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RESEARCH ARTICLE

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Assessing health facility performance in Indonesia using the Pabón-Lasso model and unit cost analysis of health services

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Summary

Total health care costs have dramatically increased in Indonesia, and health facilities consume the largest share of health resources. This study aims to provide a better understanding of the characteristics of the best-performing health facilities. We use 4 national Indonesian datasets for 2011 and analysed 200 hospitals and 95 health centres. We first apply the Pabón-Lasso model to assess the relative performance of health facilities in terms of bed occupancy rate and the number of admissions per bed; the model gathers together health facilities into 4 sectors representing different levels of productivity. We then use a step-down costing method to estimate the cost per outpatient visit, inpatient, and bed days in hospitals and health centres. We combined both ratio analysis and applied bivariate and multivariate analyses to identify the predictors of the best-performing health facility; 37% of hospitals and 33% of health centres were located in the high-performing sector of the Pabón-Lasso model. The wide variation in unit costs across health facilities presented a basis for benchmarking and identifying relatively efficient units. Combining the unit cost analysis and Pabón-Lasso model, we find that health facility performance is affected by both internal (size and capacity, financing, type of patients, ownership, accreditation status, and staff availability) and external factors (economic status, population education level, location, and population density). Our study demonstrates that it is feasible to identify the best-performing health facilities and provides information about how to improve efficiency using simplistic methods.

KEYWORDS

costs, efficiency, health facilities, Pabón-Lasso model, performance

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1 | INTRODUCTION

In Indonesia, as in other parts of the world, escalating health care costs have increased interest in improving efficiency in resource use.[1] Between 1999 and 2013, gross domestic product per capita in Indonesia grew by 6% annually while health expenditures have grown by 15% annually.[2,3] Compared with other lower- to middle-income countries, Indonesia has a higher total health expenditure per capita but lower performance in terms of indicators such as mortality and vaccination coverage.[3-6]

Inefficient health facilities have contributed to rising health care costs.[7] Health facilities, especially hospitals, represent the largest share of health care spending; Indonesian hospitals account for 55% of total health[6,8] (Figure 1). Between 2005 and 2014, the share of hospitals' expenditures increased by 22 percentage points, but performance did not improve. The average hospital bed occupancy rate (total number of inpatient days in a year over the number of beds) is just over 60%, which is lower than the recommended occupancy levels of 85% to 90%.[6,8-12] The average contact rate in public primary care (Puskesmas) is just above 1 visit per person per year, which is low compared with other countries in Asia, such as Malaysia (3.5), Vietnam (2.3), and Thailand (2.1).[13-15] The suboptimal health care utilisation indicates inefficient health facility services.[16]

There are 2 main types of health facilities in Indonesia: hospitals and primary care. As of 2016, there are 2032 hospitals in Indonesia, 56% of which are privately owned. Indonesia Ministry of Health categorises hospitals into 4 classes (A to D) based on their size and capacity[17,18]: class A hospitals are the largest hospitals, mainly for national referrals (3%), followed by class B (13%), class C (33%), and class D (23%).[17] The main distinction between the classes of hospitals is the capacity of services. For example, class A hospitals have a minimum of 37 doctors per hospital, while class D hospitals have a minimum of 6 doctors per hospital.[19]

At primary care level, public-owned primary care facility, namely, Puskesmas provide basic curative and preventive health care services. Puskesmas exist mainly at the subdistrict level with a network of Puskesmas satellites in villages.[20,21] Puskesmas can be categorised on the basis of their location: urban, rural, and remote area, and availability of inpatient services.[21] There are 9705 Puskesmas across the country, and around 35% have inpatient services.[20] Puskesmas are regulated to have a minimum of 1 doctor per Puskesmas without inpatient services and 2 doctors per Puskesmas with inpatient services.[21]

Indonesia is a diverse archipelago made up of 13 466 islands with 34 provinces and 514 districts/municipalities.[22,23] Indonesia is the fourth most populous country, with a population of 252 million in 2014, 60% of which live on Java island.[24] Indonesia's health indicators statistics vary across the country. For example, life expectancy at birth in Yogyakarta province is 74 years, but it is 11 years lower in Nusa Tenggara Barat province.[25] Similarly, while the infant mortality rate in Jakarta province is 22 per 1000 live births, it is 74 per 1000 live births in West Papua

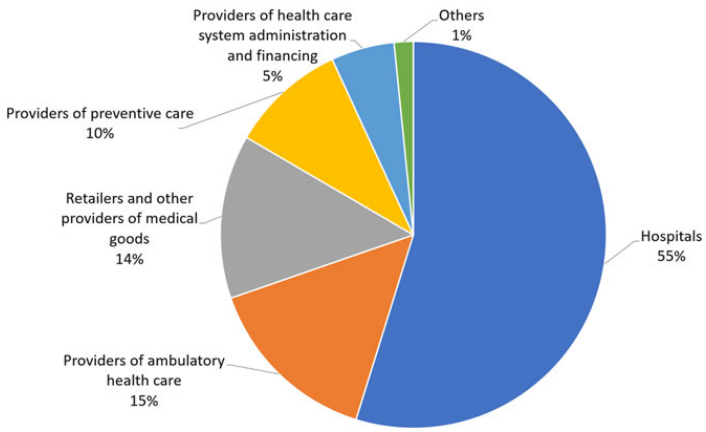

FIGURE 1 Health expenditure by providers in Indonesia, 2014. Source: CHEPS, PPJK, and AIPHSS[8]

province.[25] These large variations in performance illustrate the country's heterogeneity and suggest that there may be lessons to learn from better-performing health facilities. The purpose of this study is to identify the contextual factors that lead to improved efficiency.

This study's findings can assist health facility managers and policy makers to control and assess performance. Bitran[26] categorised 2 types of ratio analysis of efficiency: technical (physical input to output ratios) and economic (cost of inputs to output ratios). Facilities often use simple ratios (eg, bed occupancy rate, number of admissions per bed) to evaluate health facility technical efficiency. Lasso[27] suggests using bed occupancy rate, bed turnover rate, and average length of stay simultaneously to provide a better picture of health facility performance. Also, comparing performance indicators using economic ratio of health facilities can help assess efficiency.[28-31] Accounting methods are appropriate to measure economic efficiency to explain the variance in average costs of services within a period.[32] A health facility with a relatively "high" unit cost may indicate inefficiency, providing valuable information for policy decisions at the facility, local, and central government levels.[28,33] We combined both ratio analyses to identify the best-performing health facility and explored factors underlying the relative performance.

While some studies report on the cost of providing health services in health facilities,[34-36] to the best of our knowledge, there is only 1 costing study examining primary care in Indonesia to assess the relative efficiency of health facilities.[37] One Indonesian study uses a Pabón-Lasso model to assess hospital performance and identifies strategies to improve efficiency.[38] However, these methods have never been used to analyse the contextual factors of health facilities. Using a national dataset of health care facilities across Indonesia, this study measures efficiency in health facilities in a developing country and extends the use of 2 relative efficiency measurements via a joint application.

2 | MATERIALS AND METHODS

2.1 | Data

This study assesses the determinants of productivity in health facilities by analysing data from 4 different sources. First, we used data from a health facility costing study that used a survey performed by Indonesia's Ministry of Health (MoH) between October 2010 and September 2011. The survey collected data on the services, resources (eg, infrastructure, equipment, staff, pharmaceuticals, and medical supplies), and expenditures (eg, office supplies, maintenance, and transport expenses) for 234 Puskesmas (3%), 122 public hospitals (17%), and 78 private hospitals (17%). We used the data to estimate the relative efficiency of health facilities and identify internal factors determining efficiency. Second, we used data from the 2011 Indonesia case base groups (INA-CBGs); this is the hospital payment mechanism used by the health insurance scheme for the poor. It contains patient-level information related to patient demographics, diagnosis, and reimbursement tariffs. This study uses reimbursement tariffs for diagnosis to consider the variation in patients' severity and estimate the expected in-hospital death rate. Third, we used data from the 2011 National Socioeconomic Survey (SUSENAS), a district representative sample that collected household socioeconomic information. In this work, we mainly focus on district household characteristics such as education, health insurance coverage, and household expenditures. Fourth, we used village potential statistics (PODES), which was a census providing information about village characteristics across Indonesia such population size, main source of family income, availability of and access to health facilities, and death rate. We identify geographic and infrastructure characteristics, including the availability of health care services.

We used hospital identifiers to merge health facility costing study dataset and INA-CBGs dataset. We merged SUSENAS dataset using districts identifier both for hospitals and Puskesmas. PODES datasets were merged using district identifier for hospitals, and subdistrict identifier for Puskesmas. Our merged dataset from these 4 sources comprises 89 variables for 200 hospitals, and 65 variables for 95 Puskesmas. See Table S1 for the list of variables, their descriptions, their nature, and a report of data missing for each variable. There was no multiple imputation for missing value.

2.2 | Ethical review

A quantitative secondary analysis study does not require ethical review. Datasets are anonymised and publicly available, and permission to use them has been obtained from the Indonesia Ministry of Health and Statistics Indonesia.

2.3 | Pabón-Lasso model analysis

Lasso[27] developed a graphical technique, plotting the health facilities in the 4 sectors using combination of efficiency indicators. There are 3 main indicators: (1) average bed occupancy rate, which is represented on the horizontal axis and measures the percentage of time an average bed was occupied in the year; (2) average bed turnover rate, which is represented on the vertical axis and measures the average annual number of discharges per bed in the year; and (3) average length of stay, which is represented by the gradient of a straight line from the origin to the observation and measures the average duration of inpatient admissions.[27] We applied the Pabón-Lasso model to assess health facility productivity by plotting 2 indicators: the number of admissions per bed and the bed occupancy rate. These indicators divide the figure into 4 sectors representing different levels of productivity (Figure 2): health facilities in sector I (lower left) have low throughput (number of admission per bed) of patients and long periods where beds are empty; health facilities in sector II (upper left) treat a large number of patients per bed but have long periods when beds are unoccupied; health facilities in sector III (upper right) treat patients with high throughput and high occupancy; and health facilities in sector IV have beds with low throughput and patients stay in health facilities longer. We excluded the 139 Puskesmas without bed because they do not provide inpatient services. Instead of showing the average length of stay line in the figure, we applied the Pabón-Lasso model to examine the contextual variation across providers' settings (eg, bed size, ownership, and location).

2.4 | Costing method

We estimated the total costs and unit cost of hospitals and Puskesmas. Unit costs refer to the average cost of providing a single service. To estimate unit cost, step-down and bottom-up approaches are equally valid.[39] The selection of the appropriate method frequently relies on aggregation level of data.[40] Bottom-up approach requires more detailed data such as patient-level data, which is not feasible for this study.[40] Therefore, we used step-down approach as a common technique to calculate unit cost and offer an optimal balance between accuracy and practicality.[29,39] We allocated overhead cost to intermediate and final cost centres (eg, outpatient visits and inpatient admissions) to calculate cost per outpatient visit, cost per inpatient admission, and cost per bed day.[29,39]

The first step was cost centre classification. There were 2 final cost centres and several supportive cost centres. The final cost centres are the inpatient and outpatient departments, while supportive cost centres provide support for patient care, including administration, nonclinical support (eg, kitchen, transport, laundry), and clinical support (eg, radiology, pharmacy, operating theatre).

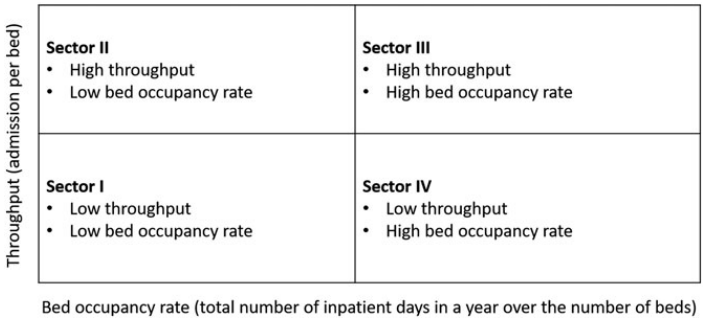

FIGURE 2 Pabón-Lasso model

The direct costs, including staffing, materials, and capital were allocated to each cost centre. Staffing costs reflect individuals' basic salary and financial incentives such as insurance and family allowances. Materials including medical supplies and drugs were valued using the Indonesia Monthly Index of Medical Specialities database. This study included building, vehicles, equipment, and furniture as capital costs, except the cost of land. We used an economic approach to estimate capital costs, covering both depreciation and the opportunity cost of investing.[41] The health facility costing study dataset collected information about buildings' value per square metre to obtain the annualised value of buildings. Capital costs were annualised using a 3% discount rate, as recommended by the WHO.[42] Since the life span of equipment and capital assets were not available in Indonesia, we estimated it using the American Hospital Association's depreciable hospital assets guidelines because it provides complete and detailed information on each item.[43] The life span of equipment varied between 1 to 20 years and 8.7 years on average.

We also allocated the direct cost of supportive cost centres to the final cost centres. Table 1 summarises the detailed criteria used to allocate these costs. All final cost centres were divided by the total number of outpatient visits or inpatient admissions to calculate the unit cost of services. We used the 2011 exchange rate to convert the Indonesian rupiah (IDR) into US dollars (USD) (1 USD = 8733.44 IDR).[44]

2.5 | Analyses of characteristics

Our objective was to analyse the relationship between each contextual factors with the best-performing health facilities in hospitals and Puskesmas. To do this, we performed 3-stage analyses. First, we used ratio analyses to identify the high-performing health facilities. High-performing health facilities have low unit costs (below the median) and are located in the high utilisation sector in the Pabón-Lasso model (sector III). Thus, the main outcome of our analysis is a binary variable taking a value 1 if the health facility is high performing, and 0 otherwise.

Second, we quantified the relationship between performance and various explanatory factors using logistic regression. Factors exhibiting an acceptable significance level (*P* value <.25) in the bivariate analysis were included in the multivariable logistic regression analyses to determine their independent contribution to the factors of health facility performance.[45] Third, in these multivariate analyses, we performed forward-stepwise selection: we included variables one by one in the model and used as criteria for inclusion a *P* value <.05, this yielded a reduced final model. Checks for multicollinearity were also performed. A variance inflation factor >10 was used to denote significant multicollinearity. We used the area under the curve of receiver operating characteristic (ROC) to estimate the ability of models to discriminate between high- and other-performing health facility. Cost computations, Pabón-Lasso diagram construction, and characteristics analyses were performed using STATA 14 (Stata-Corp, College Station, Texas).

TABLE 1 Allocation base criteria

Cost Item	Allocation Base
Administration	Floor area
Maintenance	Estimated actual cost
Office expenses	Estimated actual cost
Transport expenses	Estimated actual cost
Fixed capital cost	Floor area
Equipment	Estimated actual cost
Staff cost	Time
Food and linen	Number of beds
Drug and medical supplies	Proportion of drug value from patients survey from each department

3 | RESULTS

3.1 | Health facilities characteristics

Table 2 presents the characteristics and activities of health facilities. On average, hospitals received 81 873 outpatient visits and admitted 8984 inpatients visits. This output was produced using an average of 42 doctors, 155 nurses, 153 support staff, and 159 beds per hospital. Puskesmas, including their village satellites, produced on average 22 372 outpatient visits and 591 admissions. Puskesmas produced these outputs using 3 doctors, 29 nurses and midwives, 17 support staff, and 10 beds on average. There was a wide variation in the number of medical staff in hospitals and Puskesmas. The nurse-to-doctor ratio at hospital was 4:1 and 10:1 in Puskesmas.

3.2 | Pabón-Lasso model

3.2.1 | Hospital

Figure 3 represents the Pabón-Lasso model of hospitals; the vertical and horizontal lines represent the mean values of the bed occupancy rate and admissions per bed; it appears that 37% of hospitals are in the high utilisation sector of the Pabón-Lasso model (sector III) and 37% appear in the low utilisation sector (sector I). The Pabón-Lasso model shows that private hospitals and those with fewer beds tend to be in the low utilisation sector compared with public and larger hospitals. Hospitals in the high utilisation sector have specific characteristics compared with the low utilisation sectors: they had more full-time–equivalent nonspecialist medical doctor, treated patients with insurance for either civil servants or the poor, and were located in Java or Bali Island.

3.2.2 | Puskesmas

Figure 4 represents the Pabón-Lasso model of Puskesmas; 33% of Puskesmas with inpatient services are located in the high utilisation sector of the Pabón-Lasso Model (sector III), while 54% are located in the low utilisation sector (sector I). We find no significant difference in the number of beds and location on the Pabón-Lasso Model. However, Puskesmas in low utilisation sector face significantly more water disruptions compared with Puskesmas in the high utilisation sector.

TABLE 2 Characteristics and activities of health facilities

Characteristics or Statistics	Hospitals n =200		Public Hospitals n =122		Private Hospitals n =78		Puskesmas n =234		Puskesmas with Inpatient Services n =95		Puskesmas without Inpatient Services n =139	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Number of doctors	42	(40)	44	(46)	39	(27)	3	(4)	4	(4)	2	(3)
Number of nurses and midwives	155	(147)	184	(168)	111	(90)	29	(42)	37	(47)	24	(29)
Number of support staff	153	(146)	167	(149)	131	(139)	17	(21)	19	(24)	17	(19)
Number of beds	159	(123)	187	(139)	115	(76)	10	(5)	10	(5)	NA	(NA)
Number of outpatient visits (in thousands)	82	(127)	98	(132)	56	(114)	22	(16)	22	(17)	23	(15)
Number of admissions	8984	(6941)	10 784	(7630)	6177	(4470)	591	(493)	591	(493)	NA	(NA)
Number of inpatient days (in thousands)	36	(33)	43	(38)	23	(20)	1	(1)	1	(1)	NA	(NA)
Bed-occupancy rate	60%	(31%)	63%	(35%)	54%	(22%)	30%	(25%)	30%	(25%)	NA	(NA)

"NA" means not applicable.

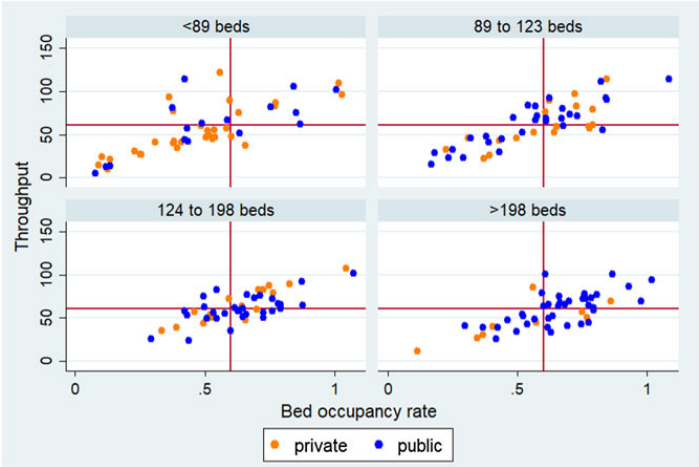

FIGURE 3 Pabón-Lasso model of hospital by ownership and bed size. Note that 2 outlier observations are excluded from the figure for reader-friendly purposes

FIGURE 4 Pabón-Lasso model of Puskesmas by location and bed size. Note that 2 outlier observations are excluded from the figure for reader-friendly purposes

3.3 | Total cost

Figure 5 represents the cost structure of health facilities. From our sample, health care provision in hospitals and Puskesmas cost 3.8 million USD (median 2.9 million USD) and 205 000 USD (median 189 000 USD) on average per year, respectively. The total costs of a class A hospital were more than 11 times that of a class D hospital. Cost structures varied by health facility. Staffing costs, including both salaries and incentives, were the largest components of total costs in all types of facilities. Private hospitals had the lowest proportion of staff costs (35%) and Puskesmas without inpatient services had the highest (57%).

Material costs, including pharmaceuticals and medical supplies also consumed a significant share of total costs, ranging from 24% in Puskesmas without inpatient services to 39% in private hospitals. Capital costs accounted for around 14% for hospitals and 19% for Puskesmas. There was no specific pattern in total cost structures based on hospital size, although Puskesmas with and without inpatient services had similar cost structures.

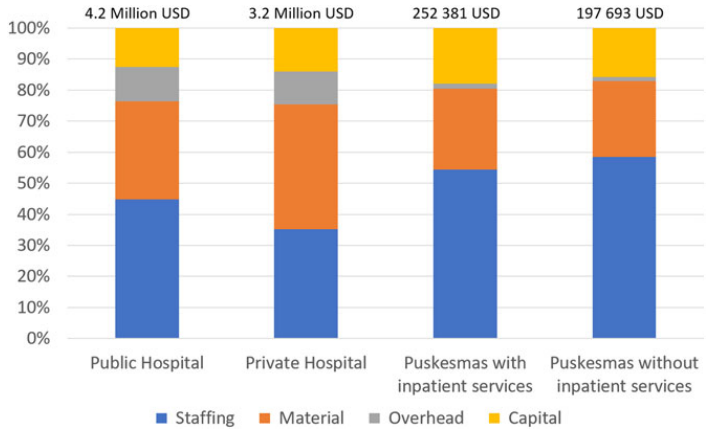

FIGURE 5 Total cost structure by health facility type

3.4 | Health care unit costs

3.4.1 | Hospitals

The average unit cost per patients in hospitals for outpatient, inpatient, and bed days were 44 USD, 299 USD, and 82 USD, respectively (Table 3). The unit costs were positively skewed; thus, the associated medians of unit costs were lower: 24 USD, 248 USD, and 68 USD for outpatient, inpatient, and bed days, respectively. There are important variations in the unit costs of services according to hospital ownership. Private hospitals had statistically significant higher unit costs than public hospitals. In particular, the costs of outpatient services were almost double and inpatient and bed days services 1.2 times higher.

Hospital size also affected unit costs. Large hospitals, such as class A or B hospitals, had lower outpatient and bed days unit costs compared with class C or D hospitals. Class B hospitals had statistically significant lower unit costs compared with class C or D hospitals. Given the small sample size of class A hospitals, unit costs showed a wide range. We therefore categorised hospital size into 3 groups proxied by number of beds[27,46]: small hospitals (with less than 100 beds), medium hospitals (between 100 and 199 beds), and large hospitals (more than 200 beds). Large hospitals had a statistically significantly lower outpatient unit cost than medium and small hospitals. Small hospitals had higher inpatient and bed days unit costs, but this was not statistically significant. The difference in casemix unit cost showed that almost all types of hospitals treated patients with less severe cases (showed in negative values). However, we found class A public hospital and private hospitals treated more severe patients compared with the other types of hospitals.

3.4.2 | Puskesmas

The average unit cost per patient in Puskesmas for outpatients, inpatients, and bed days were 12 USD, 158 USD, and 99 USD, respectively. Unit costs were positively skewed, so the associated medians of unit costs were lower: 8 USD, 133 USD, and 75 USD for outpatient, inpatient, and bed days, respectively (Table 4). The availability of services, such as basic emergency obstetric and newborn care (BEmONC), emergency services, and evening hours did not have a significant impact on unit costs. The size of Puskesmas, proxied by number of beds, was found to be negatively correlated with their unit costs: larger Puskesmas (those with more than 12 beds) had lower unit costs compared with small Puskesmas (less than 7 beds).

3.5 | Characteristics of high-performing health facilities

We examined institutions' characteristics by comparing the contextual factors of the high- and other-performing health facilities (Table 5).

TABLE 3 Unit cost per hospital patient by type of health facility

Unit Cost of Services		n	OP[a]	(95% CI) IQR	IP[b]	(95% CI) IQR	Bed Days	(95% CI) IQR	Delta Casemix Unit Cost[c] OP	IP	Bed Days
Hospital	Mean	200	44	(34-51)	299	(266-321)	82	(73-89)	−4	−19	−5
	Median		24	16-39	248	162-363	68	48-101	−3	−20	−4
Ownership											
Public hospital	Mean	122	33	(24-39)	276	(238-307)	74	(65-83)	−3	−26	−7
	Median		20	14-32	230	159-319	61	41-94	−3	−21	−5
Private hospital	Mean	78	62	(42-81)	335	(281-374)	95	(79-107)	−5	16	6
	Median		31	22-57	261	188-420	77	57-113	−5	0	4
Hospital class											
Hospital class A	Mean	2	18	(−35-71)	331	(−1221-1883)	52	(−186-290)	5	140	22
	Median		18	13-22	331	209-453	52	33-71	5	140	22
Hospital class B	Mean	52	23	(17-27)	282	(220-312)	69	(55-76)	0	−1	−0
	Median		18	12-24	230	148-380	60	41-82	−1	−7	−1
Hospital class C	Mean	101	51	(35-64)	324	(273-367)	90	(77-104)	−6	−36	−9
	Median		25	18-45	253	176-381	73	50-110	−4	−34	−7
Hospital class D	Mean	44	50	(30-70)	267	(225-310)	80	(67-92)	−5	−34	−7
	Median		29	19-56	248	156-351	69	52-101	−6	−34	−5
Hospital size											
Small hospital (<100 beds)	Mean	49	70	(46-91)	315	(258-374)	91	(77-109)	−13	−14	−5
	Median		33	24-72	247	158-396	71	53-119	−7	−16	−4
Medium hospital (100-199 beds)	Mean	51	38	(26-47)	303	(251-334)	83	(70-92)	−2	−35	−8
	Median		23	15-39	256	175-351	73	50-104	−3	−30	−6
Large hospital (>200 beds)	Mean	50	21	(17-24)	273	(222-312)	68	(55-78)	−0	−1	−1
	Median		18	14-23	227	159-363	58	41-77	−1	−10	−3

[a]Outpatient.

[b]Inpatient.

[c]Delta mean of casemix unit cost is a difference between unit cost adjusted by casemix and nonadjusted unit cost.

IQR, interquartile range

3.5.1 | Hospital

On the basis of bivariate analysis, 28 high-performing hospitals had specific characteristics compared with 172 other-performing hospitals: they were predominantly larger, more likely to publicly owned, and higher full-time–equivalent nonspecialist medical doctors. Hospitals in high-performing sectors treated more elderly patients and who were part of the insurance scheme for the poor. In terms of quality, hospitals accredited by the Indonesian hospital accreditation commission performed better, but faced higher death rate. Regarding external factors, hospitals in Java or Bali islands with easy access to health facilities were relatively more efficient compared with hospitals on other islands. High-performing hospitals were generally located in deprived areas where a high proportion of the population is poor, a low proportion of the population with secondary school education, and low household expenditures (Table S2).

We found that ownership, accreditation status, class of hospitals, elderly patients, and the proportion of poor population were independent predictors of best-performing hospitals in multivariate analysis and included in different models (Table 6). Public-owned hospitals and hospitals that are accredited were the predictors of model 1. Either public-owned hospitals or accredited hospitals have 3 times higher odds of being best-performing hospitals compared with other. In model 2, class A or B hospitals have 4 times higher odds of being best-performing hospitals compared with other-performing hospitals. For every additional 10% of poor population, a hospital's odds of best-performing hospitals go up by 128%. Compared with model 1, model 2 increased the ROC area from 0.695 to 0.712. In model 3, we included class of hospitals, ownership, and proportion of patients over 65 years old. Class A or B hospitals have

TABLE 4 Unit cost per Puskesmas patient by type of health facility

Unit cost of services		n	OP[a]	(95% CI) IQR	IP[b]	(95% CI) IQR	Bed days	(95% CI) IQR
Puskesmas	Mean	91	12	(10-13)	161	(109-163)	100	(62-105)
	Median		10	6-15	135	71-153	75	29-90
BEmONC[c] services								
Puskesmas with BEmONC[c]	Mean	48	12	(10-14)	175	(116-184)	107	(63-119)
	Median		10	6-15	140	84-181	78	42-90
Puskesmas without BEmONC[c]	Mean	32	15	(8-17)	135	(71-139)	85	(41-88)
	Median		12	10-14	175	116-184	107	63-119
Emergency services								
Puskesmas with emergency services	Mean	66	12	(9-13)	164	(108-162)	101	(60-103)
	Median		10	6-15	141	73-152	76	32-88
Puskesmas without emergency services	Mean	12	19	(9-28)	132	(−83-348)	96	(1-190)
	Median		11	8-31	92	73-232	89	62-137
Evening services								
Puskesmas open at evening	Mean	37	11	(8-13)	194	(109-201)	124	(60-134)
	Median		10	6-15	145	75-190	80	34-103
Puskesmas do not open at evening	Mean	41	15	(10-18)	124	(91-135)	73	(50-82)
	Median		11	6-18	126	73-145	71	29-88
Puskesmas size								
Beds Q1 (<7 beds)	Mean	23	16	(9-19)	180	(47-213)	143	(14-170)
	Median		12	6-19	118	77-133	88	33-88
Beds Q2 (≥7 to <10 beds)	Mean	17	14	(9-19)	165	(110-192)	98	(58-116)
	Median		11	6-15	152	84-218	79	57-89
Beds Q3 (> = 10 to <12 beds)	Mean	26	12	(8-14)	183	(88-220)	114	(45-151)
	Median		9	6-16	129	64-181	66	34-114
Beds Q4 (>12 beds)	Mean	29	9	(6-10)	130	(77-147)	74	(39-87)
	Median		7	3-11	128	45-145	62	25-88
Puskesmas location								
Puskesmas in urban	Mean	11	8	(5-10)	255	(80-312)	165	(29-221)
	Median		8	4-10	163	84-181	63	35-126
Puskesmas in rural	Mean	52	13	(10-15)	144	(100-147)	88	(56-93)
	Median		10	6-16	133	71-148	75	28-89

[a]Outpatient.

[b]Inpatient.

[c]Basic emergency obstetric and newborn care.

almost 3 times higher odds of being best-performing hospitals compared with other. Public-owned hospitals have 4 times higher odds of being best-performing hospitals compared with others. Also, for every additional 10% of patient over 65 years old, a hospital's odds of best-performing hospitals go up by 68%. Compared with models 1 and 2, ROC area increased to 0.751.

3.5.2 | Puskesmas

The bivariate analysis suggests that the 12 high-performing Puskesmas had specific common characteristics compared with the 83 other-performing Puskesmas: high-performing Puskesmas slightly had more beds than other-performing Puskesmas less electricity disruption, had a mentoring with clinical staffs, and monitoring of working hours. Regarding external contextual factors, high-performing Puskesmas were generally in high density with large population coverage (Table S3).

TABLE 5 Characteristics of high-performing health facilities

Contextual Factor	Hospital	Puskesmas
Internal	• Higher FTE of nonspecialist medical doctor • Large-size hospital, (165 beds) • Class A or B hospital • Public owned • High number of years of service • High elderly patients • High patients with poor insurance scheme • Less patients without insurance scheme • Accredited hospital • Higher death rate	• Large-size of Puskesmas (12 beds) • Less electricity disruption • Mentoring with clinical staffs • Monitoring of working hours
External	• Low total household expenditure • High % of poor population • Low pharmacy expenditure • Low % of pop with secondary school • Easy access to hospitals • Located in Java or Bali island • Less civil servants and private insurance scheme pop coverage	• High density and large population coverage

FTE, Full-time equivalent

TABLE 6 Independent contribution of best-performing hospital characteristics according to multivariate analysis

Variables	Odds Ratio	(95% CI)	*P* Value	ROC Area of Model	(95% CI)
Model 1					
Public owned	3.47	(1.13-10.67)	.030	0.695	(0.63-0.76)
Accredited	3.17	(1.03-9.78)	.045		
Cons	0.03	(0.01-0.1)	.000		
Model 2					
Class A/B	4.29	(1.83-10.07)	.001	0.712	(0.64-0.77)
Poor population	2.18	(1.23-3.87)	.007		
Cons	0.05	(0.02-0.11)	.000		
Model 3					
Class A/B	2.74	(1.14-6.59)	.024	0.751	(0.69-0.81)
Public owned	4.11	(1.26-13.38)	.019		
Patient over 65	1.84	(1.08-3.13)	.025		
Cons	0.02	(0-0.07)	.000		

The multivariate analysis suggests 3 independent predictors of best-performing Puskesmas (Table 7). Puskesmas without electricity disruption, no technician vacancy, and had regular staff performance meeting have 13, 9, and 29 times higher odds of being best-performing Puskesmas compared with other. This model has moderate discriminatory power, with an ROC area of 0.78.

4 | DISCUSSION

The ratio analyses, unit cost analysis, and the Pabón-Lasso models are useful means to assess efficiency in health facilities.[27,28] To the best of our knowledge, this study is the first to use both methods, and as such it helps to draw more robust results.

TABLE 7 Independent contribution of best-performing Puskesmas characteristic according to multivariate analysis

Variable	Odds Ratio	(95% CI)	*P* Value	ROC Area of Model	(95% CI)
No electricity disruption	12.67	(2.02-79.53)	.007	0.778	(0.68-0.86)
Technician vacancy	0.11	(0.02-0.63)	.013		
Regular performance meeting	28.50	(1.27-638.89)	.035		
Cons	0.31	(0.11-0.85)	.023		

4.1 | Utilisation

Bed occupancy rate is a basic indicator to assess health facility performance, with an 80% to 90% occupancy rate taken to indicate high efficiency[12,47]; however, neither hospitals nor Puskesmas have achieved that target; the highest bed occupancy rate was 60% in Indonesian hospitals and 34% in Puskesmas. Somanathan et al[48] also found that the average occupancy rate for primary care in Sri Lanka was less than 50%. In addition, using the Pabón-Lasso model, we identified only a few facilities in the high utilisation sector. Similarly, previous studies showed that around 20% to 45% of facilities appear in the high-performance sector (III).[27,48-50] These results indicate excess bed capacity in health facilities given the current level of utilisation.

It is critical to find the optimum health facility size to avoid surplus inputs. We found that the size of hospitals and Puskesmas, proxied by number of beds, did affect efficiency. The most interesting finding using the Pabón-Lasso model was the pattern in health facility size in each sector: the best-performing health facilities were medium sized (between 94 and 205). Previous studies found that the most efficient hospitals have between 200 and 270 beds.[51]

4.2 | Variation in costs

In terms of costs, staffing was the largest component. Studies in developing countries suggest personnel costs account for between 41% and 74% of all costs across health facilities.[52,53,65] Chatterjee et al[46] also found that private hospitals in India had lower levels of staffing costs. The main reasons for the lower proportion of staffing in private hospitals is that they offer salary structures below the market rate, have more flexibility in using staff, and greater dependence on part-time contract staff.[13,47]

We found a wide variation in unit costs across facilities partly because of the different patterns of utilisation. This further supports the finding of high inpatient unit costs in primary care due to the low levels of output.[54] Somanathan et al[48] also found higher inpatient costs in large facilities because they treat complex cases; however, our results do not support this finding.

4.3 | Internal factors

Ownership is particularly important when examining efficiency, especially given the important differences in characteristics highlighted in Table 6. Although a recent review by Herrera et al[55] showed no conclusive results for whether public or private hospitals have better performance, we found that public hospitals were more frequently in the efficient category than private hospitals. There are several possible explanations for this result. Public hospitals usually have more resources such as staff, beds, and medical technologies, and thus, they can treat more patients compared with private hospitals.[48,55] Another explanation is that public hospitals have more room to reinvest their profits in capital, including high-tech medical equipment and training medical personnel, while private hospitals often pay higher salaries to recruit qualified personnel to pursue physician-attracting strategies.[55,56] A comparison between public and private hospitals showed that public hospitals were generally located in deprived areas and treated more patients with access to the insurance scheme for the poor. Thus, the insurance scheme for the poor reduces financial barriers to health care access and increases the levels of utilisation. In addition, the Indonesian insurance scheme for the poor uses the prospective payment mechanism and it gives health providers strong incentives to operate efficiently.[57]

Therefore, apart from protecting people who may face financial catastrophic health expenditures, universal health coverage affects health facility efficiency.

Health managers may argue that meeting a minimum quality standard requires higher costs. However, our study address service quality, and found health facilities that are accredited, with no electricity disruption, and less staff vacancy lead to high-performing facilities. Also, a study found that high utilisation was associated with better health outcomes.[58] To increase efficiency in health system level, Indonesia is facing challenges. In 2011, 18% of Puskesmas did not have any electricity, predominantly in eastern Indonesia; just above 40% of Puskesmas do not have technician staff; and almost half of hospitals in Indonesia had not been accredited.[59,60]

4.4 | External factors

Assessing health facilities based on geographical location is important for policy decisions, especially in a nation's distribution of health facilities.[61,62] As in Barnum and Kutzin,[28] we found that health facilities on Java Island were more efficient compared with those on other islands. The best-performing health facilities were efficient in areas with easy access to health facilities. These factors suggest that a better transport and health facility infrastructure is important to reduce physical barriers to health care access. Governments provide satellite Puskesmas in rural areas to bring health care closer to the population. However, large infrastructure investments in the Puskesmas network without adequate health workers lead to inefficiency.[63] Therefore, the system requires better resource allocation to gain efficiency in health facilities, for example, outreach activities, and providing maintenance in addition to suitable vehicles.[64]

4.5 | Limitations

This study has some limitations due to the nature of the data and methods used. First, we only included public primary care with inpatient services; thus, the results might not apply to primary care facilities without inpatient services. Second, at this stage, we analysed health facility characteristics using a simple method, ratio analysis based on utilisation to help clarify the relationship between variables. Third, lack of health outcome data such as death rates, cure rates, or readmissions meant that our analysis could not measure the quality of services and adjust the activity. In the future, research would be useful to identify whether inefficiency stems from using too many resources or treating patients inappropriately.

To mitigate these limitations, frontier techniques of efficiency measurement may help to identify inefficiency in multiple inputs and outputs. Future research could explore factors that cause inefficiency using regression analysis and propose a practical way to overcome these inefficiencies. We also suggest that the study should be replicated in private primary care and using longitudinal data, which would highlight changes in efficiency due to policy changes or interventions. In addition, longitudinal data would help address outlier data, and whether these are true outliers or simply measurement errors. However, this study shows that it is feasible to undertake national-level assessments with different types of health facilities using simple methods that are easy to use and replicate.

5 | CONCLUSION

This study suggests that there is considerable scope for improving the efficiency of health facilities in Indonesia. Few health facilities were located in the high utilisation sector of the Pabón-Lasso model and a wide variation in unit costs. The significant variation in unit costs and utilisation can present a powerful basis for benchmarking and identifying relatively efficient units. Our study not only identifies the best-performing health facilities and their specific characteristics but also provides information about how to improve efficiency. Benchmarking using unit cost analysis and the Pabón-Lasso model technique are valuable tools that policy makers can use and understand relatively easily in routine monitoring of health facility performance.

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