CLINIC OPERATIONAL EFFICIENCY THROUGH OPTIMIZING THE DISTRIBUTION OF NURSING STAFF

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Abstract

An inpatient primary clinic is a healthcare unit characterized by fewer facilities and amenities compared to a hospital. Consequently, the distribution and allocation of health workers, particularly nurses, for operational processes differ significantly from that in hospitals. This study aims to determine the optimal number of nursing personnel required for efficient operation of an inpatient primary clinic through the application of linear programming techniques. The research methodology involves secondary data analysis, utilizing administrative information from inpatient private clinics in Lumajang Regency, East Java. The findings reveal that the linear programming model implemented is effective in optimizing nurse distribution. Specifically, the results indicate that a minimum of eight nurses is necessary to ensure efficient operation and cost-effectiveness of the inpatient clinic. This efficient distribution model can potentially lead to significant operational cost savings, thereby enhancing the overall performance and sustainability of inpatient primary clinics in similar settings.

Keywords: Clinic, Hospitalization, Efficiency, Operations

1. INTRODUCTION

Every service and manufacturing company needs clear operational information for the continuity of its business processes. A clinic is a health care facility that organizes and provides basic and or specialized medical services, organized by more than one type of health worker and led by a medical staff (Permenkes RI No.9, 2014). Clinics have fewer facilities and services than hospitals so that the operational process is expected to be more effective and efficient. Decision-making for employee distribution is different from that of a typical hospital. Therefore, the scheduling distribution method in clinics is not the same as hospitals. When referring to employee scheduling distribution such as hospitals, there will be many employees who do not work efficiently or many employees who are unemployed. Therefore, a different method is needed for the distribution of employees in each service unit at an inpatient clinic.

One of the decision-making on operational management of services in the health sector is nurse scheduling (Yustiawan, 2013). Scheduling in work is the allocation of human resources at a certain workplace with a predetermined time and place in carrying out the planned work to achieve the goals desired by the Company (Suseno, 2017). Scheduling is related to the selection of operating time. According to Heizer and Render (2009) scheduling decisions begin with capacity planning which includes the availability of all resources owned. The purpose of scheduling is to allocate and prioritize demand on limited resources

within a period. In the daily process, one of the schedules found in the health sector is nurse scheduling.

According to the Law of the Republic of Indonesia. No. 23 of 1992 concerning health, nurses are those who have the ability and authority to perform nursing actions based on knowledge obtained through nursing education. In order for the performance of nursing services at the clinic to run well, nursing personnel are needed who meet the requirements both in quality and quantity and are adjusted to the workload carried out. Each clinic has several health service facilities, namely inpatient, outpatient, and emergency room. These three facilities are the main services provided by the clinic as health services, these health services cannot stop and continue to provide services with busy conditions and urgency.

Services at inpatient Pratama clinics that require the assistance of nurses and are also core services, include: Hospitalization, Emergency Room, and General clinic. Due to the small scope of services, it is hoped that the allocation of nurse distribution can be optimized so that there are no excess personnel that cause inefficiencies in the operational process. In addition, health services that are now using insurance in their financing (BPJS) which include centralized cost control make Pratama clinics must be able to improve services and also control their operational costs in order to continue operating and developing.

Valentine & Sitorus (2023) research, from this study is the creation of an optimal schedule for a period of 31 working days in accordance with hospital rules and nurse preferences by minimizing the deviation variable in the three objective constraints. Based on Widyaningsih's research (2018), the solver results in the morning shift require at least 8 nurses, the afternoon shift requires 8 nurses, and the night shift requires 12 nurses. Based on the results of the anova test, a significance value (Sig.) of 0.829> 0.05 was obtained, so it can be concluded that statistically the average number of nurses from the three shifts is the same or there is no significant difference if the hospital uses 12 or 8 nurses.

So from these two research results, an employee scheduling formulation is obtained for a more effective and efficient operational process. Based on this explanation, the purpose of this study is to analyze the distribution of the number of nurses in an inpatient clinic. And what is the minimum total distribution of nurses at the Primary Inpatient Clinic?

2. LITERATURE REVIEW

2.1. Clinic

The definition of a clinic based on the Regulation of the Minister of Health (PMK) No. 28 of 2011 is a health care facility that organizes individual health services that provide basic and/or specialized medical services, organized by more than one type of health worker and led by a medical staff. Thus, a clinic must determine the services it will provide, as it can be limited to basic medical services, or specialty services, or both. This decision will affect the stratum in which a clinic is organized.

There are two strata of clinic organization, namely: 1) Primary Clinic and 2) Primary Clinic. Primary Clinic is a clinic stratum that is limited to providing basic medical services. Primary Clinics are strata of clinics that can organize specialized medical services only, or also at the same time organize basic medical services. The organization of the clinic must pay attention to several requirements including:

a. Location Requirements

b. Building and Room Requirements
c. Facilities and Infrastructure
d. Equipment
e. Manpower (Yuastiawan, 2013)

2.2. Human Resources and Financial Management of Inpatient Provider Clinics

As stated by Yulia Nazlia Sidy (Directorate of Primary Health Care) that the human resource needs required at the Prata Inpatient Clinic consist of at least doctors, dentists, and / or specialists in the field of primary care (meeting at least the minimum number) (Sidy, 2023). As for financial management at the Clinic, clinic expenses include operational costs, employee salaries, capital expenditures, taxation, and other expenses. Clinic operating income is income from services, capitation, insurance and other income that does not come from the clinic.

2.3. Linier Programming

According to Mulyono (2004) Linear Programming (abbreviated as LP) is one of the most widely used and well known Operating Research techniques. Linear program is a mathematical method in allocating scarce resources to achieve goals. Linear Programming is a mathematical technique designed to assist operations managers in planning and making decisions needed to allocate resources based on the opinion of Heizer and Render (2006).

3. RESEARCH METHOD

The research method in this study is descriptive quantitative research with the Secondary Data Analysis (ADS) approach. ADS is a method by utilizing secondary data as the main data source (Martono, 2010). The secondary data owned is utilized by researchers to obtain the information desired by researchers. Descriptive research is a support for researchers to support and deepen the description of activities and conditions that occur in the field and also based on the results of the analysis. The time and place of this research was in March 2024 at the Inpatient Primary Clinic in Lumajang Regency, East Java.

According to how it was obtained, this study used secondary data, namely data obtained indirectly from the object of research. The data collection method used is to process secondary data sources. Secondary data sources are books, company records or documentation, government publications, databases, industry analysis by the media, websites, the internet and so on (Sekaran, 2006). The data used is the clinical nurse schedule data.

Winston (2004) states that linear programming is a method that will solve problems with several constraint functions to achieve goals such as maximizing (profits to be achieved) or minimizing (costs). The linear nature means that all mathematical functions in this model are linear functions, while programming is a synonym for planning. Thus, linear programming is the planning of activities to obtain an optimum result, i.e. the best result from all possible alternatives.

The steps to be taken in this research are:

a. Check the Clinic's Terms of Use

Table 1. Provisions for nurse distribution and nurse preferences

Description	Terms
Morning Shift	Morning services are outpatient, inpatient, and emergency room
	Total number of nurses on the morning shift 4 people
Afternoon Shift	Morning services, namely outpatient, inpatient, and emergency room.
	Total number of nurses on the morning shift 4 people
Night shift	Night services are inpatient, and emergency room
	Total number of nurses on the morning shift 2 people
Total number of nurses	13 people
Number per shift	In 1 morning and afternoon shift, there must be a total of 4 nurses working in the morning shift and 4 in the afternoon shift (cannot be reduced).

Source: Nurse Administrative Information

b. Determining the Notation Used for the Mathematical Model
The following notation is used to determine the mathematical model:
a = Morning
b = Afternoon
c = Night
i = Inpatient
j = Outpatient
k = Emergency Room

Here are the decision variables
Xai = number of morning shift nurses in the inpatient unit
Xaj = number of morning shift nurses in the outpatient unit
Xak = number of morning shift nurses in the emergency department unit
Xbi = afternoon shift nurses in the inpatient unit
Xbj = afternoon shift nurses in the outpatient unit
Xbk = afternoon shift nurses in the emergency room unit
Xci = night shift nurse in inpatient unit
Xcj = night shift nurse in outpatient unit
Xck = night shift nurse in the emergency room unit

c. Modeling of Clinical Conditions

Table 2. Distribution of the number of nurses

Description	Inpatient	Outpatient	IGD
Morning	2	1	1
Afternoon	2	1	1
Night	1	0	1

Source: Nurse Administrative Information

d. Goal Setting for Non-Preemptive Goal Programming

$$\text{Min } Z = 2Xai+Xaj+Xak+2Xbi+Xbj+Xbk+Xci+Xck$$

e. Determining the Goal to be Achieved
The goal to be achieved in this research is expected to find optimization of the distribution of available nurses and also prove the optimality of the nurse distribution method that has been done.

f. Solving Goal Programming Problems Using LINGO Software
g. Implementation of Final Result

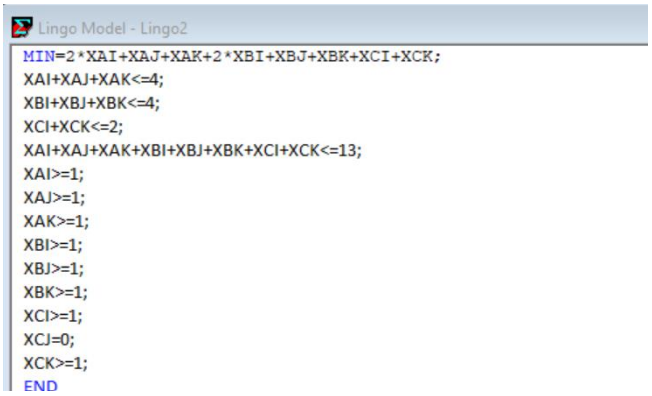
4. RESULT AND DISCUSSION

4.1. Research Result

The Primary Inpatient Clinic has its own rules in assigning its nurses. The nurse scheduling model will be formulated in the form of mathematical model constraints. There are 13 nurses assigned to this clinic. In table 2, the distribution of the number of nurses at the Primary Inpatient Clinic has been described. The results of the LINGO analysis based on table 2 and the functions and constraints are:

Min=2Xai+Xaj+Xak+2Xbi+Xbj+Xbk+Xci+Xck ……..1)

Subject to:
Xai+Xaj+Xak<=4……...2)
Xbi+Xbj+Xbk<=4……..3)
Xci+Xck<=2 ……..4)
Xai+Xaj+Xak+Xbi+Xbj+Xbk+Xci+Xck<=13……5)
Xai>=1
Xaj>=1
Xak>=1
Xbi>=1
Xbj>=1
Xbk>=1
Xci>=1
Xcj=0
Xck>=1



Source: Data processed, 2023

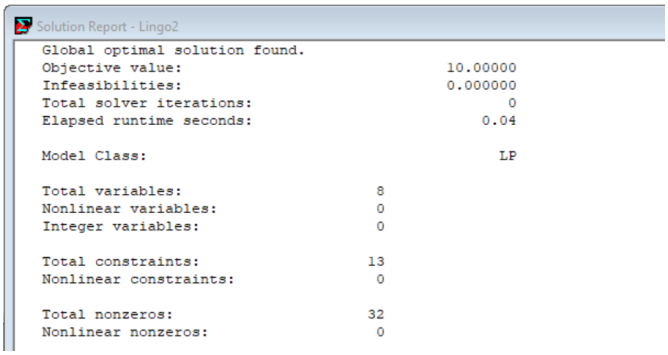
Figure 1. LINGO MODEL

4.1.1. Optimal Solution

Based on the data processed using LINGO, the following data is obtained:

a. Objection Function Value

The objective function value is under the Objective Function Value label. The objective function value of the LINGO result is 10.



Source: Data processed, 2023

Figure 2. Solution Report LINGO

b. Value

The optimal value of the decision variable under the value label. Decision variables in the LINGO output are labeled as variables. Since the above case has 8 decision variables labeled Xai,Xaj,Xak,Xbi,Xbj,Xbk,Xci and Xck, these two labels are listed under the Variable column. The number under the Value label and in the row where Xai is located indicates the optimal value of variable Xai which is 1; similarly, Xaj is 1; as stated below:

Variable	Value	Reduced Cost
XAI	1.000000	0.000000
XAJ	1.000000	0.000000
XAK	1.000000	0.000000
XBI	1.000000	0.000000
XBJ	1.000000	0.000000
XBK	1.000000	0.000000
XCI	1.000000	0.000000
XCK	1.000000	0.000000
XCJ	0.000000	0.000000

Source: Data processed, 2023

Figure 3. Solution Report LINGO

c. Reduced Cost

Reduced Cost also describes the amount of reduction in the case of maximization and addition in the case of minimization. Therefore, in this case according to Figure 3, which explains that there are no additional employees (the reduced cost value is 0) with the value listed in Figure 3.

d. Slack or Surplus

This information shows the Slack or Surplus value of each constraint when the objective function value reaches an extreme value. Since the LINGO input structure has placed the constraints starting in the 2nd order, the Row label starts with the number 2 which means the 2nd row. Thus, it is obvious that row 2 marks the 1st constraint, row 3 marks the 2nd constraint, and so on, so that based on Figure 4 it is obtained that row 2 (constraint 1), row 4 (constraint 2) and row 14 (constraint 13) are basic variables that have positive values. For rows that have zero Slack variable values are non-base variables.

Row	Slack or Surplus	Dual Price
1	10.00000	-1.000000
2	1.000000	0.000000
3	1.000000	0.000000
4	0.000000	0.000000
5	5.000000	0.000000
6	0.000000	-2.000000
7	0.000000	-1.000000
8	0.000000	-1.000000
9	0.000000	-2.000000
10	0.000000	-1.000000
11	0.000000	-1.000000
12	0.000000	-1.000000
13	0.000000	0.000000
14	0.000000	-1.000000

Source: Data processed, 2023

Figure 4. Solution Report LINGO

e. Dual Price

This information explains the change that will occur in the value of the objective function if the value of the right-hand segment changes by one unit. Therefore, the dual price in row 2,3,4 and 13 is 0 which explains that the constraint will clearly not change the objective function. While rows 6,7,8,9,10,11,12, and 14 explain that the constraint will change the objective function.

f. Sensitivity analysis

In the sensitivity analysis output, there is the following data:

a) Sensitivity Analysis of Objective Function Coefficients

Sensitivity Analysis of the objective function describes changes in values that will not change the optimal value of the decision variable. Data information related to this sensitivity analysis is as follows:

Objective Coefficient Ranges:

Variable	Current Coefficient	Allowable Increase	Allowable Decrease
XAI	2.000000	INFINITY	2.000000
XAJ	1.000000	INFINITY	1.000000
XAK	1.000000	INFINITY	1.000000
XBI	2.000000	INFINITY	2.000000
XBJ	1.000000	INFINITY	1.000000
XBK	1.000000	INFINITY	1.000000
XCI	1.000000	INFINITY	1.000000
XCK	1.000000	INFINITY	1.000000

Source: Data processed, 2023

Figure 5. Solution Report LINGO

Based on the data above, it can be concluded that changes in the value of XAI range between the upper limit of more than 2 and unlimited or down to 0 in a closed range that will not change the optimal value of the decision variable. This also applies to the decision variables Xai, Xaj, Xak, Xbi, Xbj, Xbk, Xci, Xck in a closed range.

b) Sensitivity Analysis

In this case, the right hand side value sensitivity analysis describes the interval of change in the right hand side value that ensures the validity of the dual price. Beyond that interval, the dual price value is no longer valid for estimating changes in the objective function value.

Righthand Side Ranges:

Row	Current RHS	Allowable Increase	Allowable Decrease
2	4.000000	INFINITY	1.000000
3	4.000000	INFINITY	1.000000
4	2.000000	INFINITY	0.000000
5	13.00000	INFINITY	5.000000
6	1.000000	1.000000	1.000000
7	1.000000	1.000000	1.000000
8	1.000000	1.000000	1.000000
9	1.000000	1.000000	1.000000
10	1.000000	1.000000	1.000000
11	1.000000	1.000000	1.000000
12	1.000000	0.000000	1.000000
14	1.000000	0.000000	1.000000

Source: Data processed, 2023

Figure 6. Solution Report LINGO

Changing the value of the right segment of the 1st active constraint located in the 2nd row up to above 4 or infinity or down to 3 will not change the dual price value of the 1st constraint, which is 0 and does not change the objective function.

Based on the results of the analysis, the optimum value of the function is 10, the minimum distribution of employees required is 10 people. This calculation does not consider

the preference of the requirement for the number of days off for nurses at the Primary Inpatient Clinic. If the Pratama Inpatient Clinic wants to do nurse efficiency, the total number of nurses needed is 10 people. In addition, the distribution for the 10 employees needed for the operational process is 1 person in each shift and work unit. So for the inpatient morning shift there is 1 person, the inpatient afternoon shift is 1 person and the night shift is 1 person. When compared to the conditions in the field that the total number of existing nurses is 13 people, the number is more than the linear programming calculation.

Then if there is an addition of 1 employee in each shift and work unit, it will reduce the objective function. In this function, there should be no additional employees because the function will change. Because, if additional employees are added, it is not in accordance with the purpose of the objective function, namely minimization so that the clinic can make cost efficiency. As is the case in the 4th row or the 3rd constraint which explains that the night shift for inpatient and igd is 1 nurse on duty each, it is clearly expected that there should be no change in either the addition or subtraction of nurses so that there is no change in the objective function because it is in accordance with the existing constraints that XCJ is 0 or no one is on guard.

There are limits in a closed range so that the objectives of this function can be achieved. For example, XAI has a value of 1 then if the value is below 1 (the upper range allowed is more than 2 and unlimited, and the lower range allowed is 0). If the XAI arrangement is below the range of 0, it will change the objective function, which means that there is a shortage of morning shift nurses guarding the inpatient unit. And it is allowed to make the morning shift inpatient nurse distribution formation with more than 2 nurses, it will not change the objective function. Likewise, in the morning shift for poly or outpatient units, where it is allowed to distribute the number of nurses more than 2 people and cannot be less than 0. However, this range creates a problem if there are no nurses at all because the lowest range is 0 for the morning shift of inpatient and outpatient poly, so that it can interfere with the duties of nurses in other units, namely the igd. Likewise, in other shifts and other units such as poly and outpatient, if below the range of 0 or equal to 0, it will interfere with the performance of other unit nurses to assist and replace the duties of other units.

$$Xai+Xaj+Xak<=4\ldots\ldots\ldots\ldots\ldots\ldots 2)$$

Based on Figure 5 which explains row 2 or constraint 1, where the allowed right limit is above 4 of the specified value of 4, while the allowed decrease limit value is 3. Then the number of nurses for the morning shift of inpatient, outpatient poly and igd with a total of at least 3 employees is allowed, while the maximum number of nurses for the morning shift is allowed to exceed 4 people and infinity. This explains that if in 1 morning shift there are only 2 employees, there will be problems with employee performance.

$$Xai+Xaj+Xak+Xbi+Xbj+Xbk+Xci+Xck<=13\ldots..5)$$

Based on Figure 5 which explains about row 5 or constraint 4, where the allowed right limit is above 13 and more than that value, while the allowed lower limit value is 8. Then the total number of nurses allowed, the maximum number is more than 13 nurses and infinity. However, the total number of nurses allowed for 1 inpatient primary clinic is 8

people and cannot be less than 8. If the minimum limit of the total number of nurses is violated, it will interfere with the operation such as the absence of nurses in certain service units, services become slow, complaints are not handled and the worst is if there is an emergency action but there is no igd nurse on guard in the igd unit.

Nurses are the largest number of employees in a health service and according to the law, the work that is the expertise of nurses cannot be replaced by other medical personnel. However, when looking at the level of types of health services, it is necessary to assess the number and scheduling methods in more detail to be able to control human resource costs to support the sustainability of a health service.

g. Implementation

1) The number of nurses currently working at 13 people has exceeded the minimum number of nurses based on linear programming calculations, namely 10 people. However, in the implementation of minimizing the number of nurses, consideration is needed for the number of nurses and the quality of service according to the vision and mission of the inpatient clinic.
2) The nurse distribution modeling that has been running at the Primary Inpatient Clinic is appropriate because if each shift has a value of 0 (no nurse on duty) it will change the objective function and will interfere with the operational processes of other units.
3) Modeling the distribution of nurses based on linear programming, allows the value of 0 or one of the units there are no nurses on duty but will be assisted or replaced by other nurses. In the field implementation, more monitoring is needed regarding the number of patients and the position between rooms as easy access for nurses in carrying out their duties.
4) The minimum range of nurses allowed in the linear programming calculation is 8 nurses, in accordance with the calculation of constraint 4 with a maximum limit of 13 nurses. However, the calculation has not considered the preference of the number of nurses' days off and also the working hours allowed for nurses.

5. CONCLUSION

Based on the results of the discussion above, it is known that through linear programming, information is obtained on the range of the total number of minimum and maximum nurses intended for the inpatient clinic. So it can be concluded that linear programming can assist in the distribution of nurses at the inpatient clinic to provide information related to the efficiency of clinic management costs on labor salaries.

REFERENCESS

Martono, N. (2010). *Metode penelitian kuantitatif: Analisis Isi dan Analisis Data Sekunder (sampel halaman gratis)*. RajaGrafindo Persada.

Mulyono, S. (2004). Riset Operasional. *Jakarta: Lembaga Penerbit Fakultas Ekonomi Universitas Indonesia*.

Sekaran, U. (2006). Metodologi penelitian untuk bisnis edisi 4. *Jakarta: Salemba Empat*.

Sidy, Y. N. (2023). *Kebijakan Penyelenggaraan Klinik Pada Pelatihan Bagi Pelatih Calon Surveior Puskesmas dan Klinik. Direktorat Mutu pelayanan Kesehatan*.

Suseno, S. (2017). Penjadwalan Tenaga Kerja Untuk Tiga Shift Kerja Dengan Pengembangan Metode Algoritma Tibrewala, Philippe Dan Browne. *Proceding SNTI 2017*, *3*(1), 298–300.

Valentine, E., & Sitorus, S. (2023). Model Goal Programming Untuk Mengoptimasi Penjadwalan Perawat Rumah Sakit Universitas Sumatera Utara. *FARABI: Jurnal Matematika Dan Pendidikan Matematika*, *6*(1), 58–66.

Winston, W. L. (2004). *Operations research: applications and algorithm*. Thomson Learning, Inc.

Yustiawan, T. (2013). Manajemen klinik dalam persiapan kerjasama dengan BPJS Kesehatan. *Jurnal Administrasi Kesehatan Indonesia*, *1*(3), 208–216.

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