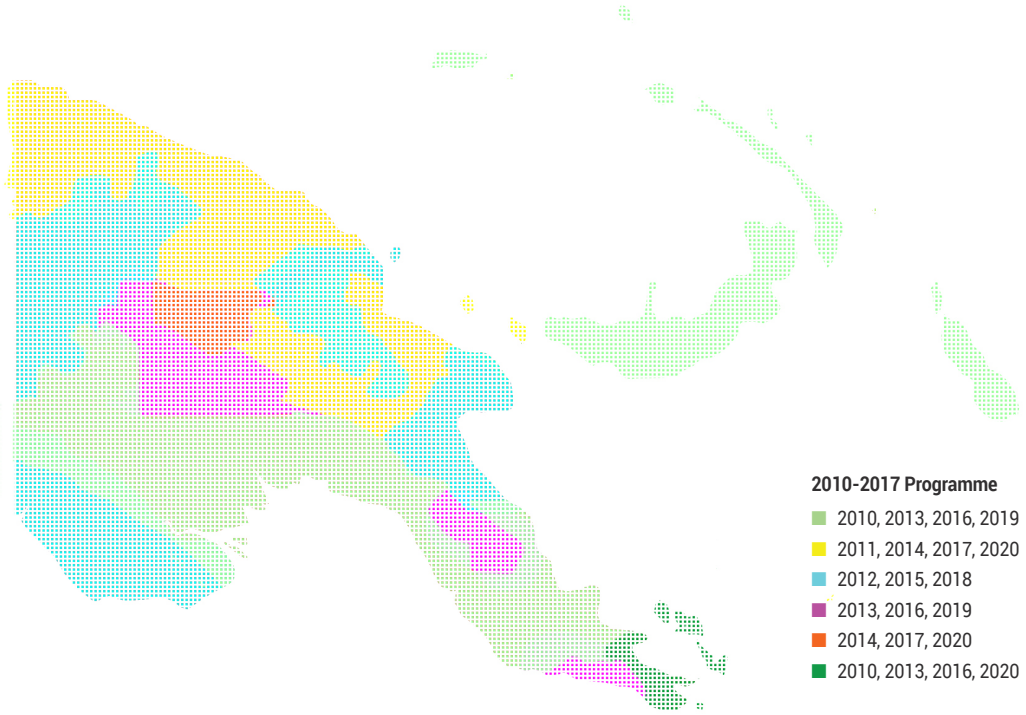
RAM teams conduct regular audits at health facilities to ensure adequate inventories and accurate recording of commodities dispensed as well as diagnostic test results and flow of patient care. These teams also ensure all malaria cases are accurately reported to the National Health Information System in a timely fashion to improve national malaria surveillance.

RAM PNG is also administering the financial aspects of the PNG Institute of Medical Research where the following research projects are being supported by The Global Fund:

- Stratification of malaria in PNG in 2018.
- Insecticide Resistance in 2018 and 2020.
- Malaria Indicator Survey, 2019 – 2020

16 Chasing Malaria in PNG - RAM Conference 2018 (CL:High)

FIGURE 4: LLIN DISTRIBUTION PLAN BY ROTARIANS AGAINST MALARIA[17]



3.1.1 Vector Borne Diseases (VBD) Trends

The prevalence of malaria in PNG is at 7.1%, which underestimates the overall severity of the problem. The prevalence of malaria for children under five is at 10%, and there is high prevalence among all ages in Madang at 16%, Milne Bay at 10.8%, East Sepik at 8.8% and New Ireland at 8.7%. The prevalence of malaria in Sandaun province for children under five years is 20.5%, which is an alarming sign.[18]

Dengue virus cases in PNG are rarely reported, but a study published by Senn *et al* (2011) indicated a seroprevalence of 8% amongst patients presenting to Madang clinics with an acute febrile illness.[19] According to Luang-Sarkia *et al* (2018), DENV surveillance is not undertaken, and patients with acute febrile illness are not regularly tested.[20]

3.1.2 Burden of Disease

Trends in malaria prevalence, by province, Papua New Guinea:

In Papua New Guinea, ~7.1% of the population is infected with malaria parasites; in highland areas (>1600m) infection with *Plasmodium falciparum* was more common than infections with *P. vivax*. Around 9.5% of children <5 years of age living in villages below 1600m were infected with malaria parasites, while no malaria infections were found in children living at 1600 masl and above.[21]

[17] Chasing Malaria in PNG – RAM Conference 2018 (CL:High)

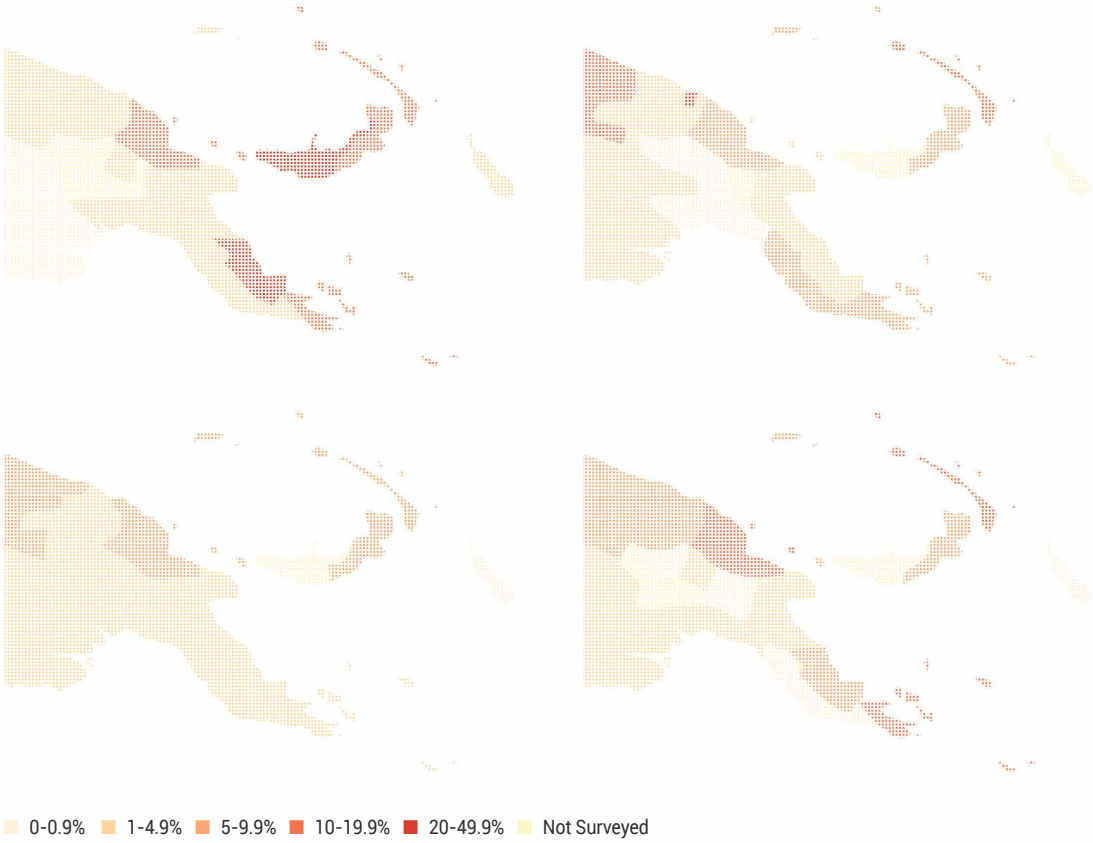
[18] Papua New Guinea Malaria Indicator Survey 2016-2017 (CL: High)

[19] Nicolas.Senn, et.al. (2011) (CL: Medium)

[20] Dagwin Luang-Suarkia, et.al. (2018) (CL: Medium)

[21] Papua New Guinea Malaria Indicator Survey 2016-2017 (CL: Medium)

FIGURE 5: PERCENTAGE OF PERSONS INFECTED WITH *PLASMODIUM* PARASITES (ANY SPECIES)[22]



Source: National Malaria Control Programme Evaluation

3.1.3 Economic Burden of VBD

One study in Papua New Guinea aimed at determining the household cost of malaria in children less than 3 years of age. Intra-country household cost differences were put forward for the first time as they may have compelling implications for health policy choices.[23]

TABLE 5: COST OF MALARIA EPISODE IN DIFFERENT PROVINCE OF PNG[22]

Cost	Madang Province (US $)	Maprik Province (US $)
Outpatient Malaria Episode	7.54	9.20
Inpatient Malaria Episode	25.20	14.08

Intra-country cost needs to be considered in estimating the household cost for both outpatient and inpatient malaria treatment. The total household cost per outpatient episode of malaria was lower in Maprik than in Madang (incremental cost of USD1.67), while the total household cost per inpatient episode of malaria was higher in Madang than in Maprik (difference of USD11.16).

These different charges imposed by health facilities on their services are mainly because of the lack of government policy. The other reason is the distance from health facilities, which affects treatment seeking choices. Hence, transportation costs and time lost during treatment seeking shall be considered by the country's health policy-makers.

[22] WHO (CL: High)

[23] Elisa Sicuri, et.al. (2012) (CL: Medium)

3.1.4 Measures/Initiatives for Vector Control

A number of campaigns are increasing the level of awareness and promoting the use of mosquito nets and other vector control measures.

Malaria Control and Prevention Campaigns

TABLE 6: MALARIA CONTROL AND PREVENTION CAMPAIGNS[24]

Name of the Campaign	Time Period	Target Disease	Coverage	Organization	Digital Campaign	Digital Campaign
Medicines for Malaria Venture	2011 – ongoing	Malaria	Local (Lihir group of Islands)	--	No	MMV has planned out a map to eliminate malaria from Lihir group of Island by 2022
OliSearch Marasin Stoa program	2003	Malaria	Southern Highland Province	Southern Provincial Authorities	No	From 2010 to 2013 there was decreasing trend in the incidence of malaria and a shift from P. falciparum to *P. vivax* infection.
Exxon Mobil	2006 – ongoing	Malaria	Provinces of Hela, Gulf and Central	The local government	No	In 2016, the incidence and prevalence of malaria has fallen by over 70% in most areas of the country.

Medicines for Malaria Venture

Medicines for Malaria Venture (MMV) is engaged in drug development and access partnership with Newcastle Mining Limited, an Australian mining company with significant operations in PNG. Currently, MMV is working with Newcrest, IS Global, International SOS, and staff from a local medical centre in Lihir to map out a plan to eliminate malaria from the Lihir Group of Islands by 2022.[25]

FIGURE 6: MMV WORKS IN CLOSE COORDINATION WITH PHARMA-PARTNER AND STAKEHOLDERS TO PREPARE NEW PRODUCTS FOR MAXIMUM PATIENT IMPACT AND TO IMPROVE DIAGNOSTIC AVAILABILITY AT POINT OF CARE[23]

[24] FutureBridge analysis

[25] Medicines for Malaria Venture (CL: Medium)

Oil Search

Oil Search has been implementing the Marasin Stoa program, a village malaria treatment initiative at its Hides gas field project area in the Southern Highlands Province. The program entails training a community member, usually a woman, in basic malaria diagnosis using a Rapid Diagnostic Kit and supplying pre-packaged (dosage per weight category) malaria medication.[26]

FIGURE 7: TRAINING WOMEN TO SET UP LOCAL MEDICAL SHOPS TO BUILD A SUSTAINABLE FUTURE FOR THE WOMEN AND THEIR COMMUNITIES UNDER THE MARASIN STOA PROGRAM[27]

Exxon Mobil

ExxonMobil is implementing 'inside' and 'outside' fence initiatives at its operations in PNG. Inside the fence program includes awareness campaigns, mosquito bite prevention tools, anti-malarial medication, and promotes early diagnosis and treatment to fight malaria. Outside the fence, ExxonMobil, through its Malaria Initiative, has collaborated with the Rotarians Against Malaria Program on logistics, planning and bed net distribution. More than 1,000 community members were tested for malaria and treated if found infected.[28]

FIGURE 8: NET DISTRIBUTION TO COMMUNITY MEMBERS BY EXXONMOBIL[25]

[26] Malaria Consortium And Montrose International,2015 (CL: Medium)

[27] Marasin Stoa Kipa Program (CL: Medium)

[28] Malaria Consortium And Montrose International,2015 (CL: Medium)

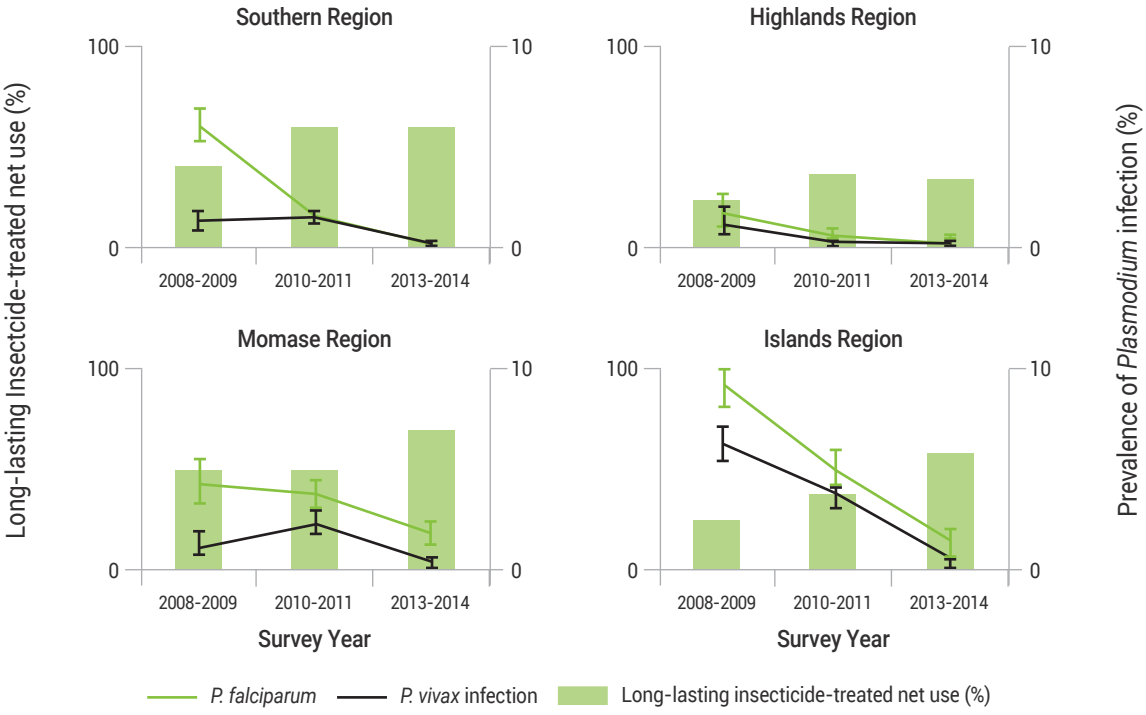
MosquitoZone

MosquitoZone was designated to lead the vector/pest control efforts for one of its clients, the Liquefied Natural Gas (LNG) project in Papua New Guinea. A major achievement for MosquitoZone has been the total prevention of malaria cases among the pipeline construction crews as they cut through the rainforest, laying a 34-inch pipe over 400 kms. MosquitoZone's vector control program area covers 6,000 workers, 12 camps, and 273 kms that include onshore pipeline construction, an airport, a gas conditioning plant construction and client living quarters in Port Moresby, the capital city.[29]

National Malaria Control Program:[30]

In 2004, a partnership of the PNG government, an NGO and the National Malaria Control Program was initiated, largely funded by The Global Funds to fight AIDS, Tuberculosis, and Malaria. The main initiatives that are implemented by the National Malaria Control Program include distribution of LLINs, rapid diagnostic tests and artemisinin-based combination therapy for the treatment of malaria.

FIGURE 9: PREVALENCE OF *PLASMODIUM* INFECTION AND INSECTICIDE-TREATED NET USE, BY REGION AND SURVEY DATE, NATIONAL MALARIA SURVEYS, PAPUA NEW GUINEA, 2008–2014[31]



It can be clearly stated that an increased use of LLINs in Papua New Guinea was associated with a rapid and significant decline in malaria prevalence, with the lowest prevalence ever recorded in 2013–2014. The decline also occurred in the epidemic-prone highlands region.

Australia-China-Papua New Guinea Pilot Cooperation:[32]

The Australia – China – Papua New Guinea Pilot Cooperation on Malaria Control Project (the Trilateral Project) commenced in January 2016. The trilateral project has two objectives:

- To increase the quality of malaria diagnosis in the Papua New Guinea health services
- To pilot effective cooperation between Australia, China, and Papua New Guinea

[29] MosquitoZone International (CL: Medium)

[30] Swiss Tropical and Public Health Institute (CL: Medium)

[31] Manuel W Hetzel et.al. 2017 (CL: Medium)

[32] PNG Institute of Medical Research (CL: Medium)

3.1.5 Challenges

Financial System:

In Papua New Guinea, RAM started a private sector program to commercially sell LLINs. There were around 33 outlets selling nets in Port Moresby but most of them were centrally located. Revenue from total sales has been 77,000 Kinas (USD 22,830), with ~57 bales of nets and ~2000 Mosbar repellents sold. The project raised enough revenue to cover the costs of the project. Mosbar was targeted at rural villages with malaria problems as identified by the Chasing Malaria Programme. Follow-up surveys showed that Mosbar works well and was very popular with the villagers. The program has been suspended as the Inland Revenue wanted to start charging a Goods and Service Tax (GST) on nets for household distribution, which may affect the costs of the products to households.[33]

Community Involvement:

Community involvement is a problem unless there is someone present to supervise the malaria program. Efforts are still underway to find ways to encourage schools and communities to act without full project involvement. Since LLIN distribution was done in a continuous mode by RAM, there was a decline in malaria until January 2016. It is also difficult to prove the community's involvement when the reported cases themselves were low. The RAM also tried to employ an entomologist to help run the program, but this was unsuccessful.

Logistics:

Malaria has been endemic in the lowland areas of PNG, and the higher areas of up to ~1600m have been prone to epidemics whenever the weather conditions were favourable for disease transmission. The major challenge in PNG is in logistics, i.e. transportation of LLINs to rural areas because of poor road and transport infrastructure, as many villages are only accessible by air, boat or long-distance walking.

FIGURE 10: LLIN DISTRIBUTION IN REMOTE AREAS OF PAPUA NEW GUINEA[34]

[33] Chasing Malaria in PNG - RAM Conference 2018 (CL: Medium)

[34] Chasing Malaria in PNG- RAM Conference 2017 (CL: Medium)

4. Market Analysis

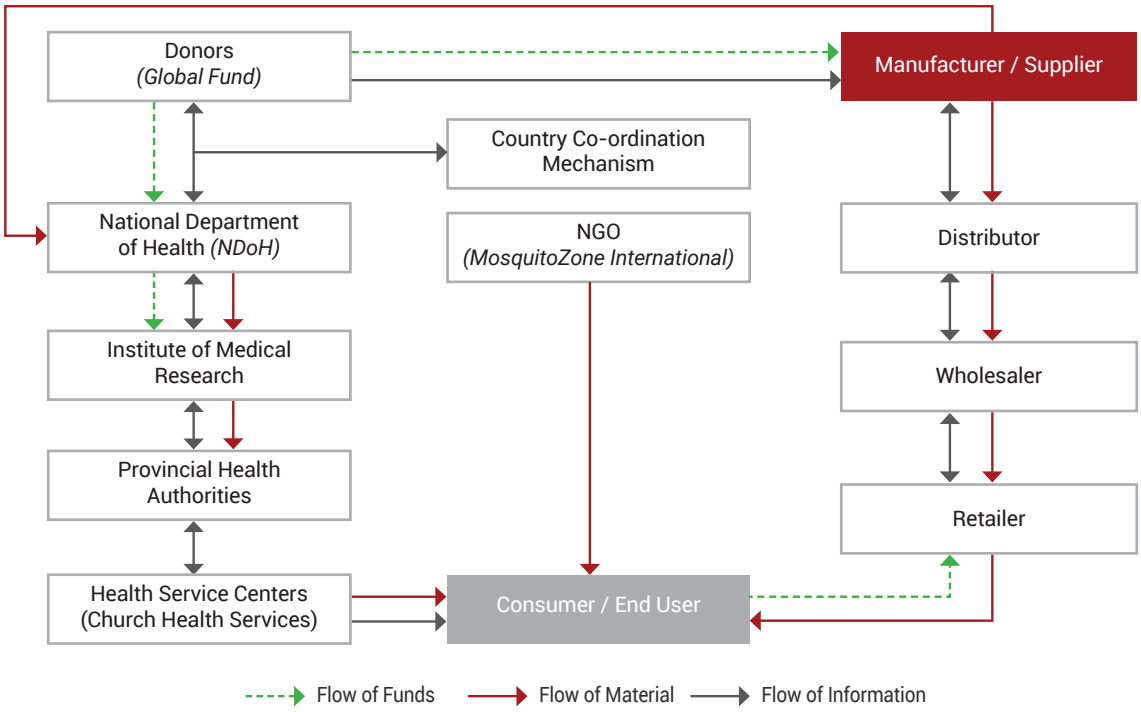
4.1 Procurement channels

Rotarians Against Malaria (RAM) is funded by The Global Fund and works together with the National Department of Health and provincial health offices to ensure that every village in PNG receives mosquito nets every three years. To date, they have coordinated the distribution of over 9.6 million LLINs to household level throughout PNG. Together with household distributions, they have supplied a further 1.3 million nets to vulnerable groups such as pregnant women, boarding schools and correctional centers.[35]

4.1.1 Overview of procurement channels

Relationship between stakeholders[36,37]

FIGURE 11: RELATIONSHIP BETWEEN STAKEHOLDERS[34,35]



- A country coordination mechanism works by submitting the funding application to The Global Fund on behalf of the country.
- The Global Fund nominates the Rotary Club of Port Moresby as the Principal Recipient who then works in close coordination with the National Department of Health and the Institute of Medical Research.
- RAM also coordinates with Provincial Health Authorities and Health Service Centre for the distribution of LLINs with the support from Village Councillors, Village Health Authorities and village leaders.

[35] Chasing Malaria in PNG: Annual Report 2018 (CL: High)

[36] Rotarians Against Malaria (CL: High)

[37] FutureBridge analysis

4.1.2 Stakeholders

The various stakeholders that are involved in procurement and distribution of LLIN's in Papua New Guinea are as follows:

Global Bodies

Principal Recipient

Rotary Club of Port Moresby

Manufacturers

Distributors

PNG National Department of Health

PNG Institute of Medical Research

Non-Government Organization

MosquitoZone International

Corporate Social Responsibility

4.1.3 Procurement channels – Gap analysis

Mosquito Net Access and Use:[38]

Based on the predicted 2017 population of PNG, an estimated 2.7 million people lacked access to LLINs, and so ~1.4 million LLINs are required to fill this gap.

The table below shows population with access to LLIN, population without access to LLIN, and number of LLIN required to fill the gap.

TABLE 7: LLIN ACCESS GAP[36]

Region	Population*	Population with Access to LLIN	Percent with Access to LLIN	Population without Access to LLIN	Number of LLIN required
Southern	1,650,232	1,363,923	72.0	286,309	143,155
Highlands	3,217,953	1,870,485	44.7	1,347,468	673,734
Momase	2,145,302	1,973,273	76.3	172,029	86,014
Islands	1,237,674	633,229	75.3	604,446	302,223
Total	8,251,162	5,503,525	66.7	2,747,637	1,373,818

* 2017 Population projection

4.2 Sponsors & Payers

The investment made by The Global Fund (GF) in Papua New Guinea is of USD160 million, out of which they have committed to USD147.9 million and disbursed around USD147.4 million.[39]

The **Global Fund** has signed an amount of USD38.6million out of which they have committed USD26.5 million and disbursed USD26 million for the period of January 01, 2018 – December 31, 2020. It will support strategies and interventions in alignment with PNGs Malaria Strategic Plan (MSP). The grant will be implemented by The Rotary Club of Port Moresby Inc. The Rotary Club will work in close cooperation with the National Department of Health (NDoH) and the Institute of Medical Research.[40]

Swiss Tropical and Public Health Institute (Swiss TPH) is currently evaluating the Papua New Guinea National Malaria Control Program, for the 2018-2020 period. The project will provide accurate, up-to-date information on malaria control intervention coverage, the prevalence of malaria infection, and on different aspects of the changing malaria epidemiology in PNG.[41]

The Australia-China-PNG Trilateral Malaria Project is working in partnership to end malaria in Papua New Guinea. The Project is funded by the Australian Government and supports leading experts from PNG, China, and Australia to improve malaria diagnosis, and carry out research to inform malaria policy and program decision-making. The Project was designed for a three-year period (2016 to 2018), with a funding allocation of USD2.8 million and in-kind contributions (staff, facilities, equipment) from all three governments.[42]

[38] Papua New Guinea Malaria Indicator Survey 2016-2017 (CL: Medium)

[39] The Global Fund Papua New Guinea 2019 (CL:High)

[40] The Global Fund Papua New Guinea 2019 (CL:High)

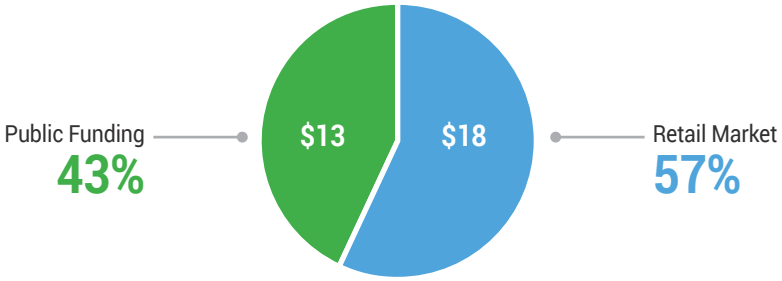
[41] Swiss Tropical and Public Health Institute (CL:High)

[42] PNG Institute of Medical Research (CL:High)

4.3 Vector Control Related Spending

PNG has a very high incidence of malaria cases, with low coverage of at-risk population by LLINs. This can be increased by activities such as mass distribution of LLINs to the high endemic regions. Although the retail market is ~60%, the total market size is low (as depicted in figure 12).

FIGURE 12: SHARE OF VECTOR CONTROL MARKET SPENDING ($MN), 2017-18[43]



4.3.1 Funding

The global bodies are the major source of funding for vector control initiatives which includes The Global Fund, Australian Aid, Swiss TPH, and Against Malaria Foundation (AMF).

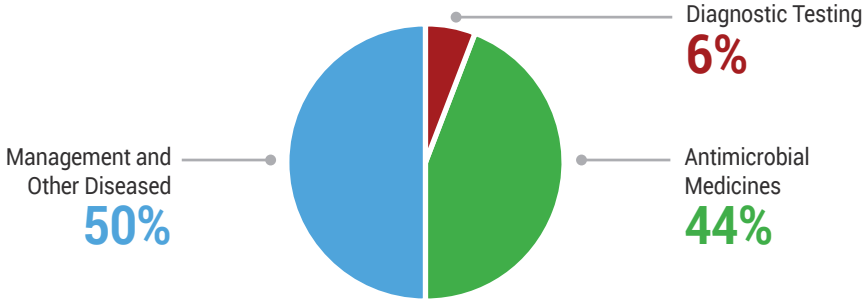
4.3.1.1 National Funding

The national funding by Government of Papua New Guinea is quite minimal. The majority of funds distributed are from international bodies like The Global Fund. The following are the estimates provided by the World Malaria Report 2018[44] for malaria control (as per contributions reported by countries).

TABLE 8: NATIONAL FUNDING[39]

National Funding (in million dollars)	2015	2016	2017
Government of Papua New Guinea	1.6	1.8	0.75

FIGURE 13: GOVERNMENT EXPENDITURE BY INTERVENTION IN 2017[42]



Government expenditure in 2017 (Figure 13) has been mostly on management and other diseases, antimicrobial medicines and diagnostic testing rather than on vector control management.[45]

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42 PNG Institute of Medical Research (CL:High)

43 FutureBridge analysis

44 World Malaria Report 2018 (CL:High)

45 World Malaria Report 2018 (CL: High)

4.3.1.2 International Funding

The majority of funding for vector control comes in from international bodies which are as depicted in the following image:

FIGURE 14: INTERNATIONAL FUNDING AGENCIES FOR VECTOR CONTROL[46]

The Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) continues to be the major source of external funding for malaria in Papua New Guinea. The only other consistent source of foreign funding has been Australian Aid which is working in partnership with China and Papua New Guinea on a Trilateral Malaria Project.

TABLE 9: INTERNATIONAL FUNDING[47]

International Funding (in million dollars)	2015	2016	2017	2018
Global Fund	11,000,000	5,900,000	10,330,449	26,038,555
WHO	--	--	95,000	--
UK	70 085	135 814	49 180	--
Others	--	--	911 770	--

The Global Fund aims to accelerate the reduction of Malaria in Papua New Guinea, so that by 2020 the incidence rate is reduced by 50% as compared to the 2014 baseline.

The major objectives of The Global Fund are:[48]

- To maintain universal coverage and increase the utilization of LLINs.
- To maximize the access to and utilization of quality assured early diagnosis and appropriate treatment for Malaria (EDAT).
- To strengthen malaria program management as well as monitoring and evaluation (M&E) at all levels, with the District level as the priority.
- To procure and distribute testing and treatment courses for malaria cases. As it is not necessary to supply RDTs and ACTs, and government funding is available, savings from the grant may be reprogrammed into other priority areas.
- Strengthening of the Health Information System and M&E, including the continued support for IMR.

The Swiss Tropical and Public Health Institute is involved in the evaluation of the National Malaria Control Program 2018-2020 and is largely funded by The Global Fund. The major activities include the following:

- Activity 1: Stratification (defining areas with distinct malaria burden amenable to different combinations of interventions)
- Activity 2: School Malaria Survey (assessing malaria prevalence in school-aged children)
- Activity 3: National Malaria Indicator Survey (assessing intervention coverage and malaria prevalence nationwide)
- Activity 4: Insecticide Resistance Monitoring

[46] FutureBridge analysis

[47] World Malaria Report 2018 (CL: High)

[48] The Global Fund Papua New Guinea 2017 (CL: High)

The governments of Papua New Guinea, China and Australia jointly implemented the Australia-China-Papua New Guinea Trilateral Malaria project. The project is funded by the Australian government. In 2017, scientists and researchers from the three countries provided training to 200 national laboratory staff and health workers in the accurate use and quality assurance of malaria RDTs, microscopic analysis and highly sensitive molecular diagnostic techniques. The project also supported the PNG Institute of Medical Research to conduct long-term malaria surveillance at four sites around the country in order to monitor trends in malaria transmission, which helps the National Department of Health ensure that people have access to early diagnosis and treatment.

FIGURE 15: THE TRILATERAL PARTNERS WITH KURIVA PRIMARY SCHOOL STUDENTS[49]

4.3.2 Funding Gap

Funding from The Global Fund is on a decline over the years specifically for Long-Lasting Insecticidal Nets:[50]

1. USD 10 million a year from 2010 to 2014
2. USD 6 million a year from 2015 to 2017
3. USD 4.5 million a year from 2018 to 2020.

A decrease in funding over the years has led to an increase of malaria cases in many provinces during the last two years. Even LLINs don't appear to have the same impact, and drug shortages are experienced in many parts of the country.

4.4 Market Description and Analysis

Retail Market:

The retail market for vector control products in Papua New Guinea consists of electric insecticides, insecticide coils, spray/aerosol insecticides and home insecticides, vaporizing mats, and repellents (lotions and wipes), of which Aerogard, RID, and BushMan are the top retail market products used in the country. Reckitt Benckiser Group Plc (RB) (England), RID Australia (Australia) are some of the leading players in the vector control retail market in PNG.[51]

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[49] Australian High Commission Papua New Guinea (CL: High)

[50] Chasing Malaria in PNG RAM Conference 2017 (CL: Medium)

[51] FutureBridge analysis

Before the start of the PNG private program, no one was selling LLINs except one of the retailers: Brian Bell, City Pharmacy in Port Moresby. All other mosquito nets available in shops are untreated Chinese nets of variable quality. Some may claim to be LLINs or treated, but none of them are WHO approved.

It is estimated that 200 million insecticide coils were sold in 2018, generating a sales value of USD 5- 10 million due to their low cost. Spray/Aerosols were the second largest market in terms of volume and also generated a sales value of USD 5-10 million.

Donor Market:

The Vector Control Market in Papua New Guinea is largely funded by The Global Fund. The other international funding agencies are the Swiss Tropical and Public Health Institute, the Australian Government and the Against Malaria Foundation. For 2019, The Global Fund has already disbursed an amount of USD26 million to Papua New Guinea; the main objective of the fund would be universal coverage and increased use of LLINs, maximized access to early diagnosis and appropriate treatment for malaria (EDAT). The major focus of the Swiss TPH is the evaluation of the National Malaria Control Program which will provide accurate, up-to-date information on malaria control intervention coverage, the prevalence of malaria infection, and on different aspects of the changing malaria epidemiology in PNG.

TABLE 10: VOLUME AND SALES OF VECTOR CONTROL PRODUCTS IN PNG[52]

Product class	PNG						
	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	125	175	200	0.04	5-10	5-10	5-10
LLIN	0.94	1.7	NA	2.25	2.12	3.83	NA
Electric Insecticides	0.48	0.71	0.95	2.1	1-3	1-3	1-3
Spray/Aerosols	1.0	1.1	1.5	4.8	5-10	5-10	5-10
Insecticide Bait	NA	NA	NA	NA	NA	NA	NA
Other Home Insecticides	NA	NA	NA	NA	1-1.5	1-1.5	1-1.5
Leading Brands	Aerogard, RID, BushMan						
Leading Companies	Reckitt Benckiser Group Plc (RB), RID Australia						

Commentary:

- The market for some retail products surpasses by far the public budget e.g. Mosquito coils in PNG.
- A portion of this retail market can be leveraged for disease control.
- As the average unit price of sprays/aerosols is higher as compared to other products, the sale volumes remain low.
- The majority of PNG population is involved in agriculture services in the highland areas, and the consumption of coils is high owing to their low price.

[52] FutureBridge analysis

FIGURE 16: MARKET SIZE OF VECTOR CONTROL PRODUCTS[53]

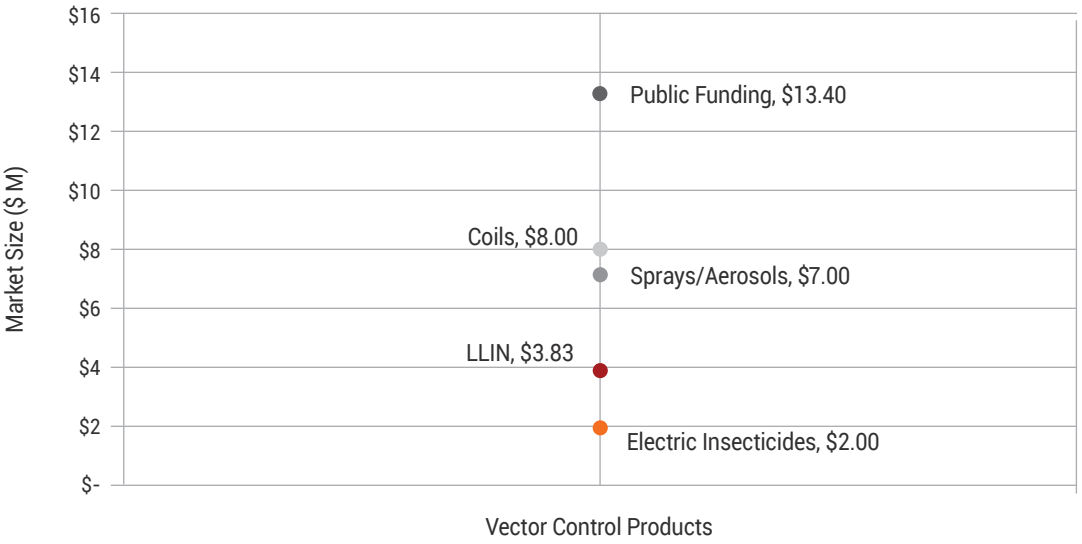


TABLE 11: MALARIA BURDEN, FUNDING AND RETAIL MARKET[54]

Parameter	PNG
Population at Risk 2017	●
Incidence of Malaria (2017)	●
LLINs (2017)	○
Public Funding (2017-18)	○
Public Fund ($)/person at risk	○
Retail Market (2018)	○
Est. funding for LLINs (% of Public Fund)	○

Note: High ● Medium ◒ Low ○

FIGURE 17: KEY RETAIL BRANDS AND PRODUCTS

Manufacturer	Electric Insecticides	Coils	Aerosols
RID Australia		RID 	RID 
Reckitt Benckiser Group Plc (RB)	Shieldtrox 	Shieldtrox 	Shieldtrox 
Bushman			Bushman 
Aerogard			Aerogard 

[53] FutureBridge analysis

[54] FutureBridge analysis

4.4.1 Level and need of awareness

One study aimed to seek and understand the knowledge, perception, experiences and malaria prevention measures of the Highland people of PNG. The objective was to discover how locals used malaria control and preventive measures effectively, what attention was given to pregnant women and infants, to understand whether the socio-economic status and social disparities contribute to malaria and to identify which strategies work best for the local community.[55]

The study revealed that they have sound knowledge of malaria signs and symptoms and correctly identify the mosquito as the vector. The knowledge gaps and misconceptions noted were the transmission routes, such as the belief oral ingestion of mosquito eggs and larvae could cause the disease. The confusion of locals in diagnosing malaria and typhoid collectively indicated specific prevention activities of malaria as inadequate. Generally, the local population's self-awareness of vulnerability and primary prevention were identified as low. The main causes of misconception were related to insufficient literacy, as well as ineffective health promotion and community health education. The environmental factors causing malaria spread are not only physical features of geography and climate; there are also greater influences of the social world, political, economic, cultural beliefs and practices. Pregnant mothers did receive attention during bed net distribution, while non-pregnant women and children still remain as vulnerable groups.

5. Regulatory Pathways[56]

There are no regulatory processes for pesticides in the country. Pesticides are governed by the Environmental Contaminants Act under the Ministry of Environment (MoE). Pesticides are imported into the country using a permit issued by the MoE.

The import permit is issued based on an application along with documents such as safety data sheets, efficacy reports, country registration certificates and labels. The cost of the permit is USD40 and the license is issued on a consignment basis, valid until the consignment is imported into the country.

There are no strict regulatory norms for pesticides uses in the country for Agriculture, Public Health etc. There are also no retail permits required for placing the imported products on the market.

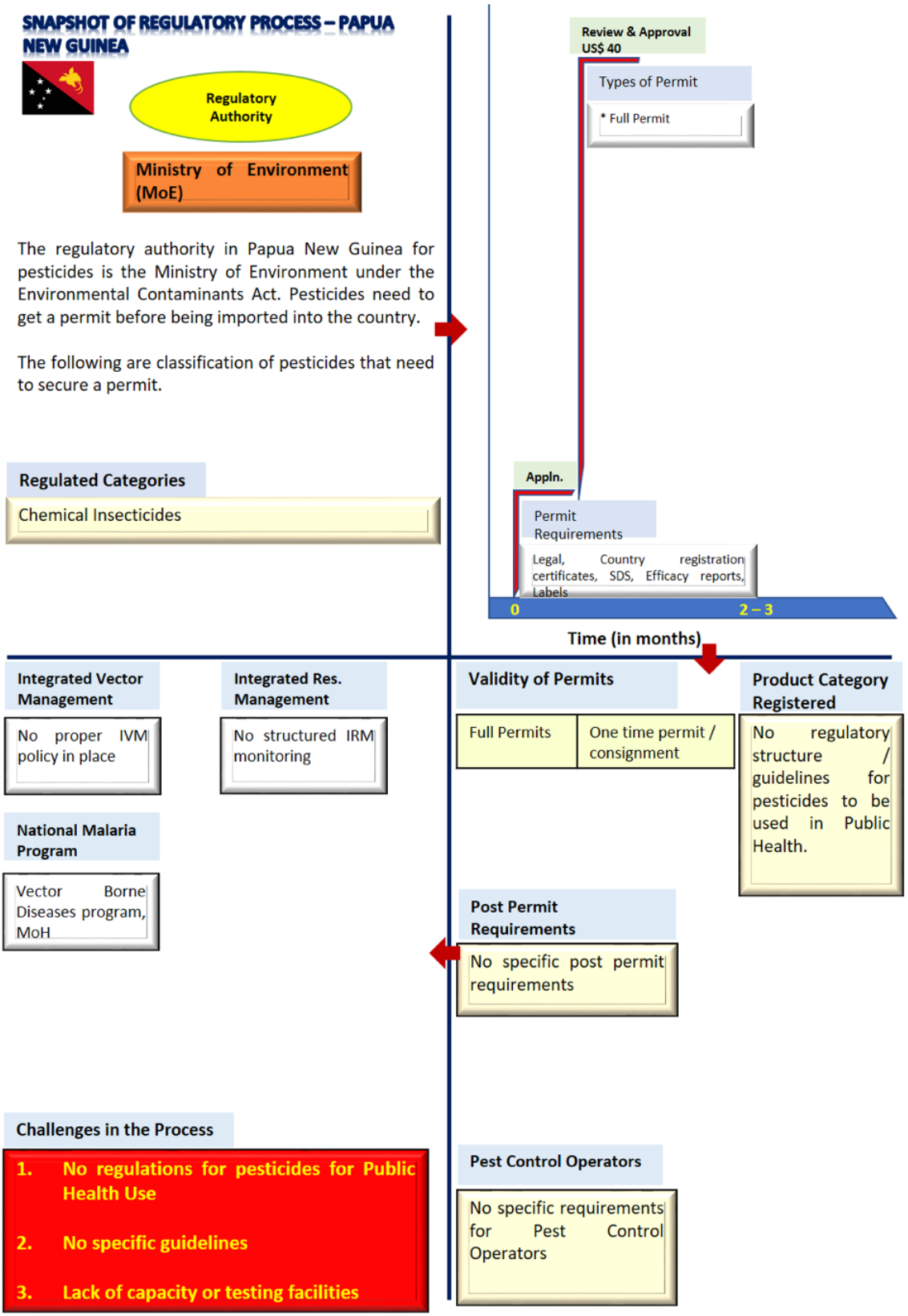
Some of the challenges of the registration process in the country are as follows:

1. No clear regulatory pathways for pesticidal products.
2. A lack of testing capacity and capability in the country.
3. A lack of clear guidelines on monitoring of pesticide imports

[55] Bang et.al. 2010 (CL: High)

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

FIGURE 18: SNAPSHOT OF REGULATORY PROCESS[56]



6. Market Dynamics

6.1 Market Trends

Women Development Programs for Training in Vector Control:

The Australian government, through the Department of Foreign affairs and Trade, have invested in PNGs Pacific Women Shaping Pacific Development (Pacific Women) with USD88 million from 2012-2022. It has four objectives: increasing women's objective and influence; increasing economic opportunities for women; strengthening the response to violence against women and expanding support services; and enhancing knowledge and evidence to inform policy and practice.[57] A mid-term review of Pacific Women delivered in August 2017 found that it was on track to achieve its objectives and outcomes. Through sharing lessons and strengthening links between activities and partners it has facilitated a coordinated program of work that was greater than its component parts. Over half of the projects addressed more than one intended outcome and there was substantial evidence of partners acting together for change.

After implementing the above strategies for women, they can also be trained in various measures of vector control, such as distribution of LLINs, training in diagnosis by RDTs and point-of-care techniques.

Increase in Corporate Social Responsibility by private sectors:

ExxonMobil has been a major private sector funder of global efforts to prevent malaria infections and deaths. They have committed USD170 million in grants between 2010 and 2018. The company is dedicated to seeing an end to malaria by leveraging its business expertise, network and convening power to fight the disease. ExxonMobil's workplace malaria control program offers prevention tools, early diagnosis and treatment for company employees and surrounding communities, and is a model for other malaria control initiatives.[58]

Oil Search is the largest Papua New Guinean Company and is involved in a range of programs that contribute to creating better outcomes for the country. Oil Search builds infrastructure on behalf of the government, provides community education and food security programs in its area of operations, and supports the development of sustainable power options for communities across PNG. In 2017, over 500,000 people had access to the Oil Search Foundation's programs, and they leveraged around PGK17 million (USD5 million) from other partners in funding, supported the further strengthening of health systems in three provinces, and established new programs.[59]

ExxonMobil and Oil Search have invested largely in various health programs in PNG for malaria control and even to strengthen the health system. A new entity can collaborate with these private sectors so as to gain an access to various initiated programs by these companies, and by using those programs as platform to enter the market of vector control products.

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[57] Australian Government AID Program Performance Report (CL: High)

[58] ExxonMobil World Malaria Day (CL: Medium)

[59] Oil Search Foundation(CL: Medium)

6.2 Market Drivers

Use of Internet for Vector Control awareness:[60]

Out of the total estimated 8 million people in Papua New Guinea, there are 900,000 internet users, reporting an Internet penetration of about 10%. Internet access is expected to improve, due to the building of a new submarine cable known as the Coral Sea Cable System which will link PNG to the Solomon Islands, with a connecting cable to the Australian (Sydney) landing station. It will provide increased capacity and reliability as well as reduce Internet costs for consumers. As there is an upsurge in people using mobile phones in PNG and as the internet services are strengthening due to Sea Cable System, the use of internet to publicize various measures of vector control of a specific product can be achieved by advertising them through various texts and calls over the cellular network.

Application of Mobile and Geographic Information System (GIS) technology:[61]

The Papua New Guinea Remote Sensing Centre came forward with an m-health initiative to strengthen malaria surveillance in a 184-health facility, multi-province project aimed at strengthening the National Health Information System (NHIS) in a country with fragmented malaria surveillance, striving towards enhanced control and pre-elimination. A remote-loading mobile application and a secure online platform for health professionals were created to interface with the new system (eNHIS). Since its inception in 2015, 160,750 malaria testing records, including the village of residence, have been reported to the eNHIS. The study demonstrates that using mobile technologies and GIS in the capture and reporting of NHIS data in Papua New Guinea provides the timely, high quality, geo-coded, case-based malaria data required for malaria elimination. The use of an m-health initiative will help in tracking the malaria infection at the village level, so that a specific village with recurrent malaria infections can be targeted to decide what measures of vector control could be applicable. By the use of this continuous surveillance over the period of time, the entity can also check whether the vector control measures initiated are on the right track to eliminate malaria infections.

Partnership Model to improve Service Delivery:

The Community Mine Continuation Agreement Middle (CMCA) and South Fly Health Program (the Health Program) is a partnership to improve health service delivery in remote Papua New Guinea (PNG). The Health Program is delivered by a private contractor working in partnership with existing health service deliveries using existing government systems, where possible, and aligns with national policies, plans, and strategies. Implementation of the health program leads to an increase in the outpatient visit per person, a rise in vaccination coverage and an upsurge in antenatal care. Heath worker training, especially in obstetrics, was cited as improved services. Following implementation, substantial improvements in health service delivery indicators were observed in the Health Program area as compared with the pre-program period and the stagnating or declining national performance. This model could be considered for similar contexts where existing health service providers require external assistance to provide basic health services to the community.[62]

Various village aid post and provincial health authorities can tie up with a private contractor as used by the CMCA and Health program so as to strengthen the health service delivery in remote areas. This partnership model can also be taken into consideration for the delivery of various vector control products and can also strengthen the existing health system. Therefore, IVCC can also partner with CMCA and Health program that gives them a base to market their vector control products.

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[60] Coral Sea Cable System (CL: Medium)

[61] Alexander Roswell, et.al. (2017) (CL: Medium)

[62] Emma Field, et.al. (2018) (CL: Medium)

Potential Drivers

Disease Pattern:

Malaria has been endemic throughout Papua New Guinea (PNG) with the exception of the highland areas over 1600m in altitude where low temperatures prevent stable transmission. The overall prevalence of Malaria in PNG stands at 7.1%, but this estimate seems to be underestimating the severity of the problem. The major victims of malaria infection are mostly children under the age of 5, where the incidence rate is at 10%. Due to the lack of dengue surveillance programs and the understanding of the disease, patients with acute febrile illness are not regularly tested; however, seroprevalence of 8% can be seen in dengue cases which are reported to Madang clinics.

Impact of the Disease:

Between the years of 2014 to 2017, there has been a nine-fold increase in the number of malaria cases in Papua New Guinea as reported by the PNG Institute of Medical Research (IMR). The major finding is that there is an increase in the total population infected with malaria parasites, from 50,309 in 2014 to 432,000 in 2017, which represents overall 8.6-fold increase. As the annual population growth rate of PNG is at 3.1%, there is a high possibility of the infection rate to rise.

Economic Dynamics:

The government of Papua New Guinea currently spends around 4.5% of the GDP on its health services, of which 20% is mostly funded by donors. The amount that the government spends on vector control is minimal: about USD0.5 million to USD1.5 million in 2014, 2015 and 2017. The majority of this money is attributed towards antimicrobial testing, and the diagnosis and management of other diseases rather than on vector control. The economic cost for a household with a child during an inpatient malaria episode cost ranges between USD14 and USD25 depending upon the different regions in the country.

Technology:

There is a surge in the use of Internet in Papua New Guinea, with penetration rates at about 10% of the total population. With newer technological developments like the Coral Sea cable system that links PNG to Solomon and Australia, internet users are expected to increase, which further helps to reduce the cost of Internet. An m-health initiative has been launched by the PMG Remote Sensing Center that provides a base for malaria surveillance in almost 184 health facilities.

6.3 Success Stories

WeRobotics:

WeRobotics was recently asked by the Centers for Disease Control and Prevention (CDC) to organize training on medical cargo drones in PNG. The purpose of the training was to engage key stakeholders on the opportunities and challenges of using cargo drones in the wake of PNGs most recent polio outbreak. An important component of the training was a hands-on demo of cargo drone deliveries. South Pacific Flying Labs are already using cargo drones to help reduce dengue fever in Fiji, and the Flying Labs in Peru and The Dominican Republic are using cargo drones for other public health needs. Similarly, the PNG Flying Labs will be introduced by the South Pacific Flying Labs, and these medical cargo drones can be used to distribute LLINs and artemisinin-based combination therapies to fight malaria.[63]

[63] iRevolutions (CL: Medium)

Rotarians against Malaria:

Rotarians against Malaria (RAM) is an organization working in the field to eradicate malaria. The major emphasis is on dissemination of ITNs for the malaria-susceptible population in Papua New Guinea, the Solomon Islands and more recently, Timor Leste. Dr. Brian Handley of the Rotary Club of Chatswood (NSW) started RAM in 1990 after the stoppage of DDT-based Malaria programs. RAM was launched in 1995 in Tulagi, Solomon Islands, by the Rotary Club of Honiara and Rotary District 9600. In 1997, the Adopt-a-Village program was initiated by Ronn Seddon and the Rotary Club of Port Moresby to inspire the Rotary Club of Australia to fund nets in Papua New Guinea on a village-by-village basis. After PNG, the program was successfully implemented in the Solomon Islands, and later in 2005 RAM stretched its support to the National Malaria Program in Timor Leste.[64]

Debug Project by Verily Life Sciences:

Alphabet is a Google Parent Company actively involved in mosquito control through Verily, a research organization that conducted a project to kill mosquitoes in Fresno, California, in 2017. The Debug Project has been raising male mosquitoes that are infected with a bacterium called *Wolbachia*, which causes infertility in female mosquitoes. The infected male mosquitoes are released in a given area to mate with female mosquitoes and the aim is to slowly render the mosquito population unable to reproduce till they don't have another generation. Over a period of 6 months, Debug project released more than 15 million mosquitoes in Fresno, California, and the project was able to decimate the overall mosquito population by 95%.[65] Once the project has been established, a similar approach can be used in the Pacific Nations, including Papua New Guinea.

7. Market Access Analysis

The following points needs to be considered before entering the Papua New Guinea market:

Market Access with Partnership:

The Global Fund is the major funding body for malaria elimination in Papua New Guinea, and their principal recipient is the Rotary Club of Port Moresby. The Rotary Club of Port Moresby then works in close coordination with the National Department of Health and the PNG Institute of Medical Research, which help distribute Long Lasting Insecticidal Nets (LLINs) to the citizens of Papua New Guinea.

Similarly, one more foundation called Against Malaria Foundation (AMF) distributes LLINs through Rotary Club of Port Moresby; in 2017 and 2018, AMF distributed almost 2.8 million nets.

So, for any new product entry, a partnership with the Rotary Club of Port Moresby and the PNG Institute of Medical Research would be reasonable to gain access to the market and the people of PNG.

The Asia Pacific Leader Malaria Alliance for antimalarial medicines:

Collaborative efforts are underway in Papua New Guinea to strengthen its system for the procurement and supply of quality antimalarial medicines. A team of the Australian Therapeutic Goods Administration (TGA) and the Asia Pacific Leader Malaria Alliance (APLMA) had several rounds of discussion with the PNG Minister of Health and senior officers from the National Department of Health. The focus was on a renewed commitment to malaria-free Melanesia by the Prime Ministers of Papua New Guinea, Solomon Islands and the Republic of Vanuatu. Such discussions provided a platform for a potential collaboration between the PNG National Malaria Program and The Global Fund procurement facility for countries to obtain quality antimalarials.[66] Such a partnership might offer a solution to provide future LLINs through various procurement and distribution branches.

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[64] Rotary Australia World Community Service, 2019 (CL: Medium)

[65] Debug Project (CL: Medium)

[66] Asia Pacific Leader Malaria Alliance (CL: High)

Digital Network:

Internet usage has been increasing steadily in Papua New Guinea with over 900,000 users out of the 8,000,000-total population. It will further increase in coming years with new players entering the market, and the laying of the Coral Sea Cable System that will connect the Solomon Islands with a cable connecting to the Australian (Sydney) Landing Station. The Internet can be used as a tool to reach out to people and help them understand the new product via various advertisements.

Similarly, the Papua New Guinea Remote Sensing Center launched an m-health initiative for health professionals to interface with the National Health Information System (NHIS). This mobile application helped in the surveillance of 184 health facilities with NHIS timely, geo-coded, cased-based malaria data. By using such an interface, a new product launched could be integrated with the m-health initiative, so that the product usage and statistics could be easily curated.

Distribution Channels:

The Digicel group is a leading global communication provider with operations in 31 markets in the Caribbean, Central America and Asia Pacific; the company is renowned for delivering the best value, service and network. Digicel PNG Foundation was established on the 15th of October 2008, and has directly invested PGK85.97 million (USD27.03 million) in PNGs rural, remote and social communities across all provinces and districts. They work with communities to develop and build sustainable and meaningful projects and programs focusing on the areas of education and health. The core of the Digicel PNG foundation is encouraging positive community ownership to improve the lives of the PNG people.

The Digicel Foundation Papua New Guinea are involved in providing basic health services to rural and remote communities. The health services are provided through Mobile Health Clinics (MHCs) and Rural Health Aid Post (RHAPs). The Digicel PNG foundation has funded 33 MHCs and 9 RHAPs which have been delivered to various church partners and government-run health facilities. Till date, they have conducted 73,000 outreach programs, where 800,000 people received medical aid/treatment. This program has helped many remote villages of PNG where health services are received at the doorsteps of people, otherwise they would have to walk long distances for treatment. By using Digicel Foundation's MHCs and RHAPs as distribution channels, a new entity or product can easily reach all rural and remote communities in Papua New Guinea.

Medical Cargo:

South Pacific Flying Labs are using cargo drones to help reduce dengue fever in Fiji, and the Flying Labs in Peru and The Dominican Republic are using cargo drones for other public health needs. In Fiji, the cargo drones were used to release *Wolbachia*-treated mosquitoes, which prevents them from transmitting viruses like Zika and dengue. On the same grounds, a training session was carried out in PNG by WeRobotics in coordination with the CDC to set up a PNG Flying Lab. As the transportation infrastructure is poor in PNG and some remote villages are only accessibly by air or boat, the medical cargo drones can be used to distribute vector control products from the source area to a target place in least amount of time.

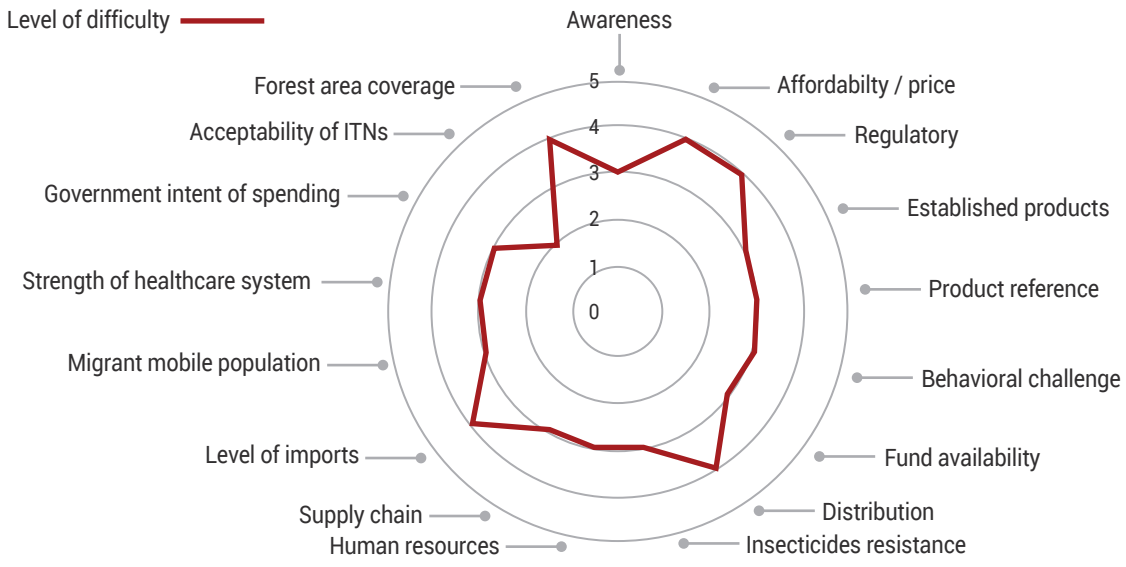
8. First Conclusions

International Bodies are the major funding agencies for malaria elimination in Papua New Guinea. Rotarians against Malaria are funded by The Global Fund, and are involved in the mass distribution of LLINs to the citizens of PNG. RAM tried to set up a private sector for commercial selling of LLINs; however, as the Inland Revenue started applying GST on nets for household distribution, it was abandoned and is currently under review. The private sector could help by filling up the gaps where mass campaigns/distribution are not possible on a routine basis.

The Australian government has invested largely in women development programs to empower them in society, and to make them self-reliant in terms of economics so that they are well aware of all the on-going policies and programs. By using the Pacific Women Development program, a new product can easily penetrate the market and the volumes can be increased by spreading the awareness at the household level. Secondly, the use of digital tools in terms of Internet access and mobile applications helps to track malaria incidence at ground level, and to deliver any point-of-care antimalarial or vector control measures at the village level. Internet usage is also on the verge of increasing, as is the use of mobile applications like the NHIS app (m-health initiative) to track the incidence of malaria, which will help us understand real-time malaria disease patterns so that vector control measures can be delivered at a specific location. Papua New Guinea's infrastructure is poor and is the main barrier for access to rural and remote communities. To increase the foothold in PNG, partnership with the available NGOs that are involved in medical services would help a new product/entity to reach out to every person in PNG. Even during epidemics or major disasters, the use of drones as medical cargos are suitable options to deliver a product in a short space of time.

In terms of challenges for new products in PNG, affordability, distribution and difficulty to reach forest areas and rugged topography, rank the highest.

FIGURE 19: CHALLENGES FOR NEW PRODUCTS IN PNG[67]



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

[67] FutureBridge analysis

9. References

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

1. Global Head of Public Health – Leading Insecticide Manufacturer
2. Regional Director – Leading Bed Net Manufacturer
3. Senior Technical Manager - Global Donor Body

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 (Mn) (2017)	>10	5-10	<5
Public Funding ($Mn) (2017-18)	>50	30-50	<30
Public Fund ($)/person at risk	>10	2-10	<2
Retail Market ($Mn) (2018)	>100	50-100	<50
Est. funding for LLINs (% of Public Fund)	>25%	10-25	<10

3. Malaria Burden Funding, Retail Market – Data

Key Parameters	PNG
Population at Risk 2017	8.2
Incidence of Malaria (2017)	189
No. of LLINs distributed (2017)	0.3
Public Funding (2017-18)	13.4
Public Fund (D)/person at risk	D1.6
Retail Market (2018)	18
Retail Spending (D)/person at risk	2.2
Est. funding for LLINs (% of Public Fund)	5%