Implementation of Integer Programming to Determine the Amount of General Practitioner for Respon Darurat Kesehatan Program, A Case Study at Layanan Kesehatan Cuma-Cuma Jakarta-Banten, Dompet Dhuafa

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Abstract

Human resource is one of many resources that needs to be managed well. This includes the amount of human recourse that is considered most efficient and effective for a company or organization. This can be achieved mathematically with various calculations including Integer Programming. The purpose of this study is to determine the minimal amount of general practitioner needed to fulfill the demand of Respon Darurat Kesehatan (RDK) Program from Layanan Kesehatan Cuma-Cuma (LKC) Jakarta-Banten, Dompet Dhuafa using Integer Programming. The expected finding is the amount of people that needs to be hired in order to fulfill the operational demand of RDK program, LKC Jakarta-Banten, Dompet Dhuafa. The result shows that Integer Programming can be used to determine the amount of human resources. The model used in this study could be replicated and used in various cases in many sectors.

Keyword: Linear programming, human recourse, amount of general practitioner

Background

Respon Darurat Kesehatan (RDK) is a one of the programs initiated by Layanan Kesehatan Cuma-Cuma (LKC) Dompet Dhuafa. This program is a form of mobile health services for poor patients. Activities in this program includes examination and basic management of patients at home (home visit), transportation to and from medical facilities, administrative advocations for patients who do not have proper documentation and to manage new Dompet Dhuafa member applications for patients that need access to free health services. (Uyang, 2016) These services are prioritized for patients in need of emergency services but do not rule out other cases if resources are sufficient.

In carrying out these tasks, the scope of work of RDK is divided according to region. One of the RDK region is the Jakarta-Banten RDK region with a very wide working area covering up to 10,324.5 km2. Currently, RDK Jakarta-Banten Region has one doctor, one nurse and two drivers.

The enormous coverage of region with a high number of poor people, large workloads and limited human resources are major challenges in the implementation of the Jakarta-Banten RDK program. Therefore, RDK plans to add human resources in order to expedite the operation of RDK. This includes hiring more general practitioners (GPs). This addition needs to weigh the cost effective of adding more employees.

Various mathematical formulations could be used to determine the most effective and efficient amount of GPs that needs to be hired to meet current RDK operational needs. In this study, we tried using Integer to solve this problem.

Literature Review

Management decisions are often related to the decision to seek the most effective formulation in the use of various resources. These resources include human resources, raw materials, equipment or machinery, services, etc. This decision can be taken with the help of various mathematical calculations.

Linear Programming (LP) is a mathematical technique established to assist in planning and decision making on resource allocation. At first, these mathematical calculations were used and developed in the military field but later on was used also by various sectors. Use of LP can be done if the case has the following characteristics. (Render, Stair, & Hanna, 2012)

- The goal to maximize or minimize

  All problems have a goal to maximize or minimize such as maximizing profits and decreasing resource use while still obtaining the most effective results. This is called the objective function which must then be formulated clearly in a mathematical form.

- Has constraints

  LP can only be used in conditions with constraint or limitations. These constraints can be in the form of limited human resources, limited raw materials, limited funds and etc.

- Alternatives are available

  There are several alternative conditions that can be selected as the best condition or scenario. The best conditions are sought using LP.

- Linear mathematical equation

  A linear mathematical equation means that all mathematical formulations that are made must be in the first degree.

LP can be used in various scenarios. LP can be used in the field of marketing, production, transportation scheduling, finance, use of raw materials and so forth. LP can also be used to solve the problem of scheduling human resources including in the health field. (Satheeshkumar, Nareshkumar, & Kumaraghuru, 2014).

Unlike certain materials or resources that can be divided, to calculate human resources the end result of the calculations should be an integer. This sometimes could not be achieved using LP and it also incorrect to manually round up the decimal results. This is where another type of programming comes to hand. Integer programming (IP) has the same principles as LP but ensures that the solution is in integer. The formulation of IP can be completed either by manual calculation with the help of graphs or by using computerization. The use of graphs is intended for simple problem formulas such as cases with two variables. In the case of more than two variables, IP can use either Excel's solver or QM for Windows Computer Program. (Render, Stair, & Hanna, 2012)

In this study, IP is used to determine the minimum number of general practitioners most effectively needed to meet the operational needs of RDK.

Methodology

Model Description
The demand of GP for RDK operations are as follows.

Table 1. Model Description

No	Day	Number of GPs needed
1	Monday	3 general practitioners
2	Tuesday	2 general practitioners
3	Wednesday	2 general practitioners
4	Thursday	3 general practitioners
5	Friday	2 general practitioners
6	Saturday	2 general practitioners
7	Sunday	2 general practitioners

RDK activities take place seven days a week. Every doctor should have two days of breaks in a row every week.

Objective Function

The objective function of this study is to determine the minimum number of GPs needed to meet the demand of GPs for RDK program from LKC, Dompet Dhuafa.

Constraint

Constraints of this model are as follows.

- Monday has to have at least 3 GPs or more
- Tuesday has to have at least 2 GPs or more
- Wednesday has to have at least 2 GPs or more
- Thursday has to have at least 3 GPs or more
- Friday has to have at least 2 GPs or more
- Saturday has to have at least 2 GPs or more
- Sunday has to have at least 2 GPs or more
- Every doctor should have two days of breaks in a row every week.

Total Formulation of Problem

If:

X1 = GPs working Monday - Friday
X2 = GPs working Tuesday – Saturday
X3 = GPs working Wednesday – Sunday
X4 = GPs working Thursday – Monday
X5 = GPs working Friday - Tuesday
X6 = GPs working Saturday – Wednesday
X7 = GPs working Sunday - Thursday

Objective Function

Minimum number of GPs required (Z) = X1+X2+X3+X4+X5+X6+X7

Constraint

X1+ X4+X5+X6+X7 $\geq$ 3 (Monday)
X1+X2+ X5+X6+X7 $\geq$ 2 (Tuesday)
X1+X2+X3+ X6+X7 $\geq$ 2 (Wednesday)
X1+X2+X3+X4+ X7 $\geq$ 3 (Thursday)
X1+X2+X3+X4+X5 $\geq$ 2 (Friday)
X2+X3+X4+X5+X6 $\geq$ 2 (Saturday)
X3+X4+X5+X6+X7 $\geq$ 2 (Sunday)
X1,X2,X3,X4,X5,X6,X7 > 0

Results

This model was solved using QM for Windows because its variables are more than two. Results obtained through the program are as the following table.

	X_1	X_2	X_3	X_4	X_5	X_6	X_7		RHS
Minimize	1	1	1	1	1	1	1		
Monday	1	0	0	1	1	1	1	>=	3
Tuesday	1	1	0	0	1	1	1	>=	2

	X_1	X_2	X_3	X_4	X_5	X_6	X_7		RHS
Wednesday	1	1	1	0	0	1	1	>=	2
Thursday	1	1	1	1	0	0	1	>=	3
Friday	1	1	1	1	1	0	0	>=	2
Saturday	0	1	1	1	1	1	0	>=	2
Sunday	0	0	1	1	1	1	1	>=	2
Solution	1	0	0	1	0	1	1	optimal	$4

Integer programming gave results for Z = 4

Discussion & Conclusion

The minimum number of GPs needed to meet the demand in RDK LKC Jakarta-Banten, Dompet Dhuafa can be answered using IP. Not only does it answer the amount of GPs needed but it can simultaneously help determine the schedule plan. The solution shows that LKC should hire one X_1 (GP working Monday – Friday), one X_4 (GP working Thursday – Monday), one X_6 (GP working Saturday – Wednesday) and one X_7 (GP working Sunday – Thursday). This formulation can be used with flexibility in many different settings.

Scope for Future

The use of IP to solve the problem of the minimum number of human resources required to fill certain operational needs can be applied to various human resources in various sectors.

Reference

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