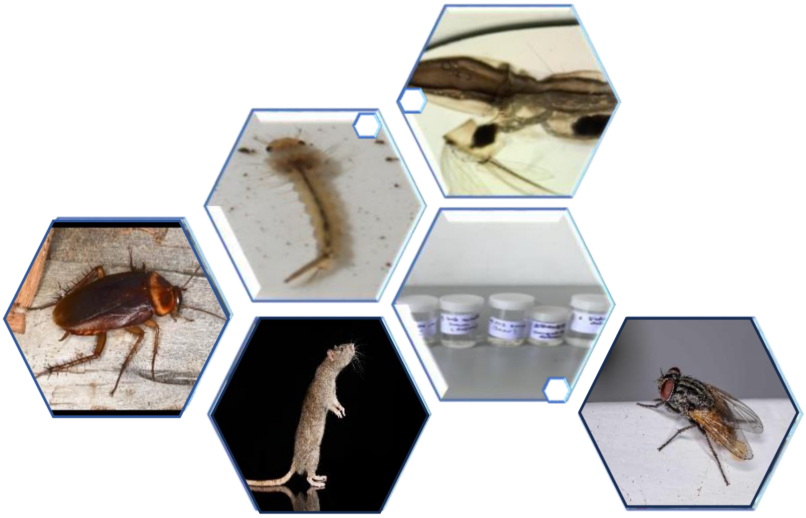
# VECTOR CONTROL MANAGEMENT OF CLASS I PORT HEALTH OFFICE IN MAKASSAR, INDONESIA

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**PUBLIC HEALTH STUDY PROGRAM**

**FACULTY OF PUBLIC HEALTH**

**HASANUDDIN UNIVERSITY**

**MAKASSAR**

**2023-2024**

# VECTOR CONTROL MANAGEMENT OF CLASS I PORT HEALTH OFFICE IN MAKASSAR, INDONESIA

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**2023/2024**

THESIS

**VECTOR CONTROL MANAGEMENT OF CLASS I PORT HEALTH OFFICE IN MAKASSAR, INDONESIA**

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**Statement of authenticity of the thesis and abundance of COPYRIGHT**

I hereby declare that the thesis entitled "Vector Control Management of Class I Port Health Office in Makassar, Indonesia" is truly my work with direction from the supervisor Dr. Syamsuar Manyullei, S.KM, M.Kes. M.Sc.PH and title as Main Supervisor and Mr. Ruslan La Ane, SKM., MPH, as Co-Supervisors. This scientific work has not been submitted and is not being summitted in any form to any university. Sources of information originating from or quoted from published or unpublished works of other authors have been mentioned in the text and included in the references of this thesis. If in the future it is proven or can be proven that part or all this thesis is the work of someone else, then I am willing to accept sanctions for this action based on the applicable regulations.



Makassar, 26 June 2024

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## THANK-YOU NOTE

بسم الله الرحمن الرحيم

**Assalamualaikum Warahmatullahi Wabarakatuh**

*Alhamdulillahirabbil'alamin*, the author gives all praise and gratitude the presence of *Allah Subhanahu Wa Ta'ala* for all His grace and guidance so that the writer can complete the preparation of the thesis. The author does not forget to give prayers and greetings to His Majesty Rasulullah *Shallallahu 'Alaihi Wa Sallam* who is the best role model for humanity. This thesis is entitled " Vector Control Management of Class I Port Health Office in Makassar, Indonesia" as one of the requirements for completing education at the Faculty of Public Health, Hasanuddin University.

In preparing this thesis, the author experienced many obstacles. However, thanks to the help, guidance and sincere cooperation from various parties, this thesis was finally completed successfully. The achievement of this final assignment cannot be separated from the services of the author's parents. The author would like to express his sincere thanks to his beloved parents, father Ali Ahned and Mrs. Abeda Sultana for their support, unlimited love, all forms of motivation that have been given as well as material sacrifices and prayers that always accompany the author's steps for health and safety in pursuing education until the completion of the thesis.

The author also wants to express his deepest gratitude to **Dr. Syamsuar Manyullei, S.KM, M.Kes. M.Sc.PH** as supervisor I and **Mr. Ruslan La Ane, SKM., MPH**, as supervisor II who has provided guidance with sincerity and patience, as well as taking his time and thoughts to provide direction to the author.

The author would also like to thank the honorable:

1. **Prof. Sukri Palutturi, S.KM, M.Kes., MSc.PH, Ph.D.** as Dean of the Faculty of Public Health, Hasanuddin University.
2. **Dr. Erniwati Ibrahim S.KM., M.Kes.** as Chair of the Environmental Health Department, Faculty of Public Health, Hasanuddin University.
3. **Dr. Ansariadi, SKM.,M.Sc.PH.,Ph.D.** as the author's academic supervisor who has provided advice, motivation and support while studying at the Faculty of Public Health, Hasanuddin University.
4. **Dr. Hasnawati Amqam, SKM.,M.Sc** as examiner from the Department of Environmental Health and **Dr. Ida Leida Maria, SKM.,M.KM.,M.ScPH** as an examiner from the Department of Epidemiology who has provided suggestions, criticism and directions for improvement in completing this thesis.
5. All Lecturers at Hasanuddin University, especially Lecturers in the Bachelor of Public Health Study Program, Faculty of Public Health, Hasanuddin University, Makassar, who have provided their knowledge and knowledge to the author during their studies, as well as employees and all staff of the Hasanuddin University Faculty of Public Health who have helped with the lecture process on campus.
6. My biological brothers and sisters as well as the extended family in Bangladesh who if I mentioned one by one it would be very long, thank you infinitely. Those who have provided support, encouragement, attention, and never get bored and give up to provide support, encouragement, to the author. When the writer feels bored and hopeless, they always encourage the writer. Without the love and affection of my family, perhaps this thesis could not have been completed.

7. **Dr. Ida Leida Maria, SKM.,M.KM.,M.ScPH** as a mother in Indonesia and also my role models, thank you for always providing support, positive enthusiasm, motivation, positive input to build the future better, and prayer support so that this thesis can be completed.
8. Thanks to all international office staff who have helped me during my study and my stay period in Indonesia.
9. To extended family, Class of 2018, which the author cannot mention one by one. Thank you for your togetherness and support to the author in completing this thesis.
10. To all international class student and my class mates. Thank you for your togetherness and support to the author in completing this thesis.
11. All parties who have helped, given encouragement and prayers to the author who cannot be mentioned one by one. The author expresses his thanks from the bottom of his heart and I hope that my friends' noble deeds and services will be recorded as good deeds and rewarded according to their deeds by Allah SWT, Aamiin.

The author realizes that this thesis is still far from perfection. By

Therefore, the author really hopes for constructive criticism and suggestions. Finally, I hope this thesis can provide benefits for the readers and the world of education.

Makassar, May 2024

## *ABSTRACT*

**BELAL AHMED.** *Vector Control Management of Class I Port health office in Makassar, Indonesia (supervised by* **Syamsuar Manyullei** *and* **Ruslan La Ane***)*

***Background:*** *Vector control has been the power against vector-borne diseases. Controlling vector-borne diseases across international borders is a crucial public health issue. Port health office which is known KKP in Indonesia carries out its duty in working area of seaport and airport.* ***Purpose:*** *The purpose of this research is to obtain information related to the management of vectors at Sultan Hasanuddin international Airport, Makassar and Port of Soekarno-Hatta, Makassar.* ***Method:*** *The type of research used is quantitative descriptive. The descriptive method used in this research is to serve the purpose of the research.* ***Results:*** *The field of Environmental Risk Control is a field that focuses on environmental sanitation at the Makassar port health office. Fly and Mosquito vector is mainly control through spraying insecticides. On the other hand, rat and cockroach vector is controlled by using traps and further examinations. For mosquito it is noticed that in the month from March to May the house index have increased. One of the reasons of this trend can be explained as these months are rainy season in Makassar. Rats vector in a port setting suggest poor maintenance, including unclean and damp conditions, limited food, and poor management of environmental cleanliness. Flies vector results indicate a relationship between use of insecticide and fly density level. When the fly density levels were high both in port and airport higher level of insecticide were used. From mid-2021, the level of Cockroach life survey in port was increasing but from March 2022 the level was 0 again. On the other hand, in airport the Cockroach life survey was continuously increasing from April*

*2022. Due to increase in survey this trend can be observed.* ***Study limitation:*** *For the mosquito vector data was not found in the airport 2018 and 2019 and Data related vector control was also not found. This paper is limited to describing the vector control management of Makassar port health office.* ***Conclusion:*** *Although vector control programs were fulfilled by port health office, there is still room for improvement as most of the vector are still present and in some cases vector density is still high.*

***Keywords****: Management, Airport, Port, Vector control*

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# CHAPTER I

# INTRODUCTION

## A. Background

Although the phrase "vector control" refers to the prevention of the spread of disease from one animal species to another, most of the vector control programs focus exclusively on diseases that are transmitted by insects. Vector control also refers to efforts taken against a disease vector in order to minimize its potential to transmit the disease by protecting regions known to be receptive to transfer (Tizifa et al., 2018). Many major endemic and emerging illnesses are spread by arthropod-biting vectors. Vector functional features can influence disease transmission rates both directly and indirectly through their impact on vector population dynamics. The diseases that are spread by vectors are usually known as vector-borne diseases (Cator et al., 2020).

Several significant and quickly spreading infections of people, animals, and wildlife are "vector-borne." However, the term "vector" has been used to refer to a variety of agents in a wide array of epidemiological systems. (A. J. Wilson et al., 2017). Most vector can cause vector borne diseases. Up to 60% of the world's population is at risk of infection from vector-borne diseases like yellow fever, dengue, chikungunya, malaria, and dengue fever, which are recorded in over 100 countries and account for more than 500 million cases annually (World Health Organization, 2016b).

The poorest communities in the developing world are disproportionately affected by vector-borne diseases including malaria, dengue, and leishmaniasis, which cause significant morbidity and mortality. Controlling vectors is one of the most important strategies for eradicating vector-borne diseases (A. L. Wilson et al., 2015). Vector control is a crucial step in disease prevention, but conventional methods have known shortcomings in adjusting to the complex changes in the ecological and social factors that influence vector infestation (Alfonso-Sierra et al., 2016).

Controlling vector-borne diseases across international borders is a crucial public health issue. With the existence of Yellow Fever, Zika, Dengue, and Chikungunya, there has been a significant increase in international travel and the number of travelers from endemic countries (S. N. Sharma & Singh, 2021). The frequency of ship and airline departures and arrivals is crucial in the movement of different pest insect species that may infect the crew and passengers, both regionally and internationally. Both directly and indirectly, vectors and animals that spread diseases can harm people (Marhanto & Depu, 2022).

The rapid spread of vector-borne diseases throughout the world is largely attributed to international travel and shipping**.** Ships have historically been a significant factor in the global spread of infectious diseases. People in the 19th century believed that commercial routes and merchant vessels contributed to the spread of cholera pandemics (Barton, 2012). Newly emerging infectious diseases, and previously prevalent infectious diseases that are reappearing poses a hazard to public health on a worldwide scale. The disease's effects are a result of the free market's implementation or the era of globalization, and they can have devastating effects on a nation or region's economy, trade, social environment, cultural landscape, and politics (Purwanto et al., 2014).

Those who live in low-income nations with few resources for disease control are disproportionately affected by this burden. There are at least five primary vector-borne diseases that residents of some regions of sub-Saharan Africa, Asia, and the Americas are susceptible to (World Health Organization, 2016b). Given the geographic overlap of the main vector-borne diseases, it is conceivable to use control resources to combat multiple diseases at once (Golding et al., 2015).

Vector control has been the power against vector-borne diseases. There are many ongoing vector eradication programs across the globe. The goal of the Global Technical Strategy for Malaria 2016– 2030 from the World Health Organization is to assist nations in minimizing the human suffering brought on by the deadliest mosquito-borne disease (World Health Organization, 2016a). Fruit flies in Japan had a significant impact on the production of fruits and vegetables. The Ministry of Agriculture, Forestry, and Fisheries (MAFF) agreed to start eradication activities in order to protect the mainland and provide permanently free movement of host plants from these locations. On Kikai Island in 1968, the OFF-eradication program in the Southwestern Island was started on an experimental scale by using male annihilation (Yoshizawa, 1997).

The reason for doing this research is because according to the data collected from the port heath office it was observed that there was presence of vectors in the last 5 years. Due to this presence of vectors this paper wants to describe the vector control management in Makassar port. The port related health problems for Makassar, Indonesia, are managed by the port health office, often known as Kantor Kesehatan Pelabuhan or KKP. (KKP, 2021).

Port health office which is known KKP in Indonesia is an executing unit of Health Ministry and direct responsibility to Director General of Ministry of Health Republic Indonesia. The function of the KKP is to prevent entry of infectious diseases, potential outbreak, quarantine, control environmental risk impact and as well as providing limited health services (KKP, 2021).

Following the government rule (SK Menkes Number 356/ Menkevslgll /2008) KKP carries out its duty in working area of seaport and airport. The main function of this organization is to prevent diseases entering the country and keeping the seaport and airport environment healthy for passenger, workers and other people. Vector control department of this organization regularly monitor the vectors like mosquito, flies, cockroaches, and rats. This paper describes the last 5 years of data which was collected from the KKP and wanted to know how these vectors were managed during those years (KKP, 2021).

## B. Problem formulation

From the description in the background, the formulation of the problem is obtained as follows:

"How is the vector control management of class I Port Health Office in Makassar over last 5 years?"

## C. Research Purpose

1. General purpose

   The general objective of this study is to describe vector control management in port heath office of airport and Port over last 5 years.

2. Specific purpose

   Based on the general objectives that have been described, the specific objectives of this paper are as follows:

   a. To describe the Mosquito control management in Makassar port health.

b. To describe the cockroach control management in Makassar port health.

c. To describe the Rat control management in Makassar port health.

d. To describe the flies control management in Makassar port health.

**D. Benefits**

1. Benefit for scientific

   The findings of this study are anticipated to serve as a source of knowledge, scientific theory, and references, particularly for students who will do additional research.

2. Benefit for researcher

   The findings of this study are anticipated to give researchers knowledge and expertise regarding the necessary steps to manage vectors and efforts to stop an increase in vector-related diseases at Makassar's airport and seaport.

3. Benefit for public

It is hoped that the findings of this study would improve public awareness of the significance of constantly maintaining environmental health in ports and of the possibility that ports may serve as entry points for diseases.

4. Benefit for institutions

The findings of this study are anticipated to be used as a source of motivation by the Makassar Port Health Office Class 1 in Makassar, South Sulawesi Province, the Makassar City Health Office, and other relevant agencies in order to inform policymakers about the control of vectors in port.

# CHAPTER II

# LITERATURE REVIEW

## A. Vector control

Vector control refers to efforts taken against a disease vector in order to minimize its potential to transmit the disease by protecting regions known to be receptive to transmission (Smith Gueye et al., 2016). Local communities are an important actor and resource in this effort. According to WHO's 2017-2030 Global Vector Control Response, engaging impacted communities is critical to developing "sustainable control programs that are resilient in the face of technical, operational, and financial challenges."(Bartumeus et al., 2019).

Given that the World Health Organization (WHO) estimates that close to 80% of the human population is at risk of contracting at least one vector-borne disease (VBD) in their lifetime and that more than 700,000 people die each year from VBDs, the GVCR (Global Vector Control Response 2017–2030) is a strategic approach developed by the WHO to combat both vectors and vector-borne diseases VBDs (Tourapi & Tsioutis, 2022). Malaria, dengue, Zika, chikungunya, yellow fever, tick-borne encephalitis, and Lyme disease are only a few of the diseases caused by infections spread by mosquitos and other vectors (Turell, 2021).

Because of the scarcity of vaccines and effective clinical treatments for the majority of the diseases listed above, as well as the added dangers associated with inadequate preventative measures, vector control has emerged as the most essential method.(Liu & Wang, 2022) Traditional insect vector control methods include home modifications, health education, and the use of chemical pesticides with extended residuals in domestic and pre-domestic settings (Vargas-abasolo et al., 2023).

The primary method used in interventions to control the vectors of human diseases, including malaria, leishmaniasis, dengue, and other illnesses, is the vector control management plan. Critical flaws in the acquisition, use, safety precautions, storage, and disposal of vector control methods were found in the chosen countries' vector control programs, which had an impact on the effectiveness, efficiency, and safety of vector control (van den Berg, Velayudhan, et al., 2021). The World Health Organization (WHO) evaluated its procedures for creating and disseminating guidelines and recommendations in 2018. Better communication of the norms, standards, and procedures supporting these recommendations is one of the opportunities for improvement noted by the assessment (OMS, 2020).

There are numerous vector control tools available, which can be broadly divided into chemical- and non-chemical-based tools. Additionally, a number of cutting-edge vector control techniques are being worked on, including the genetic modification of mosquitoes, bacterial infection of vectors (such as Wolbachia), and insecticide-treated eaves tubes. (A. L. Wilson et al., 2020) the table 2.1 shows the types of vector control available:

**Table 2.1 Methods used to control Vector-Borne diseases**

| Categories | Methods |
|---|---|
| Environmental Control | Source reduction<br>Habitat manipulation<br>Irrigation management and design<br>Waste management |
| Chemical Control | Insecticide<br>Indoor residual spraying<br>Chemical repellent |
| Biological Control | Natural enemy conservation<br>Biological larvicide<br>Fungi |

(Source:(World Health Organization (WHO), 2009)

i. Environmental Control

Environmental pest control strategies are the most environmentally friendly. These procedures alter the environment permanently and generate circumstances for the development of undesirable pests. Implementing and establishing a drainage system or using trap to control vectors are some of the environmentally beneficial approaches (R et al., 2019). The fundamental advantage of these techniques is that they do not pose the risk of environmental contamination or toxicity, and they are not susceptible to the development of biological resistance, as many larvicides are. Furthermore, the effects of environmental changes are frequently long-lasting and require minimal additional investment to maintain. (Buhler et al., 2019)

Even though the necessity for alternative ways has been emphasized, the utilization of non-chemical vector control strategies, such as environmental management or the use of microbial products, remains marginal for a disease like malaria. Furthermore, in many countries, the optimal implementation and monitoring of vector control strategies remains a considerable difficulty. (van den Berg, Velayudhan, et al., 2021)

ii. Chemical Control

Chemical insecticides used to kill or discourage vectors have been the mainstay of vector management globally. These pesticides were mostly applied through insecticide-treated nets (ITNs), residual spraying, space spraying, and larvicide. Pyrethroid-only nets (long-lasting insecticidal nets and conventionally treated nets), pyrethroid-piperonyl butoxide

(PBO, synergist) nets, and dual-insecticide nets (adding a pyrrole or a juvenile hormone mimic) are examples of ITNs. (van den Berg, da Silva Bezerra, et al., 2021). Chemical pesticides are still widely employed and damaging to living organisms and the environment. Historically, highly poisonous synthetic pesticides such as organophosphates, pyrethroids, and carbamates were employed to attack mosquitoes, mostly on insect larvae (Silvério et al., 2020).

However, the increased use of chemical control programs has resulted in the emergence and spread of insecticide resistance in natural vector populations, and while the public health impact of this phenomenon is unknown, it raises serious concerns about the future of our most effective vector control methods.(Shaw & Catteruccia, 2019)

iii. Biological Control

One of the three vector control approaches is a biological control method that uses natural ingredient. Plants have long been utilized to control insect pests by indigenous communities (Wahyuni et al., 2019). Biological management relies on the use of a natural adversary rather than pest modification. Because there is no natural adversary involved, biological control also excludes transgenic and gene drive technologies in which the vector itself is genetically modified for the aim of population suppression or population replacement tactics (Thomas, 2018).

Chemical pesticides are restricted in their ability to control vectors because they acquire resistance to them. As a result, attempts have been made to eradicate vectors using environmentally acceptable methods. According to research, one of the most important environmentally friendly vector control methods is biological control, which employs several predators and other microorganisms to manage vectors and pests (Vatandoost, 2021). One reason for the increase in biological control is that fewer new chemical pesticides are being introduced to the market, and many older ones can no longer be utilized. Furthermore, the general population is frequently more aware and less tolerant of vector management methods that may be hazardous to humans and the environment. (Ann E. Hajek, 2018).

| Date | Location | Programme | Disease | Vector species targeted | Vector control methods implemented | Effects observed | Reference |
|---|---|---|---|---|---|---|---|
| 1955–1969 | Worldwide | Global Malaria Elimination Programme | Malaria | Varied depending on location | IRS with DDT and other residual insecticides | Worldwide | (Nájera et al., 2011) |
| 1951–1980 | China | National visceral leishmaniasis control programme | visceral leishmaniasis | Phlebotomus chinensis<br>P. longiductus<br>P. wui<br>P. alexandri | IRS of houses and animal shelters using DDT, and elimination or topical deltamethrin treatment of dogs | Massive reduction in case incidence from 94/100,000 in 1950 to approximately 0.03/100,000 by 1980 | (Lun et al., 2015) |
| 1920–1935 | Indonesia | 'Species sanitation' led by N. H. Swellengrebel. | Malaria | An. ludlowi (now An. sundaicus)<br>An. aconitus<br>An. maculatus | Environmental management, e.g., filling and draining of ponds, maintaining and flushing drains, planting trees | Reduction in malaria | (Takken et al., 1990) |

**Table 2.2 Vector Control Example**

(Source: (A. L. Wilson et al., 2020)

Vector-borne diseases are an important public health issues across the globe. The table above shows that vector control methods used in different countries on different times. For example, In the early 1900s, environmental management was thriving in both Malaya (now Malaysia) and the Netherlands East Indies (now Indonesia). Sir Malcolm Watson, a British physician who joined the Malayan Medical Service in 1900, oversaw malaria vector control initiatives using an understanding of the ecology of regional vectors (A. L. Wilson et al., 2020).

Some vector control management researchers employ a combination of strategies. One of them is combining chemical and non-chemical vector control approaches to reduce the spread of vector-borne diseases like dengue. Space spraying with an appropriate insecticide for rapid eradication of the adult vector (mosquito) population is one method of chemical control. While non-chemical control implements an environmental management method that stops disease transmission by changing human habitat or behavior, i.e. an action required to limit human-vector contact (Kasbawati et al., 2019).

vector control challenges are increasing day by day. Global climate change is one of the factors that effecting vector globally. Previously controlled vector-borne diseases have resurged or resurfaced in new geographic locations over the last three decades, with some disease outbreaks impacting humans being initiated by numerous unique pathogens. Few vaccinations for vector-borne illness prevention have been developed. Furthermore, reports of medication and pesticide resistance in vector-borne diseases and vectors are growing. As a result, there is an urgent need to create new or supplementary control tools for VBDs that include vector management as a pillar in order to reduce vector-human contact (Torto & Tchouassi, 2021).

**B. Mosquito**

Arthropod vector-borne diseases, such as mosquitoes and ticks, contribute significantly to the global burden of infectious disease, with approximately half of the world's population at risk of infection with a vector-borne pathogen at any given time. Mosquito-borne diseases are a major source of concern because they include both high-burden and emerging diseases such as human malaria, dengue fever, chikungunya, and Zika virus disease. (Franklinos et al., 2019) Mosquitoes are the most harmful vectors due to their role in pathogen transmission. Key mosquito species are being introduced into new ecosystems through commerce and tourism (Dahmana & Mediannikov, 2020).

Mosquitoes are a varied group of insects that belong to the Diptera fly order. Except for Antarctica, every continent has over 2,500 species. By biting arthropods, mosquitos spread pathogens. Transmission of these infections is strongly tied to the ecology of mosquito vector populations, which includes biting behavior, pathogen competence, survival, and life history (Mordecai et al., 2019). The mosquito's life cycle includes four stages: egg, larva, pupa, and adult. Mosquito life stages with complete metamorphosis occupy distinct habitats, and variations in microclimate experiences following the larva and adult stages are common (Ezeakacha & Yee, 2019).

Mosquito breeding increases in some condition. Mosquito larval breeding in a habitat is influenced by abiotic factors such as vegetation, temperature, turbidity, pH, ammonia concentration, salinity, nitrite and nitrate, sulfate, phosphate, chloride, calcium, and water hardness (Ranasinghe & Amarasinghe, 2020). The following are some of the most prevalent diseases spread by mosquito bites around the world: Zika virus, West Nile virus, and chikungunya virus infections, dengue fever, and malaria. Most of these diseases have no vaccination or treatment to prevent or treat them (Franklinos et al., 2019).

*Zika virus*

The Zika virus (ZIKV) is a significant arbovirus that belongs to the family Flaviviridae's genus Flavivirus. It was first discovered in 1947 after being isolated from a rhesus monkey in Kampala, Uganda's Zika forest (Dick et al. 1952). While the first human isolation of ZIKV was reported from a 10-year-old female from Nigeria in 1953 (MacNamara 1954), the first seropositive human infection cases were reported from Tanzania and Uganda in 1952. Since that time, ZIKV has extended to numerous nations in Africa, Asia, Oceania, and the Americas. In these populations of people, sporadic episodes of self-limiting sickness still occur. The bulk of the 53 distinct virus species in the genus Flavivirus are spread by mosquitoes (V. Sharma et al., 2020).

*West Nile virus*

Since its first discovery in Uganda in 1937, the West Nile virus (WNV) has spread throughout Africa, the Middle East, Russia, and Europe via an enzootic mosquito-borne transmission cycle, with lineage 2 being the most common strain. Typically, infections were described as subclinical or as producing a mild febrile sickness. A novel strain of WNV (lineage 1) that appeared in the middle of the 1990s caused a high percentage of neurological illnesses, with epizootics happening in Israel, Russia, Romania, and other regions of Europe (Ronca et al., 2021).

*Chikungunya virus*

An alphavirus spread by mosquitoes, the chikungunya virus (CHIKV). The virus was initially discovered in the serum of an infected patient in 1952 in Tanzania, where there had been a widespread outbreak of a crippling arthritic condition. The term "chikungunya" (which translates to "disease that bends up the joints") is a descriptive term used by the native Tanzanian Makonde people to characterize the illness. Following its initial isolation, CHIKV only sometimes caused outbreaks in Africa and Asia over the next 50 years (about). Despite the low fatality rates associated with CHIKV, this virus imposes considerable morbidity, which has a large negative impact on the quality of life of those afflicted as well as huge economic losses, particularly in developing nations (de Lima Cavalcanti et al., 2022).

*Dengue fever*

More than one-third of the world's population is at danger of contracting dengue fever, which is spread to people through the bites of female Aedes mosquitoes that are infected.

Dengue is an acute febrile viral disease that frequently presents with headaches, bone or joint pains, and muscular pains as symptoms. It is caused by four antigenically distinct but related viruses known as DENV-1 to DENV-4 serotypes. Dengue infection can have a wide range of clinical manifestations, from an inapparent (asymptomatic) and mild disease to a severe and occasionally fatal hemorrhagic clinical picture. According to modeling estimates, there are about 390 million dengue infections each year, of which 96 million show any degree of illness severity in terms of symptoms (Aguiar et al., 2022).

*Malaria*

It is thought that malaria outbreaks have existed since the dawn of humanity. It is the most prevalent sickness that has caused a great deal of human casualties and is even suspected of being to blame for major military losses and the disappearance of several nations. Ancient Chinese medical records from 2700 BC and the Ebers Papyrus, written 1200 years later, provide the earliest descriptions of malaria. A microscopic protozoon from the Plasmodium species family, which includes multiple subspecies, is the cause of malaria. A few Plasmodium species can make people sick. An internal parasite of the genus Plasmodium that builds up malaria pigment (Talapko et al., 2019).

Worldwide, 17% of infectious diseases are vector-borne diseases (VBD), which are a significant public health concern. Malaria and dengue, two VBD, continue to carry a heavy illness burden. Effective vector control is crucial for the management of these diseases, hence numerous vector control measures can be used to reduce mosquito populations (Kumar et al., 2021). Mosquito management has grown difficult due to changes in mosquito physiology and behavior that make vector-control measures ineffective. While behavioral resistance refers to modifications that make mosquitoes avoid exposure, physiological resistance comprises changes in the sensitivity to the pesticides used to control vectors. (Musiime et al., 2019).

Safe, long-term methods are urgently needed to lessen the load of infections spread by mosquitoes. Due in part to resistance resulting from physiological (such as insecticide resistance) and behavioral changes (such as mosquitoes changing their blood-feeding times in response to bed nets), common mosquito control strategies with chemical insecticides and environmental management are only moderately effective. Pollinators, among other insects not intended as targets, are also adversely affected by chemical interventions (Wang et al., 2021).

*Vector control for mosquito*

Vector-based interventions are the main strategies for lowering the public health burden of the majority of diseases spread by mosquitoes. Prior to the invention of pesticides, these treatments relied on environmental management and were concentrated on eliminating mosquito breeding grounds and enhancing housing with screens to stop mosquitoes from entering through windows and doors (Jones et al., 2021). Utilizing a variety of chemical, biological, and mechanical techniques, there are ways to reduce the burden of mosquito-borne diseases (Onen et al., 2023).

Fogging or fumigating chemical insecticide is one of the methods for controlling this vector. Insecticides inhibit the transmission of diseases carried by mosquitoes. The majority of conventional insecticides, including carbamates, neonicotinoids, pyrethroids, chlorinated hydrocarbons, and organophosphates, kill insects by interfering with particular neurophysiological processes (Meier et al., 2022).

Pyrethroid-treated bed nets (ITNs), indoor residual spraying (IRS) with residual insecticides, and other insecticide-based tactics were frequently employed as front-line treatments for diseases spread by mosquitoes between 2000 and 2015. However, despite being debatable, increasing pesticide resistance mechanisms pose a threat to undo the advances gained thus far in the eradication or management of the primary diseases spread by mosquitoes. Research on biological control, transgenic, and paratransgenic methods has come under scrutiny in this context as prospective alternatives or supplements to existing chemical tactics (Niang et al., 2018).

Although biological control has the potential to control mosquito vector, the expenses for such a program is very high. Due to this reason mechanical techniques can be an affordable option. Mechanical techniques can be environmental modification which entails making physical changes to the land, the water, and the flora that are typically long-lasting or permanent in order to prevent, eliminate, or reduce the habitats of vectors without significantly degrading the quality of the environment for people. The second factor, environmental manipulation, refers to any deliberate, ongoing activity with the intention of temporarily reducing the breeding circumstances for vectors in their habitats. Changes in water salinity, stream flushing, reservoir water level adjustment, dewatering or flooding of swamps or bogs, removal of vegetation, shade, and solar exposure are some of the techniques used (Cheng et al., 2021).

## C. Rats

Rats are members of the order Rodentia, which is a collection of tiny animals that play important roles in diverse ecosystems as food or predators, as well as disease vectors and reservoirs. Because of their interactions with pathogenic organisms and their physicochemical environment, rats are recognized to be a source of disease. Contact between humans and rats, whether by feces, urine, or rat bites, can induce rat illness. When there is an increase in population, which results in a decline in the proportion of land that was once a habitat for wild animals becoming residential areas, rats and humans interact either directly or indirectly (Setiati et al., 2021).

Urban Norway and black rats (Rattus norvegicus and Rattus rattus) are a significant and expanding problem in cities around the world because of the negative effects they have on human health and the economy (Feng and Himsworth, 2014). Rats, for instance, represent a threat to public health because they are the source of numerous zoonotic diseases, or disease-causing bacteria that can spread from rats to people, such as Leptospira interrogans, which cause significant human morbidity and mortality (Himsworth et al., 2013b). Infestations can also be a source of ongoing worry for locals, harming their physical and emotional health (Byers et al., 2019).

Since their inception in Asia, brown and black rats (Rattus norvegicus, Berkenhout, 1769, and R. rattus, Linneaus, 1748) have coexisted with people all throughout the world. These rodents have spread harmful germs into numerous new geographical locations, including Yersinia pestis, Bartonella, and hantavirus. Additionally, outside of their natural habitats, both brown and black rats have picked up additional macroparasites. As a result, they effectively spread infections among humans, domestic animals, vectors, and wildlife (Strand & Lundkvist, 2019).

Rats' seemingly limitless reproductive potential, ravenous appetite (which can result in cannibalism), and astonishing ability to survive in difficult and frequently unclean surroundings only serve to tarnish their image among many members of the general public. Except for deserts, tundra, and polar ice, rats can be found in practically every terrestrial setting. Because of their physical resilience, omnivorous diet, and adaptable personality, they adapt well to new conditions. They dig burrows and construct elaborate networks of tunnels and passageways in riverbanks and open spaces where they dwell and breed (Modlinska & Pisula, 2020).

Direct contact with infected rodents (such as breathing in contaminated air, touching contaminated materials and then touching eyes, nose, or mouth, being bitten or scratched by an infected rodent, or consuming food contaminated by an infected rodent) can cause the transmission of some diseases from rats to people. Hantavirus, Leptospirosis, and Plague are some of the diseases that are caused by rats (Setiati et al., 2021).

*Hantavirus*

Hantaviruses cause two illness syndromes: hemorrhagic fever with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS) or hantavirus cardiopulmonary syndrome (HCPS). Old World hantaviruses, primarily found in Europe and Asia and including the prototypic hantavirus Hantaan virus (HTNV), Puumala virus (PUUV), and Dobrava virus (DOBV), cause HFRS with a case fatality rate ranging from 1 to 15% depending on the infecting virus (Brocato & Hooper, 2019).

*Leptospirosis*

The most significant recognized sources of Leptospira infection are wild rats (Rattus spp.), particularly the Norway/brown rat (Rattus norvegicus) and the black rat (R. rattus), which are both common in urban and peri domestic environment. Leptospirosis is a serious zoonotic disease that affects both human and animal health globally affecting an estimated 1.03 million people and 58,900 individuals every year are killed as a result (Boey et al., 2019).

*Plague*

Plague is a deadly human infection caused by the bacterium Yersinia pestis. It is typically caused by a flea bite from an infected wild animal, such as a rat, chipmunk, or prairie dog. It frequently develops big lesions and abscesses in the arm and leg glands. Dogs and cats, in particular, can become infected and spread the disease to their human friends (Bramanti et al., 2019).

Indirect data suggests that humans become infected mostly through contact with open sewers and annual floods that washes contaminated soil into human-use areas. Environmental controls, such as the closure of open sewers and improved drainage, would directly reduce the risk of infection for humans by limiting their exposure to a contaminated environment, but they would necessitate a large-scale concerted effort, making them more difficult and costly to implement than animal control. (Minter et al., 2019)

Apart from spreading diseases rats have history of travelling from one region to another. According to data from 2015, the Port Health Office class I Surabaya identified 23 rats out of 2734 ships during ship inspections. The presence of rats on cargo ships is extremely damaging because they can spread disease and contaminate supplies of food (Sofiyan & Keman, 2018).

*Vector control of rats*

Rats serve as reservoirs for several zoonotic diseases that are spread from animals to humans. Therefore, the appropriate management of rodent populations may have profound effects on people's health and wellbeing (Rahelinirina et al., 2021). One of the rat control methods is trapping. For rats, a variety of traps and trapping techniques have been created and put to use, such as leghold traps for furbearing predators and some bigger rodents. For rat management, numerous kill traps have also been created and are available (Witmer, 2022).

Apart from trapping chemical rodenticide are in use to control rats. The major technique used today to reduce rodent populations is the use of anticoagulant rodenticides ARs. By inhibiting the enzyme vitamin K epoxide reductase (VKORC1), they cause bleeding (Marquez et al., 2019).

## D. Flies

Insects in the order Diptera called flies have one pair of wings for flying and a second pair of wings that remain on their bodies, called knobs, which are used for balance. In addition to gnats, midges, mosquitoes, leaf miners, horse flies, house flies, blowflies, and fruit flies, more than 125,000 different species of Dipterans have been identified (Yin et al., 2022). The most prevalent and ubiquitous species of flies in the world is the house fly, Musca domestica L. (Diptera: Muscidae). It is well known that house flies can spread diseases that are harmful and even fatal to both humans and animals. The insect has been linked to more than 100 pathogens, including bacteria, viruses, fungi, and parasites (protozoans and metazoans) (Khamesipour et al., 2018).

Numerous and in-depth reviews of house fly biology, life history, and management have been conducted. Over 100 years ago, pioneering researchers began to acquire a solid grasp of the biology of the fly. It is challenging to estimate the current economic impact of the house fly issue. A 2001 estimate for the annual cost of insecticides for fly control in the poultry sector is now roughly $30 million after accounting for inflation. After accounting for inflation, estimates for the dairy and swine industries come to $135 million and $35 million, respectively (Geden et al., 2021). Eggs, larvae or maggots, pupae, and adults are the four life stages of flies. In close proximity to homes and farms, female houseflies lay their eggs in manure, compost, trash, dirty bedding, and other areas that contain wet, microbially rich decomposing organic waste. In her lifetime, a female can ovulate four to six times, each time producing 100 to 150 eggs. If the environment is wet and at an ideal temperature of 25 °C to 30 °C, the eggs typically hatch within 8 to 12 hours (Yin et al., 2022).

Adult house flies acquire bacterial contamination on their outside surfaces when they come into contact with microbe-rich substrates. By direct contact, bacteria on the fly's mouthparts, tarsi, wings, and body are displaced from their original places and transported there. At least 65 diseases, including typhoid fever, dysentery, cholera, poliomyelitis, yaws, anthrax, tularemia, leprosy, and tuberculosis are strongly thought to be transmitted to humans by house flies. Flying insects mechanically spread disease-causing organisms by regurgitating and excreting wherever they find a place to rest (Nayduch et al., 2023).

Recent research found the possibility of COVID-19 transmission through flies and cockroaches. There haven't been any reports of blood-sucking arthropods like mosquitoes transmitting COVID-19. Insects like cockroaches and houseflies, which are important pathogen-carrying mechanical vectors, however, may be able to spread the illness through contact with contaminated surfaces and even with the excrement of sick people (Dehghani & Kassiri, 2020).

Due the severity of the vector, control methods is very necessary. Controlling houseflies can be done by using attractants or manufactured physical methods to kill adult flies.

Although undesirable, the control effect makes it simple for houseflies to build behavioral resistance. Chemical insecticides are used to manage housefly larvae, which is thought to be an efficient strategy to basically kill houseflies and lessen their impact to people (Feng et al., 2021). Alarmingly, house flies have extremely high levels of pesticide resistance, despite being the mainstay of fly management for generations. The goal of fly control in animal production systems has typically been to minimize population size and, as a result, nuisance activities, with a lot less emphasis on decreasing their capacity as vector microorganisms (Nayduch et al., 2023).

*Flies Control*

To control house flies and stop the spread of disease, animal production facilities have relied heavily on pesticides (mainly pyrethroids and secondarily organophosphates), but resistance has developed to all available insecticides and is a major concern worldwide. The chemical control is also expensive. Aside from the costs of chemical and other kinds of control, house fly can also reduce productivity by causing animal stress (particularly in calves and hens) (Freeman et al., 2019).

Other than chemical fumigation there are physical control of flies. Internationally, temperature is frequently employed to physically manage pests, and cold-temperature therapy is actively being implemented in Japan. According to reports, the management of quarantine pests of the order Dipteran, including the Caribbean fruit fly Anastrepha suspensa (Loew) and the oriental fruit fly Bactrocera dorsalis (Hendel), is efficient when done at freezing temperatures (Jeon et al., 2022).

**E. Cockroaches**

The Order Blattodea includes cockroaches, one of the most diverse groups of insects that have lived on Earth for at least 300 million years. The majority of the about 4500 species of cockroaches that have been identified to this point reside in tropical and subtropical woods, where they primarily serve as decomposers by consuming dead and rotting organic materials. Since they first evolved as cave dwellers, certain cockroach species have adapted to coexisting with people (Gondhalekar et al., 2021). By polluting foods, components, or food storage, cockroaches are one of the potential vectors for transmitting disease and causing health issues for people. They may have human infections in their bodies and be polluted due to their habits and living conditions in an unclean environment. Their propensity to consume both human food and feces has the potential to serve as a mechanical vector for the spread of disease agents and other health issues that affect humans (Hayati et al., 2020).

The cockroach develops gradually, going through three stages: egg, nymph, and adult. Due to the absence of the pupa stage, it is also known as paurometabolous, hemimetabolous, or incomplete metamorphosis. Generally speaking, cockroach species are divided into one of three categories: oviparous, ovoviviparous, or viviparous(Adedara et al., 2022). One of the most successful groups of ancient animals is the cockroach. From Arctic cold to tropical heat, they are highly adaptable to a variety of habitats and environmental situations. Cockroaches are excellent mechanical and occasionally biological carriers and transmitters of a number of infections, including pathogenic bacteria, fungi, viruses, and helminths because to their eating techniques and filthy breeding habits. Furthermore, their waste products and secretions can trigger severe allergic reactions in people. The American (Periplaneta americana), German (Blattella germanica), Oriental (Blatta orientalis), and brown-banded (Supella longipalpa) cockroaches are the most prevalent worldwide. (Pan et al., 2020).

Because to their eating techniques and filthy breeding habits Cockroaches are excellent mechanical and occasionally biological carriers. Furthermore, their waste products and secretions can trigger severe allergic reactions in people. One of the most common disease causes by Cockroaches is food borne diseases (Hayati et al., 2020). Due of their unkempt behavior and frequent appearance in locations where food is stored or handled, cockroaches appear to be appropriate mechanical transmitters for a variety of food-borne pathogenic bacteria. Cockroaches can carry microorganisms externally on their cuticles or they can consume them and then later defecate or vomit them. In this method, when cockroaches come into touch with food, they can readily infect it (Donkor, 2020).

Cockroaches are common vector found in ships and ports as well. According to the CDC, 239 cruise ships docked in American ports have experienced gastroenteritis outbreaks, which include vomiting and diarrhea in both ship staff and passengers. On Indonesian port Baubau, cockroaches in large numbers were discovered on ships which could contract foodborne diseases among ship’s staff and passengers. (Supryatno et al., 2018). When the Ambon Port Health Office observed the Yos Sudarso Port in Indonesia in 2021, 112 of the 2,106 ships arriving there were still carrying cockroach vectors, which can represent risk factors for disease transmission (Ca et al., 2023).

*Cockroaches control*

Over the last few decades, the widespread and excessive use of chemical insecticides has resulted in a growing phenomenon of pesticide resistance in cockroaches, particularly in B. germanica; in the meantime, it has resulted in environmental pollution and negative effects on other organisms in the ecosystem. This is especially true of the German cockroach (Pan et al., 2020). Many studies have been conducted in various fields to control cockroaches, which have been published in separate papers or notes and describe from an angle of the topic such as getting cockroaches from sewers into buildings and their elimination, sewer cockroach population size and age-class structure, fighting measures such as insecticide susceptibility, application of dust, bait, and Inesfly paint insecticide formulations, possible plant essential oil application, and bifurcation (Nasirian & Salehzadeh, 2019).

## F. Synthesis Table

**Table 2.3 Latest Research on vector control**

| No | Title (Researcher/Year) | Study Method | Study variable | Research result |
|---|---|---|---|---|
| 1. | Vector Control Program Evaluation Aedes aegypti in Port Health Office Class II Banjarmasin, South Kalimantan (Case Study Working Area Seaport Banjarmasin) (Purwanto et al., 2014) | Descriptive | Aedes Aegypti | The results showed the lack of power and the number of functional trainings in the vector Aedes aegypti control program, not maximal implementation of vector control programs namely Aedes aegypti mosquito larvae eradication (PSN) only through surveys larvae, while surveys of eggs and adult mosquito surveys are not conducted. |
| 2. | Analysis of managerial components in mosquito vectors (aedes aegypti) control in the buffer area of the class 1 Surabaya port health office (Ramadhani, 2021) | Descriptive observational | Aedes aegypti | The results explained that man power, money, materials, market, technology, and information were all in accordance with the SOP of the Surabaya Port Health Office. However, the larva survey method did not comply with the SOP as officers still used the visual method. |

| | | | | |
|---|---|---|---|---|
| 3. | Relationship between sanitation condition and vector's existence on vessels at the working areas of port health office (KKP) class II Semarang in 2019 (Chika Aldila Cahyani,Yusniar Hanani, 2021) | Analytical method and cross-sectional design | Sanitation condition and vector's existence | The results with chi-square test showed that there was a relationship between galley sanitation, pantry sanitation, warehouse sanitation, crew's bedroom, and officer's bedroom with vector's presence on the ship. |
| 4. | A Survey Study of Rat Vector in the Working Area of The Port Health Office Class (Firmansyah et al., 2022) | Descriptive | Rat | The results showed that the rats caught were still in low numbers with the types of rats caught being Rattus rattus and Rattus novergicus. Observation of the area showed that poor sanitation conditions, the density of piles of goods, sewerage, and the distance between the trash can and the canteen were opportunities for rats. |

The 4 journals that are mentioned above are related to vector control. From 4 researches methods used were descriptive in 2 journals, 1 Descriptive observational and another one is Analytical method and cross-sectional design. The variables were Aedes aegypti in 2 researches, rats in one research and other was Sanitation condition and vector's existence. Most of the researches were conducted in ports or airports related to this paper.

## G. Theoretical Framework

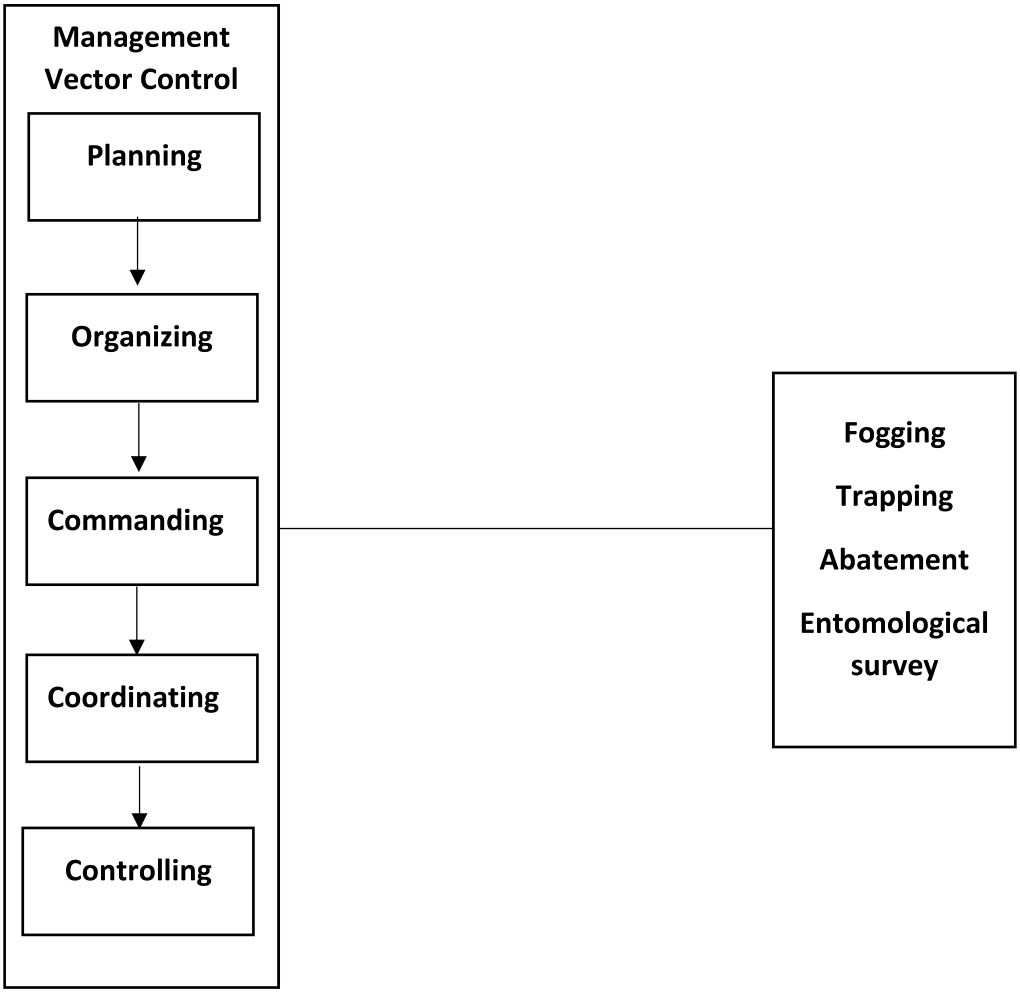


**Figure 2.1 Theoretical Framework**
Source: Modification of the Administrative Management theory by Henri Fayol (1841-1925)

Henri Fayol (1841-1925), a miner and engineer, created his administrative management ideas as a top-down strategy to assessing an organization. He put himself in the shoes of his manager and considered the situations they would face when dealing with their team. As a result, he determined that his managers, and indeed management in general, had 5 obligations when it came to personnel management: **Planning, Organizing, Commanding, Coordinating and Controlling.** (Akoko, 2019)

Administration has influenced the success or failure of various nations, political systems, organizations, and even personal family life. The significance of administration begins with the design of each given organization's goals, aims, and operations. Organizations with good and enviable mission statements and aims have frequently collapsed due to administration's ineffectiveness un achieving the noble goals sought. As a result, focusing on the administrative structure of any organization is an essential venture in evaluating their level and nature of productivity. Henri Fayol (1949) believed that the nature and method of administration used by each company determines its productivity (Akoko, 2019).

In this case **port heath office** conduct **vector control programs** like: **Fogging, Trapping, Abatements and Entomological survey**. To conduct this kind of program its important that port heath office have 5 obligations of management which are: **Planning, Organizing, Commanding, Coordinating and Controlling.**

## CHAPTER III
## CONCEPTUAL FRAMEWORK

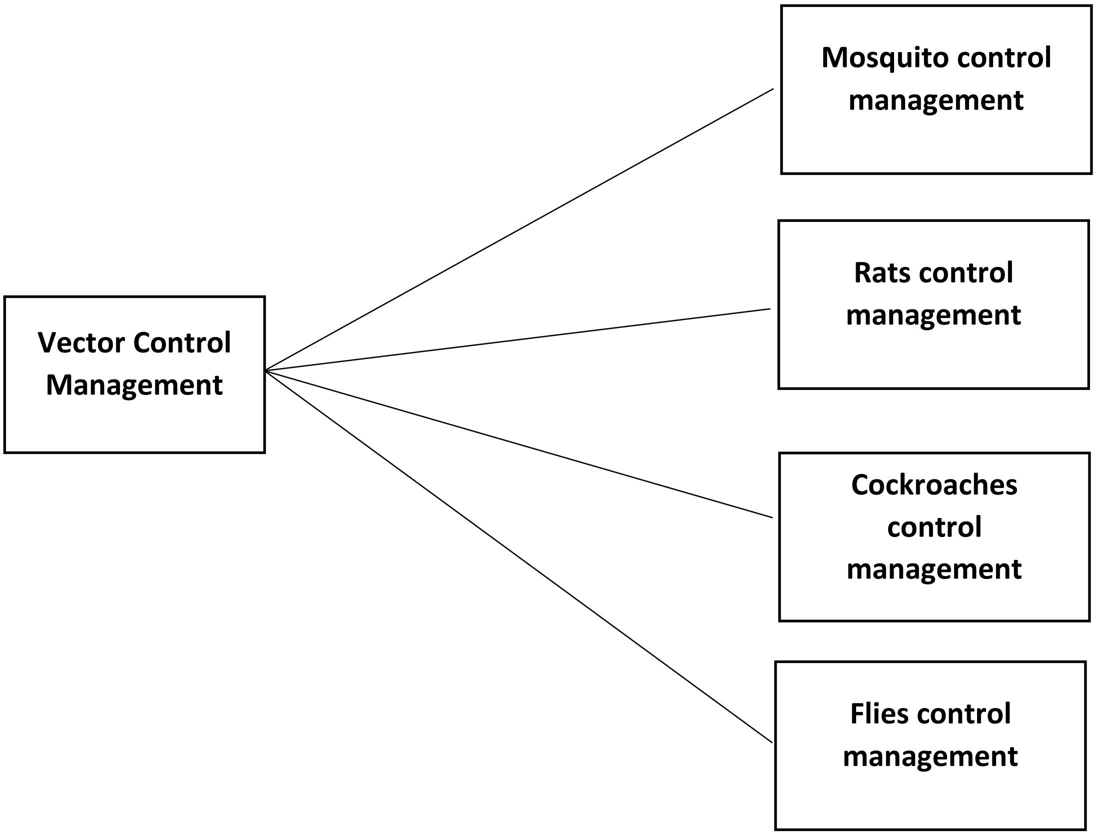


**Figure 3.1. Conceptual framework**

In the conceptual framework above visualizes that vector control management is related to vector control program of all vectors used as variables in this research.

B. Operational definition

1. Mosquitos control management

Any mosquitoes control management data including planning, organizing, and controlling conducted by port heath office class I Makassar in the last 5 years period.

2. Rats control management

Any rats control management data including planning, organizing, and controlling conducted by port heath office class I Makassar in the last 5 years period.

3. Cockroaches control program

Any cockroaches control management data including planning, organizing, and controlling conducted by port heath office class I Makassar in the last 5 years period.

4. Flies control program

Any flies control management data including planning, organizing, and controlling conducted by port heath office class I Makassar in the last 5 years period.

5. Vector Control Management

Management of vectors using control methods by the port heath office class I Makassar in the last 5 years period.