http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 11, No 02 September 2022
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

OPTIMIZATION, ASSIGNMENT MODEL, AND DECISION ANALYSIS OF HOSPITAL CALL CENTER IN PT. XYZ

I Nyoman Indra Kusuma Sukma Putra*[1], Aryo Robinsar Simanjuntak[1], Angeliliana Surya[1], Desnita Putri Ardiyanti[1], Christy Dwita Mariana[2]
[1] BINUS Business School, Bina Nusantara University, Jakarta 10271, Indonesia
[2]Faculty of Economics and Business, Universitas Indonesia, Indonesia

ARTICLEINFO

Keywords:
Hospital, Call Center, Optimization Model, Assignment Model, Decision Analysis

ABSTRACT

The acquisition led PT XYZ management to prioritize improving the hospital's public service. One of the main focuses is the centralization of the Call Center from 6 Hospital branches in several areas of Greater Jakarta. The Call Center centralization plan also need to conduct several analysis using Optimization Model, Assignment Model, and Decision Analysis to increase operating staff's effective performance and to make sure the management decision is aligned with the Hospital's management plan.

E-mail:
i.putra016@binus.ac.id

1. INTRODUCTION

PT ABC has just acquired PT DEF which oversees it as a step to expand and strengthen business lines in the field of health services which already manages two hospitals. With the acquisition of PT DEF shares, it will add to the network of hospitals managed by PT ABC. This acquisition had an impact on management's decision to merge the business lines of several hospital entities owned by both companies. The group is currently operating with a branding change using the name under PT XYZ with 6 hospital networks in several areas of Greater Jakarta (Jabodetabek).

The main plan for the integration of this business line, apart from branding, will be prioritized to improve the hospital's public services. One of the main focuses is the centralization of the Call Center so that PT XYZ is the only private hospital that has a centralized Call Center for the entire hospital business network. Through the centralization of the Call Center, it is hoped that it will be able to increase patient traffic, provide clearer information and provide higher quality services through the speed of response in responding to phone calls and the accuracy of providing information or promotions that apply, as well as making it easier for patients to make appointments which will have an impact on the satisfaction of the customer (Gans et al. 2003).

Hospital Call Center services are considered intangible products that are rendered quickly and courteously by a knowledgeable and helpful service provider are almost certainly valued highly by most customers (Strother J.B., 2014). There is no doubt that high-quality service is an important determinant of patient loyalty, but most of the studies have dealt with the patient-doctor relationship (Kenagy et al., 1999; Crow et al., 2003)

However, this Call Center centralization plan is also not an easy thing, there needs to be optimization of working staff, division of shift tasks, and analysis of decisions to increase operating staff effective performance.

2. METHOD

In this study, several analyses were conducted according to the need of Call Center from Optimization Model, Assignment Model, and Decision Analysis. The method used in this research is a qualitative research method descriptive case study analysis, by collecting factual and accurate information about the business processes of PT XYZ through interviews. The numbers used in this study are dummy data to represent the actual data which is confidential. However, the analysis was representing the main problem that relates to the current company situation that needs to be solved.

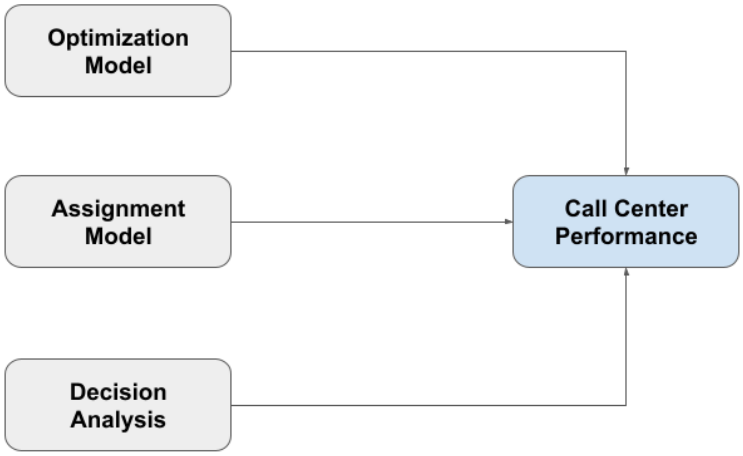


Figure 1. Research Analysis Framework

3. RESULT AND DISCUSSION

Optimization Model

The first case will be using linear programming which leads to optimization. Linear programming is a mathematical method to determine the optimal scenario. The theory of linear programming can also be an important part of operational research. It's frequently used in business, but it can be used to resolve certain technical problems as well (Dahleh et al., 1995).

In the context of the study case, related to the development of PT. XYZ, the management also made several changes and developments in its structure and infrastructure. One of them is by centralizing the Call Center. Management wants to allocate workers for each shift using optimization model.

The Call Center will handle 6 branches of the PT. XYZ from 6 hospital branches with a planned total Call Center staff of 40 people divided into 4 shifts with the provisions of operating hours of 7 hours per day and Call Center staff work 6 days a week (Mason et al., 1998). Companies need to calculate the ideal number of staff on duty in each shift so that the existing workforce can work optimally (the actual number of workers is disguised).

Table 1. Call Center Shifts

Shift	Operational Hour	Number of Workers needed
1	07.00 – 13.00	8
2	13.00 – 19.00	16
3	19.00 – 01.00	11
4	01.00 – 07.00	5

Source: Processed by Researchers, 2022

Shift 1 requires 8 people, shift 2 requires 16 staff, shift 3 requires 11 staff because these hours are primetime hours were based on existing phone data, telephone traffic will be the highest, and shift 4 requires 5 staff. Management plans to optimize operator staff working in a centralized Call Center so that each shift can be fulfilled optimally.

Minimize worker schedule:

X1 + X2 + X3 + X4

Subject to constraints:

X1 + X4 >= 8

X1 + X2 >= 16

X2 + X3 >= 11

X3 + X4 >= 5

Using the POM-QM software, the result is:

- Increasing the value constraint 2 will reduce the total workforce by 1 person
- Increasing the value constraint 4 will reduce the total worker by 1 person

Total Call Center Staff = 21 Staff

X1 = 10 (Shift 1)

X2 = 6 (Shift 2)

X3 = 5 (Shift 3)

X4 = 0 (Shift 4)

From the results of the Optimization Model above, it can be concluded that it takes a total of 21 staff at the Call Center with the provisions of shift 1 as many as 10 staff, shift 2 as many as 6 staff, shift 3 as many as 5 staff and shift 4 there is no additional staff because it is combined with shift 1.

Assignment Model

The methods for solving assignment problems are called, the Hungarian method that was developed by D. Konig in 1955. The results of the evaluation of the Call Center service during 2021 from the previous 4 hospitals, showed that there was an abandon call rate which was still quite high above 10%. Based on this data, management evaluates and plans to add 6 more Call Center staff, where it was initially decided that the total number of workers is 40 Call Center staff to handle 6 Hospital branches (the staff will be divided into 6 teams and each focus team to handle 1 Hospital).

It is hoped that with this evaluation, the abandon call rate can be significantly reduced. This plan also aims to anticipate the impact of the centralization of the Call Center which will potentially increase the traffic of incoming telephone calls. Based on these considerations, the company needs to calculate the assignment staff to handle incoming calls so that there is no accumulation of abandoned calls.

Table 2. Staff Assignment Handle Incoming Calls

Incoming Calls	Hospital A	Hospital B	Hospital C	Hospital D	Hospital E	Hospital F
Staff 1	20	18	15	17	16	19
Staff 2	18	15	11	13	14	16
Staff 3	19	16	13	14	12	15
Staff 4	18	15	11	13	14	16
Staff 5	16	14	10	11	12	13
Staff 6	12	6	8	9	10	11

Source: Processed by Researchers, 2022

With the evaluation and plan to add 6 more Call Center staff, it is hoped that it will be able to reduce the abandon call rate from incoming calls to 6 Hospital branches simultaneously. The allocation of the Assignment table above aims to minimize costs (actual salary is disguised).

Using POM-QM software, the results of the Solution obtained:

- Staff 1 handles incoming calls from the Hospital A division with a salary of IDR 20,000
- Staff 2 handles incoming calls from the Hospital B division with a salary of Rp. 11,000
- Staff 3 handles incoming calls from the Hospital C division with a salary of IDR 12,000
- Staff 4 handles incoming calls from the Hospital D division with a salary of Rp. 13,000
- Staff 5 handles incoming calls from the Hospital E division with a salary of IDR 13,000
- Staff 6 handles incoming calls from the Hospital F division with a salary of Rp 6,000
- The total salary that all Hospital branches must spend for 6 staff is IDR 75,000

From the results of Marginal Cost obtained:

- If Staff 1 who is supposed to be in charge of receiving incoming calls in the Hospital A division is transferred to receive incoming calls from Hospital B, there will be an additional salary of Rp. 4,000, in Hospital C by Rp. 2,000, in Hospital D by Rp. 2,000, and in Hospital F by Rp. 2,000.
- If Staff 2 who should be in charge of receiving incoming calls in the Hospital C division is moved to receive incoming calls from Hospital B, there will be an additional salary of Rp. 3,000 and in Hospital F of Rp. 1,000.
- If Staff 3 who should be in charge of receiving incoming calls in the Hospital E division is moved to receive incoming calls from Hospital A, there will be an additional salary of Rp. 3,000, at Hospital B by Rp. 6,000, in Hospital C by Rp. 4,000, in Hospital D by Rp. 3,000 and in Hospital F for Rp. 2,000.
- If Staff 4 who should be in charge of receiving incoming calls in the Hospital D division is moved to receive incoming calls from Hospital B, there will be an additional salary of Rp. 3,000 and in Hospital F of Rp. 1,000.
- If Staff 5 who should be in charge of receiving incoming calls in the Hospital F division is moved to receive incoming calls from Hospital B, there will be an additional salary of Rp. 4,000 and at Hospital C of Rp. 1,000.
- If Staff 6 who should be in charge of receiving incoming calls in the Hospital B division is moved to receive incoming calls from Hospital C, there will be an additional salary of Rp. 3,000, in Hospital D by Rp. 2,000, in Hospital E by Rp. 2,000 and in Hospital F by Rp. 2,000.

Decision Analysis

Decision Analysis helps healthcare applications to increase transparency, consistency, and decions legitimacy (Thokala et al., 2016; Zhao, 2015; Vhutipadadon, 2009). PT XYZ Hospital's management plan to add 6 more Call Center staff still has several considerations, one of which is the choice of recruiting directly or using outsourcing. If PT XYZ recruits itself, the required cost is Rp. 42,000 who works as a permanent employee, while when using outsourced the required cost is Rp. 34,500 and lower costs because the staff is managed by the outsourcing party. Meanwhile, if the company does not increase the number of staff, it is necessary to pay overtime fees for the staff who are currently working to handle incoming calls of Rp. 53,000.

Considering two states of nature, favorable and unfavorable to minimize costs, management wants to compare hiring, outsourcing costs, or do nothing. Thus, companies need to conduct analysis by making decisions under uncertainty and decision making under risk. The favorable condition is the company can acquire the best offer of staffing cost in the range of the company's budget. Meanwhile, the unfavorable condition is when the staffing cost exceeds the current company's budget. This condition can be caused due to several factors such as current talent demand trends and different salary gaps from the local government policies in certain areas of each Hospital branch located.

Decision Analysis can also use decision trees which can be used to validate decisions based on the data in the following table.

http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 11, No 02 September 2022
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)

Table 3. Decision Model

Alternative	Favorable	Unfavorable
Hire 6 staffs	42,000	55,000
Outsource 6 staffs	34,500	58,000
Do nothing	53,000	65,400

Source: Processed by Researchers, 2022

A. Decision Making Under Uncertainty

In decision making that involves risk, the decision maker is aware of the potential results and the likelihood of risks materializing. Uncertainty refers to scenarios in which this information is barely available. Therefore, uncertain decision making is actually decision making without all the information about the potential risks (Janse, B., 2021).

Decision making using the Decision Making Under Uncertainty method is based on a better value of rewards than other options in terms of decision making and is determined based on the amount of profit (maximize) or cost reduction (minimize).

The criteria that need to be met in making decisions with Decision Making Under Uncertainty are as follows:

1. Optimistic
2. Pessimistic
3. Criterion of realism (Hurwicz)
4. Equally likely (Laplace)
5. Minimax regret

Comparing conflicting sets of criteria will help decision maker carefully consider each criterion to fully control the outcomes and consequences of a decision. The removal or reduction of risks is, therefore, an important core task for management (Janse, B., 2021). When making comprehensive or important decisions, multiple criteria and levels of scale need to be accounted for to make things clear and firm.

1. Optimistic

Optimistic criteria for minimizing cost is Minimin, which is the lowest cost for each alternative considered and the alternative with the lowest best (minimum). In the case of PT XYZ, it can be seen in the table below that the optimistic choice (Minimin) is the second alternative "Outsource 6 staffs" with the lowest value of Rp. 34.500 which means the lowest cost compared to other alternatives.

Table 4. Optimistic Criteria

Alternative	Favorable	Unfavorable	Minimin
Hire 6 staffs	42,000	55,000	42,000
Outsource 6 staffs	34,500	58,000	**34,500**
Do nothing	53,000	65,400	53,000

Source: Processed by Researchers, 2022

2. Pessimistic

The pessimistic criterion for minimizing cost is Minimax, which is the worst minimum cost for each alternative considered and the alternative with the highest (maximum). In the case of PT XYZ, it can be seen in the table below that the pessimistic choice (Minimax) is the first

alternative "Hire 6 staffs" with the lowest value of Rp. 55.000 which means the lowest cost compared to other alternatives.

Table 5. Pessimistic Criteria

Alternative	Favorable	Unfavorable	Minimax
Hire 6 staffs	42,000	55,000	**55,000**
Outsource 6 staffs	34,500	58,000	58,000
Do nothing	53,000	65,400	65,400

Source: Processed by Researchers, 2022

3. Criterion of realism (Hurwicz)

The realism criterion (Hurwicz) is the agreement between the optimistic and pessimistic decisions of the available alternatives using the realism coefficient that has been defined in α. These criteria make it possible to make decisions based on a personal approach in terms of relative optimism and pessimism. In this case, PT XYZ sets α = 0.80 and the best result with the lowest cost is the second alternative "Outsource 6 staffs" with a realism value of Rp. 39,200.

Table 6. Criterion of Realism

Alternative	Favorable	Unfavorable	Weighted Average (α=0.8)
Hire 6 staffs	42,000	55,000	44,600
Outsource 6 staffs	34,500	58,000	**39,200 (Realism)**
Do nothing	53,000	65,400	55,480

Source: Processed by Researchers, 2022

The following is a calculation for each alternative with the formula:
Weighted average = α(min) + (1 - α) (max)
(0.8) (42,000) + (1-0.8) (55,000) = 44,600
(0.8) (34,500) + (1-0.8) (58,000) = 39,200
(0.8) (53,000) + (1-0.8) (65,400) = 55,480

4. Equally likely (Laplace)

The equal likelihood criterion (Laplace) is a decision criterion considering the average result for each alternative and choosing the best or lowest average. In the case of PT XYZ, as can be seen in the table below, the alternative with the lowest average result is "Outsource 6 staffs" with a row average value of Rp. 46,250.

Table 7. Laplace Criteria

Alternative	Favorable	Unfavorable	Row Average
Hire 6 staffs	42,000	55,000	48,500
Outsource 6 staffs	34,500	58,000	**46,250 (Equally Likely)**
Do nothing	53,000	65,400	59,200

Source: Processed by Researchers, 2022

The following is a calculation for each alternative with the formula:

Row average = (Favorable + Unfavorable) / 2
Hire 6 staffs = (42,000 + 55,000) / 2 = 48,500
Outsource 6 staffs = (34,500 +58,000) / 2 = 46,250
Do nothing = (53,000 + 65,400) / 2 = 59,200

5. Minimax Regret

The opportunity loss criterion or regret is a decision criterion that refers to the difference between the best lowest cost and the optimum result. In the case of PT XYZ, it is necessary to make an opportunity loss table first by reducing each alternative and both states of nature with the lowest cost value. The table below is the result of the calculation.

Table 8. Opportunity Loss

State of Nature	
Favorable	Unfavorable
42,000 – 34,500	55,000 – 55,000
34,500 – 34,500	58,000 – 55,000
53,000 – 34,500	65,400 – 55,000

Source: Processed by Researchers, 2022

From the results of reducing the opportunity loss in the table above, it will be found that the alternative part that does not have the optimum cost will be 0 as in the Unfavorable state of nature "Hire 6 staffs" and "Outsource 6 staffs" in the Favorable state of nature, as shown in the table below.

Table 9. Minimax Regret Criteria

Alternative	Favorable	Unfavorable	Maximum Regret
Hire 6 staffs	7,500	0	7,500
Outsource 6 staffs	0	3,000	**3,000 (minimax regret)**
Do nothing	18,500	10,400	18,500

Source: Processed by Researchers, 2022

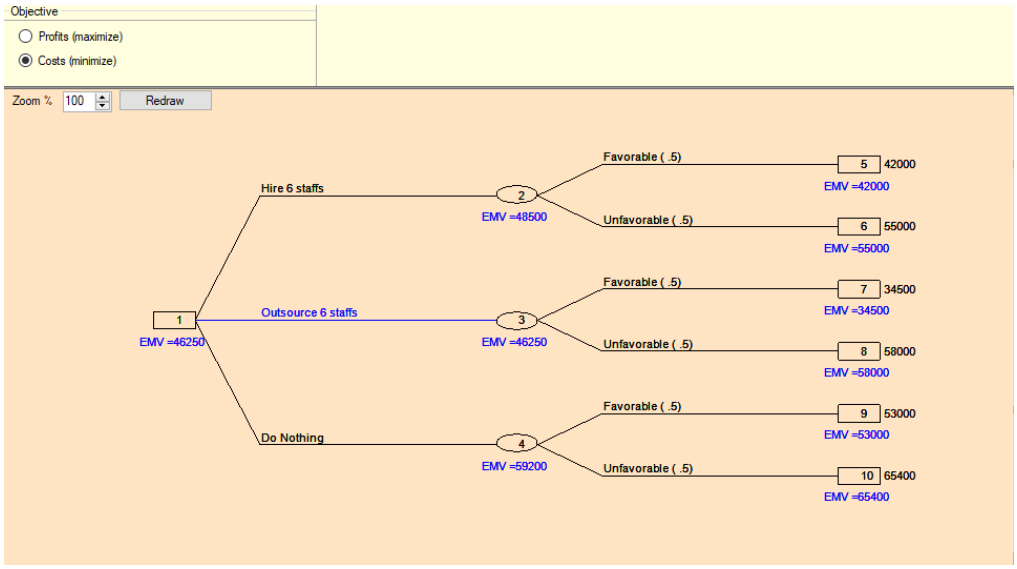
Minimax regret option is the second alternative option “Outsource 6 staffs”. When this alternative is selected, the maximum opportunity loss is not more than Rp. 3,000 which is the best lowest cost option.

B. Decision Trees

A Decision Tree Analysis is a scientific model and is often used in the decision making process of organizations. When making a decision, the management already envisages alternative ideas and solutions. By using a decision tree, the alternative solutions and possible choices are illustrated graphically as a result of which it becomes easier to make a well-informed choice (Mulder, P. 2017)

Decision making with Decision Analysis can also use Decision Trees to see the available alternatives in a more comprehensive and comprehensive manner with the main benefit of being able to know the sequence of the decisions made. In the case of PT XYZ, as in Table 3 of the previous Decision Model, three alternatives can be determined for the purpose of adding Call Center staff with the aim of minimizing costs.

http://ejournal.seaninstitute.or.id/index.php/Ekonomi
Jurnal Ekonomi, Volume 11, No 02 September 2022
ISSN: 2301-6280 (print) ISSN: 2721-9879 (online)



Picture 1. Decision Trees Result

From the results of the Decision Trees above, it can be concluded that the suggested alternative is "Outsource 6 staffs" with an expected value of Rp. 46,250 which shows the best value with the lowest cost compared to the expected value for "Hire 6 staffs" of Rp. 48,500 and Do Nothing with an expected value of Rp. 59,200. From this choice, it can also be concluded that the most appropriate decision for PT XYZ should be to increase the number of 6 Hospital Call Center staff through outsourcing. The same results are also reflected in the previous Decision Analysis calculations so that it can be ensured that the decision choices made are correct.

CONCLUSION

According to the summary of the output and each analysis result, it shows for Call Center Staffing using several analyses are feasible to conduct. Optimize the worker's schedule, reduce abandoned calls from each hospital branch, and decisions making to outsource the additional staff as part of management decision to centralize the Call Center.

Suggestion for future study, because this research was conducted during the transition of management post-acquisition of PT XYZ, there will be several changes and decisions from the group holdings. The performance result of implementation needs to be measured again to make sure the consistency of conducted analysis. Another suggestion due to the limitation of selected models and datasets, the probability methods could be applied to a different part of the organization. For example, EVPI in the decision analysis of this study can be conducted again to be more precise to ensure the decision making is the best option according to earned information, in this case from the stakeholders or investors.

REFERENCES

[1] Albright, S. C., & Winston, W.L. (2015). Business Analytics: Data Analysis and Decision Making, 5th ed. Chapter 6, Chapter 13.
[2] Avramidis, A. N., Chan, W., Gendreau, M., L'Ecuyer, P., & Pisacane, O. (2010). Optimizing Daily Agent Scheduling in a multiskill call center. European Journal of Operational Research, 200(3), 822–832. https://doi.org/10.1016/j.ejor.2009.01.042
[3] Bergh, K. V. D., 2006. Predicting Call Arrivals in Call Centers. Amsterdam: Vrije Universiteit.
[4] Dahleh, M. A., & Diaz-Bobillo, I. J. (1995). Control of uncertain systems: a linear programming approach. Englewood Cliffs: Prentice Hall.

[5] J. B. Strother (2014). "Call Centers in Health Care: Effect on Patient Satisfaction", Florida Institute of Technology.
[6] Janse, B. (2021). Decision Making Under Uncertainty. Retrieved [February 5th, 2022] from toolshero: https://www.toolshero.com/decision-making/decision-making-under-uncertainty/
[7] J. W. Kenagy, D. M. Berwick, M. S. Shore, "Service quality in health care," Journal of the American Medical Association, vol. 281, no. 7, pp. 661-665, 1999.
[8] Kasubaski, Jaclyn S. (2020). U.S. Call Center Outsourcing Strategy. University of Wisconsin-Platteville, Seminar Paper: Organizational Change Leadership. http://digital.library.wisc.edu/1793/81136
[9] Koole, G. (2004). Performance analysis and optimization in Customer Contact Centers. First International Conference on the Quantitative Evaluation of Systems, 2004. QEST 2004. Proceedings. https://doi.org/10.1109/qest.2004.1348010
[10] Koole, G. (2013). Call Center Optimization. Amsterdam: MG Books. [11] Rohmah, S., & Khuzaini, K. (2015). Pengaruh Citra Merek, Kualitas Produk, Dan Layanan Terhadap Keputusan Pembelian Produk Perhiasan. Jurnal Ilmu dan Riset Manajemen (JIRM), 4(5).
[12] Mulder, P. (2017). Decision Tree Analysis. Retrieved [February 6th, 2022] from toolshero: https://www.toolshero.com/decision-making/decision-tree-analysis/
[13] Render, B., Stair, R.M., Jr., Hanna, M.E., & Hale, T.S. (2018). *Quantitative Analysis for Management,* 13th ed. Chapter 7, Chapter 8, Chapter 9.
[14] Vuthipadadon, Somchan (2009). Scheduling inbound calls in call centers. Iowa State University. https://doi.org/10.31274/etd-180810-843.
[15] Zhao, Yanli (2015). Modeling And Optimization of Non-Profit Hospital Call Centers With Service Blending. Wayne State University Dissertation. Paper 1179.