RESEARCH ARTICLE

OPTIMIZATION MODEL FOR PATIENT ALLOCATION DURING INFECTIOUS DISEASE.

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Manuscript Info	Abstract
Manuscript History Received: 21 November 2017 Final Accepted: 23 December 2017 Published: January 2018	Dengue Hemorrhagic Fever (DHF) is a viral disease transmitted by mosquitoes that is currently the main concern of the international community. Therefore, it takes a quick initial handling to deal with this dengue fever so as not to cause an increasingly severe disease. One of the initial handling that can be done to overcome the spread of dengue virus is by way of allocating patients to the hospital. to facilitate the allocator of the patient, the patient is allocated from the puskesmas to the hospital. in this case we can conclude puskesmas become a tool to refer patient to hospital. mathematical models are designed to: (1) minimize patient distance to the hospital; and (2) the addition of resources in the event of a surge in the patient's handling request. By minimizing the expected distance the patient costs less. The high demand for patient handling has an effect on the lack of room capacity in each hospital, so it is proposed that each hospital provides 30% of the overall capacity when infectious disease symptoms occur.

Introduction:-

Outbreaks of infectious diseases are very common in this era of globalization, for example influenza, cholera, smallpox, ebola, malaria, HIV / AIDS and dengue hemorrhagic fever (DHF). In this study will be limited to only one outbreak of disease that is, dengue hemorrhagic fever. Why dengue fever, because it is known DHF is a disease most commonly found in Indonesia and even Southeast Asia, because dengue is very easy to spread in tropical and sub-tropical regions (Sun et al., 2013).

Dengue Hemorrhagic Fever is a viral disease transmitted by mosquitoes that is currently the main concern of the international community. DHF is found in parts of the tropical and sub-tropical earth, mostly in urban and semi-urban areas. DHF was first recognized in Southeast Asia in the 1950s but starting in 1975 is now the leading cause of death among children in Asian countries. Even since 1997, DBD has been declared the most important viral disease that is dangerous and fatal to humans (Martial et al., 2014).

Until now there has been no specific drug that can kill dengue virus, therefore the initial and major prevention efforts are to avoid mosquito bites for people who have not been exposed to the virus DBD as well as the allocation of patients infected with DBD virus to hospitals and related health facilities to isolate patients so the DHF virus does not spread. Cheap and effective prevention to eradicate these mosquitoes is by draining, brushing and closing the clean water reservoirs, bathtubs, flower vases and so on, at least once a week, since the mosquitoes breed from eggs to maturity over a period of time 7 - 10 days. The yard or garden around the house should be clean of objects that allow to hold clean water, especially during the rainy season. Doors and windows of houses should be opened every

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day, from morning to evening, so that fresh air and sunlight can enter, resulting in the exchange of air and healthy lighting. Thus, creating an environment that is not ideal for the mosquito (Helena et al., 2010).

Therefore, the initial treatment that can be done to overcome the spread of dengue virus that is allocating patients to the hospital support in dealing with the problem of dengue disease that the patient expected to get the initial treatment and isolated from the people around so that there is no spreading of large disease spread. Therefore, a mathematical model is required for the allocation of patients to the hospital during the outbreak of disease, in the allocation of patients at the time of outbreaks of dengue fever is required rapid handling, in this case the distance between this deep puskemas as parties that refer patients to the main hospital should be noted for a faster handling process to the patient. Apart from minimizing patient distance to the hospital, it is also necessary to add resources when an outbreak is present. So as to provide an overview of the addition of resource allocations in this case doctors, nurses, etc. when the disease is contagious.

Preliminary handling that can be done to overcome the spread of dengue virus that is allocating patients to the hospital support in dealing with the problem of dengue disease. to accelerate the handling of patients to the hospital from the puskesmas. Therefore distance is a special aspect to note at the time of outbreaks of the disease, then the formulation of the problem taken in this study is to minimize the distance traveled from the health center to the hospital. we can draw the conclusion that the distance between the puskesmas from the hospital nearby then it can be ascertained the cost of the patient is also slightly vice versa. Especially when infectious diseases occur cost is an aspect that is rarely noticed because the healing and handling of patients more quickly is a top priority. In addition, lack of resources is a common occurrence in the event of a disease then it is necessary addition of resources when the surge in demand for patient handling.

In this research optimization models will be formulated and solved to help decision makers address the patient and resource allocation issues faced by a multi – facility healthcare network in a medium term influenza outbreak.

Method:-
This research uses literature study method. the first step in this research is to assume several things for making mathematical modeling formulation for patient allocation and model of mathematical model formulation with the addition of resources.

Assumptions used in this study:
1. For the hospital room is divided into two parts, namely non-ICU and ICU, and at the time of disease outbreak every hospital is estimated to provide 30% capacity of total capacity available, for making estimation model giving 30% capacity can see the next discussion .
2. To clarify research assumptions will be given an example of mapping if there are 16 districts in a city assumed to have 7 different hospitals of its level. For more details, consider the estimated mapping of patient allocations from the 16 selected sub-districts, this mapping drawing is based on the exposure and observations made in previous journals (Sun., et al 2014).
3. In this study, it is assumed that each sub-district has one puskesmas (one sub-district one puskemas), which acts as the first health facility at the time of the outbreak and asked to refer the patients to referral hospitals based on moderate disease level or weight.

Result:-
Model optimization of patient allocations at the time of outbreaks of disease, mathematical modeling is required, the first step defines the notation used in the mathematical model:

H   : Hospitals
A   : Population areas
T   : Time
R   : Equipment resource types
P   : Patient types
Ps   **:** Puskesmas
parameters :
j_{ah} : distance from population area a to hospital h
pr_{pat} : demand of patient type p from area a on day t

k_{rh}	: initial capacity of resource r in hospital h
lt_p	: length of stay
ja_{ph}	: number of patient type p at hospital h prior to planning horizon
rp_{pht}	: number of patient type p at hospital h prior to the planning horizon who are released on day t

Intermediate variables :

np	: number of patient type p at hospital h on day t

Decision variables :

x_{paht}	: number of patient type p from area a assigned to hospital h on day t

Based on previous research on patient allocation at the time of infectious diseases with no consideration of available capacity in each hospital then the researcher here adds a model that assumes each hospital provides 30% of the total available capacity at the hospital at the time of significant patient spike in the event of an infectious disease. Models for available room capacity in hospital:

$$30\% \sum_{h_{i=1}} Kapasitas_{r,h} = Kapasitas_{r1,h1} + Kapasitas_{r2,h2} + ... + Kapasitas_{rn,hn}$$

$$30\% Kapasitas_{hi} \tag{1}$$

The function of this constraint explains that during infectious disease it is assumed that each hospital provides 30% of the available capacity at the hospital.

Objective function :

$$\sum_p \sum_a \sum_h \sum_t x_{p,a,h,i} \ j_{a,h} \tag{2}$$

the goal is to minimize the distance between puskesmas to the hospital.

Constraints :

$$\sum_h x_{p,a,h,t} = pr_{p,a,t} \qquad \forall \ p,a,t \tag{3}$$

Defining the demand constraint, each patient is referred to a particular hospital according to the available capacity at the hospital.

$$np_{p,h,1} = ja_{p,h} + \sum_a x_{p,a,h,1} \qquad \forall \ p,h \tag{4}$$

To calculate the number of patients from each hospital on the first day by considering the initial patient at the time before the patient's assignment plan.

$$np_{p,h,t} = np_{p,h,t-1} + \sum_a x_{p,a,h,t} - \sum_a (x_{p,a,h,t} - lt_p) - rp_{p,h,t} \qquad \forall \ p,h,t \tag{5}$$

To calculate the number of patients in each hospital.

$$\sum_{h_i \in H} np_{p,h,t} \le 30\% Kapasitas_{h_i} \qquad \forall \ h,t \tag{6}$$

Capacity constraints, with capacity goals not exceeding demand.

$$X_{p,a,h,t} \ge 0 \qquad \forall \ p,a,h,t \tag{7}$$

The nonnegativity constraints

Lack of resources is likely to occur during epidemic outbreaks. This is due to a surge in demand for patient care at the hospital, hence from the need to establish a mathematical model formulation to estimate how much additional

resource allocation will be needed at the time of the outbreak. Therefore additional parameters are needed to make the mathematical model formulation of the addition of resource allocations.

Parameters:-

$P_{n_{rt}}$: number of additional resources r available on day t

Decision variables :

$P_{n_{rht}}$: number of resources r allocated to hospital h on day t

Constraints :

$$\sum_h P_{n_{r,h,t}} \le P_{n_{r,h}} \qquad \forall r,t \qquad\qquad\qquad (8)$$

Additional resource allocations aimed at ensuring the allocation does not exceed the additional resources available.

$$\sum_p np_{p,h,t} \le k_{r,h} + P_{n_{r,h,t}} \; \forall r,h,t \qquad\qquad\qquad (9)$$

Discussion:-

Planning and modeling optimization for the allocation of patients at the outbreak of the outbreak is very influential on the initial treatment of patients. this makes the risk of death smaller (Sun et al., 2013).

The age span distribution at the time of patient allocation at the time of dengue fever attacks a country so effectively that there is no more dangerous transmission and more effective treatment and treatment (Martial et al., 2014).

The optimal use of control at the time of the outbreak of dengue disease is sufficiently efficient to reduce the impact of the spread of dengue fever (Helena et al., 2010).

Conclusion:-

Preliminary planning by making optimization models for patient allocation during infectious diseases, the availability of 30% of room space in each hospital of the overall total is effective for the initial handling of the patient and preventing the occurrence of death.

Acknowledgments:-

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