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Hafidz, F orcid.org/0000-0002-1787-4930, Ensor, TRA orcid.org/0000-0003-0279-9576 and Tubeuf, S orcid.org/0000-0001-9001-1157 (2018) Assessing health facility performance in Indonesia using the Pabón-Lasso model and unit cost analysis of health services. International Journal of Health Planning and Management, 33 (2). e541-e556. ISSN 0749-6753

https://doi.org/10.1002/hpm.2497

Full title: Assessing health facility performance in Indonesia using the Pabón-Lasso Model and unit cost analysis of health services

Short title: Assessing health facility performance in Indonesia

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Keywords: Efficiency, health facilities, Pabón-Lasso model, costs, performance

Key messages: This paper provides simple and robust guidance for policy makers to identify the internal and external contextual factors for the best performing health facilities.

Acknowledgments: The authors would like to acknowledge the Indonesia Ministry of Health and Statistics Indonesia for giving access to the datasets used in this paper (2011 National health facility costing study, 2011 Indonesia Case-Based Group, Survey Sosial Ekonomi Nasional 2011 (Gabungan), ID number: DDI-00-SUSENAS-2011-M1-GABUNGAN-BPS, and Pendataan Potensi Desa 2011, Survey ID number: 00-PODES-2011-M1). The views expressed herein do not necessarily reflect the views of the Ministry of Health and Statistics Indonesia. This work was supported by the Indonesia Endowment Fund for Education [S-1075/LPDP.3/2014].

Word count: 4640

Abstract

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 employ four 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 four 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. Forty percent of hospitals and 33 percent 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.

1 Introduction

In Indonesia, as in other parts of the world, escalating healthcare costs have increased interest in improving efficiency in resource use [1]. Between 1999 and 2013, gross domestic product (GDP) per capita in Indonesia grew by six percent annually while health expenditures have grown by 15 percent annually [2,3]. Compared to other lower-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 healthcare spending; Indonesian hospitals account for 55 percent of total health [8] (Figure 1)[6]. 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%–90% [6,8-12] . The average contact rate in public primary care (Puskesmas) is just above one visit per person per year, which is low compared to other countries in Asia, such as Malaysia (3.5), Vietnam (2.3), and Thailand (2.1) [13-15]. The sub-optimal healthcare utilisation indicates inefficient health facility services [16].

Figure 1 Health expenditure by providers in Indonesia, 2014
Source:

There are two main types of health facilities in Indonesia: hospitals and primary care. As of 2016, there are 2,032 hospitals in Indonesia, 56 percent of which are privately owned. Indonesia Ministry of Health categorises hospitals into four 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 sub-district level with a network of Puskesmas satellites in villages [20,21]. Puskesmas can be categorised based on their location: urban, rural, and remote area, and availability of inpatient services [21]. There are 9,705 Puskesmas across the country, and around 35 percent have inpatient services [20]. Puskesmas are regulated to have a minimum of one doctor per Puskesmas without inpatient services and two 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 percent 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 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 two 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 (e.g. 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 time 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 one 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 healthcare facilities across Indonesia, this study measures efficiency in health facilities in a developing country and extends the use of two 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 four different sources. First, we used data from a health facility costing study that used a

survey carried out by Indonesia's Ministry of Health (MoH) between October 2010 and September 2011. The survey collected data on the services, resources (infrastructure, equipment, staff, pharmaceuticals, and medical supplies), and expenditures (e.g. 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 healthcare 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 dataset were merged using district identifier for hospitals, and sub-district identifier for Puskesmas. Our merged dataset from these four sources comprises 89 variables for 200 hospitals, and 65 variables for 95 Puskesmas. See Supplementary table 1 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 four sectors using combination of efficiency indicators. There are three 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, 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 two indicators: the number of admissions per bed and the bed occupancy rate. These indicators divide the figure into four 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 (e.g. bed size, ownership, and location).

Figure 2 Pabón-Lasso model

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 employed step-down approach as a common technique to calculate unit cost and offers an optimal balance between accuracy and practicality [29,39]. We allocated overhead cost to intermediate and final cost centres (outpatient visits and inpatient admissions) to calculate cost per outpatient visit, cost per inpatient admission, and cost per bed day. [3929,39]

The first step was cost centre classification. There were two 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, non-clinical support (e.g., kitchen, transport, laundry), and clinical support (e.g., radiology, pharmacy, operating theatre).

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 (MIMS) 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 percent 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 summarizes 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].

Table 1. Allocation base criteria

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 a three 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 <0.25) 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]. 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 <0.05, this yielded a reduced final model. Checks for multi-collinearity were also performed. A variance inflation factor >10 was used to denote significant multi-collinearity. 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, TX, USA).

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, admitted 8,984 inpatients visits, and performed 1,900 surgeries. 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

Table 2 Characteristics and activities of health facilities

3.2 Pabón-Lasso model

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 percent 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 to public and larger hospitals. Hospitals in the high utilisation sector have specific characteristics compared to the low utilisation sectors: they had more full-time-equivalent non-specialist medical doctor, treated patients with insurance for either civil servants or the poor, and were located in Java or Bali Island.

Figure 3 Pabón-Lasso Model of Hospital by ownership and bed size

Note: two outlier observations are excluded from the figure for reader-friendly purposes

Puskesmas

Figure 4 represents the Pabón-Lasso model of puskesmas; 33 percent of Puskesmas with inpatient services are located in the high utilisation sector of the Pabón-Lasso Model (sector III), while 54 percent 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 to Puskesmas in the high utilisation sector.

Figure 4. Pabón-Lasso Model of Puskesmas by location and bed size

Note: two 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 percent in Puskesmas without inpatient services to 39 percent in private hospitals. Capital costs accounted for around 14 percent for hospitals and 19 percent for Puskesmas. There was no specific pattern in total cost structures based on hospital size, though 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

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 to class C or D hospitals. Class B hospitals had statistically significant lower unit costs compared to 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 three 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 to the other types of hospitals.

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

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 seven beds).

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

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 5 Characteristic of high-performing health facilities

Hospital

Based on bivariate analysis, 28 high-performing hospitals had specific characteristics compared to 172 other-performing hospitals: they were predominantly larger, more likely to publicly owned, and higher full-time-equivalent non-specialist 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. With regard to external factors, hospitals in Java or Bali islands with easy access to health facilities were relatively more efficient compared to 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 (Supplementary table 2).

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

Table 6 Independent contribution of best-performing hospital characteristic according to multivariate analysis

Puskesmas

The bivariate analysis suggests that the 12 high-performing Puskesmas had specific common characteristics compared to the 83 other-performing Puskesmas: high-performing Puskesmas slightly had more beds than other performing hospitals, less electricity disruption, had a mentoring with clinical staffs, and monitoring of working hours. With regard to external contextual factors, high-performing Puskesmas were generally in high-density with large population coverage (Supplementary table 3).

The multivariate analysis suggests three 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.

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

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.

4.1 Utilisation

Bed occupancy rate is a basic indicator to assess health facility performance, with an 80 to 90 percent 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 percent in Indonesian hospitals and 34 percent in Puskesmas. Somanathan, Hanson, Dorabawila, Perera [48] also found that the average occupancy rate for primary care in Sri Lanka was less than 50 percent. 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 percent of facilities appear in the high-performance sector (III) [27,49-51]. 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 [52].

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 percent of all costs across health facilities [53,54]. Chatterjee, Levin, Laxminarayan [47] 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 due to 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 [48]. Somanathan, Hanson, Dorabawila, Perera [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, Rada, Kuhn-Barrientos, Barrios [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 to private hospitals [49,56]. 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 [56,57]. 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 [58]. 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 and low cost of health facilities were associated with better health outcomes [59]. 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 [60,61].

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 [62,63]. As in Barnum, Kutzin [28], we found that health facilities on Java Island were more efficient compared to 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 leads to inefficiency [64]. 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 [65].

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.

In order 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.

4.6 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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SUPPLEMENTARY DATA

Supplementary table 1. List of variables

Supplementary table 2. Characteristics comparison between high and other performing hospitals

Supplementary table 3. Characteristics comparison between high and other performing Puskesmas

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

Table 2 Characteristics and activities of health facilities

Characteristics or statistics	Hospitals		Public hospitals		Private hospitals		Puskesmas		Puskesmas with inpatient services		Puskesmas without inpatient services	
	n=	200	n=	122	n=	78	n=	234	n=	95	n=	139
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Number of doctors	42	(40)	44	(47)	39	(27)	3	(4)	4	(4)	2	(3)
Number of nurses and midwife	155	(147)	184	(168)	111	(90)	29	(42)	37	(56)	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 thousand)	82	(127)	98	(132)	56	(114)	22	(16)	22	(17)	23	(15)
Number of admission	8984	(6941)	10 784	(7630)	6177	(4470)	591	(493)	591	(493)	NA	(NA)
Number of inpatient days (in thousand)	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= Not applicable

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

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

Unit cost of services	n	OP[a] mean median	95% CI IQR	IP[b] mean median	95% CI IQR	Bed days mean median	95% CI IQR	Delta casemix unit cost[a]		
								OP mean median	IP mean median	Bed days mean median
>200 beds								-0	-1	-1
		18	14 to 23	227	159 to 363	58	41 to 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 non-adjusted unit cost

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

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

Unit cost of services	n	OP[a] mean median	95% CI IQR	IP[b] mean median	95% CI IQR	Bed days mean median	95% CI IQR
		9	6 to 16	129	64 to 181	66	34 to 114
Beds Q4 (>12 beds)	29	9	6 to 10	130	77 to 147	74	39 to 87
		7	3 to 11	128	45 to 145	62	25 to 88
Puskesmas location							
Puskesmas in urban	11	8	5 to 10	255	80 to 312	165	29 to 221
		8	4 to 10	163	84 to 181	63	35 to 126
Puskesmas in rural	52	13	10 to 15	144	100 to 147	88	56 to 93
		10	6 to 16	133	71 to 148	75	28 to 89

[a]Outpatient
[b]Inpatient
[c] Basic emergency obstetric and newborn care

Table 5 Characteristic of high-performing health facilities

Contextual factor	Hospital	Puskesmas
Internal	• Higher FTE of non-specialist medical doctor • Large-size hospital, 165 beds (median) • Class A or B hospital • Public owned • More experience • 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 Askes and private insurance scheme pop coverage	• High density and large population coverage

Table 6 Independent contribution of best-performing hospital characteristic 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 to 10.67)	0.030	0.695	(0.63 to 0.76)
Accredited	3.17	(1.03 to 9.78)	0.045		
cons	0.03	(0.01 to 0.1)	0.000		
Model 2					
Class A/B	4.29	(1.83 to 10.07)	0.001	0.712	(0.64 to 0.77)
Poor 10%	2.18	(1.23 to 3.87)	0.007		
cons	0.05	(0.02 to 0.11)	0.000		
Model 3					
Class A/B	2.74	(1.14 to 6.59)	0.024	0.751	(0.69 to 0.81)
Public owned	4.11	(1.26 to 13.38)	0.019		
Patient over 65	1.84	(1.08 to 3.13)	0.025		
cons	0.02	(0 to 0.07)	0.000		

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

Variables	Odds ratio	(95% CI)	P value	ROC area of model	(95% CI)
No electricity disruption	12.67	(2.02 to 79.53)	0.007	0.778	(0.68 to 0.86)
Technician vacancy	0.11	(0.02 to 0.63)	0.013		
Regular performance meeting	28.50	(1.27 to 638.89)	0.035		
cons	0.31	(0.11 to 0.85)	0.023		

Supplementary table 1 List of variables

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
Dependent variables	**Unit cost**	unit cost op	Outpatient unit cost	Continuous	6	1	HFCS
		unit cost ip	Inpatient unit cost	Continuous	9	18	HFCS
		unit cost bd	Bed-days unit cost	Continuous	4	18	HFCS
Internal factors	**Utilisation**	ALOS	Average length of stay	Continuous	0	19	HFCS
		BOR (%)	Bed occupancy rate	Continuous	4	0	HFCS
		throughput	Admission per bed	Continuous	9	0	HFCS
		Outpatient visit/ inpatient days	Ratio of outpatient visits over inpatient days	Continuous	6	18	HFCS
	Degree of specialisation	GP FTE	General practitioners and dentist full time equivalent	Continuous	0	NA	HFCS
		Medical specialist FTE	Medical specialist full time equivalent including internal medicine, paediatrician, neurologist, psychiatrist, dermatologist, dentist specialist, anaesthetist, rehabilitation physicians, other medical specialist.	Continuous	0	NA	HFCS
		Surgical specialist FTE	Surgical specialist full time equivalent including general surgeon, neurosurgeon, obstetrics and gynaecology, ear nose throat specialist, ophthalmologist eye	Continuous	0	NA	HFCS
		Major_spec_FTE	Major specialist full time equivalent including internal medicine, general surgeon, paediatrician, obstetrics and gynaecology.	Continuous	0	NA	HFCS
	Size and capacity	Doctor	Number of doctor	Continuous	NA	0	HFCS
		Nurse	Number of nurse	Continuous	NA	8	HFCS
		Midwife	Number of midwife	Continuous	NA	8	HFCS
		Other staff	Number of other staff	Continuous	NA	0	HFCS
		No of Puskesmas satellite	Number of Puskesmas satellite	Continuous	NA	0	HFCS
		24/7 emergency services	Availability of emergency services in Puskesmas	Binary	NA	15	HFCS
		Open at evening	Puskesmas open at evening	Binary	NA	15	HFCS
		BEmONC services	Availability of Basic Emergency Obstetric and Newborn Care services in Puskesmas	Binary	NA	12	HFCS

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
		No of beds	No of beds	Continuous	0	0	HFCS
		Class A or B	Hospital class A or B	Binary	0	NA	HFCS
	Ownerhsip	Public	Hospital publicly owned	Binary	0	NA	HFCS
		Profit	Hospital for-profit	Binary	0	NA	HFCS
	Teaching	Teaching	Hospital has a MoU/partnership with medical education university	Binary	0	NA	HFCS
	Case-mix	NCD disease	% of non-communicable disease treated	Continuous	0	NA	HFCS
		Case index	Case index of hospital	Continuous	76	NA	INA-CBGs
		Patient 0-4 year	% of patient under 5 years old	Continuous	0	0	HFCS
		Patient >60 year	% of patient over 60 years old	Continuous	0	0	HFCS
	Experience	Age in year	Age of health facility in year	Continuous	10	18	HFCS
	Financing	Askes insurance outpatient	% of outpatient with Askes insurance	Continuous	55	NA	HFCS
		Company insurance outpatient	% of outpatient with company insurance	Continuous	122	NA	HFCS
		Poor insurance outpatient	% of outpatient with poor scheme insurance	Continuous	43	NA	HFCS
		Other insurance outpatient	% of outpatient with other insurance	Continuous	116	NA	HFCS
		No insurance outpatient	% of outpatient without insurance	Continuous	18	NA	HFCS
		Askes insurance inpatient	% of inpatient with Askes insurance	Continuous	43	NA	HFCS
		Company insurance inpatient	% of inpatient with company insurance	Continuous	120	NA	HFCS
		Poor insurance inpatient	% of inpatient with poor scheme insurance	Continuous	37	NA	HFCS
		Other insurance inpatient	% of inpatient with other insurance	Continuous	114	NA	HFCS
		No insurance inpatient	% of inpatient without insurance	Continuous	18	NA	HFCS
		Askes insurance bed days	% of bed-days with Askes insurance	Continuous	63	NA	HFCS
		Company insurance bed days	% of bed-days with company insurance	Continuous	133	NA	HFCS
		Poor insurance bed days	% of bed-days with poor scheme insurance	Continuous	53	NA	HFCS
		Other insurance bed days	% of bed-days with other insurance	Continuous	127	NA	HFCS
		No insurance bed days	% of bed-days without insurance	Continuous	35	NA	HFCS
		Askes insurance payment	% of payment with Askes insurance	Continuous	32	NA	HFCS

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
		Company insurance payment	% of payment with company insurance	Continuous	97	NA	HFCS
		Poor insurance payment	% of payment with poor scheme insurance	Continuous	24	NA	HFCS
		Other insurance payment	% of payment with other insurance	Continuous	137	NA	HFCS
		No insurance payment	% of payment without insurance	Continuous	6	NA	HFCS
	Pharmacy	Generic prop	% of generic drugs prescribed in hospital	Continuous	19	NA	HFCS
		Non-generic prop	% of non-generic drugs prescribed in hospital	Continuous	19	NA	HFCS
	Quality	Death rate	Number of death per admission	Continuous	17	NA	HFCS
		Expected death ratio	Ratio of actual number of death over expected number of death	Continuous	82	NA	INA-CBGs
		Accredited	Hospital accredited by Indonesian hospital accreditation commission	Binary	3	NA	HFCS
		Water-disruption	Water disruption in health facility in the past year	Binary	0	0	HFCS
		electricity-disruption	Electricity disruption in health facility in the past year	Binary	0	0	HFCS
		medicine-disruption	Medicine disruption in health facility in the past year	Binary	0	0	HFCS
		salary-late	Employee salary was late on schedule in the past year	Binary	0	0	HFCS
		incentive-late	Employee incentive was late on schedule in the past year	Binary	0	0	HFCS
		Management-vac	Difficulty in filling management vacancy	Binary	14	0	HFCS
		Doctor-vac	Difficulty in filling doctor vacancy	Binary	14	0	HFCS
		Nurse-vac	Difficulty in filling nurse vacancy	Binary	14	0	HFCS
		Tech-vac	Difficulty in filling technician vacancy	Binary	14	0	HFCS
		other-vac	Difficulty in filling other staff vacancy	Binary	14	0	HFCS
		Performance- once per week	Regular meetings to discuss the performance of services (medical and management) once per week	Binary	0	0	HFCS
		death-per year or more	Meetings to discuss the case of deaths in health facility, not limited to clinical staff but also the elements of management are being held, once per year or more	Binary	0	0	HFCS
		mentoring-no	No Mentoring with clinical staffs	Binary	0	0	HFCS

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
		workhour_monitoring-no	No Monitoring of working hours of the employee	Binary	0	0	HFCS
External factors	Health expenditure	Household health exp	Total household health expenditure for the last three months including curative, preventive, and pharmacy expenditure.	Continuous	0	0	SUSENAS
		Curative exp	Curative household expenditure for the last three months including expenditure on public or private hospitals, Puskesmas, Clinic, Medical practice (midwife/ nurse), traditional medicine, traditional delivery attendance	Continuous	0	0	SUSENAS
		Preventive exp	Preventive household expenditure for the last three months including expenditure on antenatal care, immunisation, medical check-up, family planning, other preventive expenditure	Continuous	0	0	SUSENAS
		Pharmacy exp	Pharmacy household expenditure for the last three months including prescribed drugs, drugs without prescription, traditional drugs, glasses, protease, wheel chair.	Continuous	0	0	SUSENAS
	Economic	%Pop in agriculture	Proportion of family working in agriculture	Continuous	6	0	PODES
		Total household expend	Total household expenditure	Continuous	0	0	SUSENAS
		Gini index	Gini index in district	Continuous	0	0	SUSENAS
		%Poor	Proportion of poor population in district	Continuous	0	0	SUSENAS
	Market competition	Hospital/1000 pop	Ratio of hospital, including general hospital and maternal hospital over 1000 population	Continuous	6	0	PODES
		Primarycare/1000 pop	Ratio of primary care, including clinic, Puskesmas, Puskesmas satellite, general practitioner, village health post, village delivery post over 1000 population	Continuous	6	0	PODES
	Education	%Pop with highereducation	Proportion of population with higher education in the district	Continuous	0	0	SUSENAS
		%Pop with secondaryschool	Proportion of population with secondary school education in the district	Continuous	0	0	SUSENAS
		%Pop with primaryschool	Proportion of population with primary school education in the district	Continuous	0	0	SUSENAS

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
	Demographic	Population	Number of population in district for hospital, and sub-district for Puskesmas	Continuous	6	0	PODES
		Population covered	Number of population covered by Puskesmas	Continuous	NA	15	HFCS
		Population density	Density population in sub-district	Continuous	NA	28	HFCS
		Female % population	Proportion of female population	Continuous	6	0	PODES
	Health status	<5 mortality /1000 pop	Ratio of mortality under five years old for the last three years over 1000 population	Continuous	6	0	PODES
		Maternal mortality /1000 pop	Ratio of maternal mortality for the last three years over 1000 population	Continuous	6	0	PODES
	Geography	Hospital easy	Proportion of very easy and easy to access hospital, including general hospital and maternal hospital	Continuous	0	0	PODES
		Hospital difficult	Proportion of very difficult and difficult to access hospital, including general hospital and maternal hospital	Continuous	0	0	PODES
		Primarycare easy	Proportion of very easy and easy to access primary care, including clinic, Puskesmas, Puskesmas satellite, general practitioner, village health post, village delivery post	Continuous	0	0	PODES
		Primarycare difficult	Proportion of very difficult and difficult to access primary care, including clinic, Puskesmas, Puskesmas satellite, general practitioner, village health post, village delivery post	Continuous	0	0	PODES
		Jawa and Bali	Health facility located in Jawa and Bali island	Binary	0	0	HFCS
		Urban	Puskesmas located in Urban area	Binary	NA	1	HFCS
	Population insurance	Askes	Proportion of household covered by Askes insurance (scheme for civil servant)	Continuous	0	0	SUSENAS
		Jamsostek	Proportion of household covered by Jamsostek insurance (scheme for employee)	Continuous	0	0	SUSENAS
		Private ins	Proportion of household covered by private insurance	Continuous	0	0	SUSENAS
		Company ins	Proportion of household covered by company insurance (for employee)	Continuous	0	0	SUSENAS
		Poor ins	Proportion of household covered by poor scheme	Continuous	0	0	SUSENAS

Group	Sub-group	Variable	Description	Variable type	Missing		Source
					Hospital n=200	Puskesmas n=95	
			insurance				
		Health fund ins	Proportion of household covered by health fund insurance (poor scheme)	Continuous	0	0	SUSENAS
		Other ins	Proportion of household covered by other health insurance scheme	Continuous	0	0	SUSENAS

Supplementary table 2. Characteristics comparison between high and other performing hospitals

Group	Sub-group	Variable	High Performance (n=28)		Other (n=172)		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
Internal factors	Unit cost	Outpatient unit cost	16.91	11.9 to 18.8	26.51	17.3 to 45.2	0.000
		Inpatient unit cost	160.12	118.1 to 187.4	264.91	187.8 to 396.7	0.000
		Bed-days unit cost	41.50	30.2 to 53.5	73.30	53.7 to 108.5	0.000
	Utilisation	ALOS	3.80	3.5 to 4.1	3.72	3.2 to 4.5	0.653
		bed_occ	0.78	0.7 to 0.9	0.56	0.4 to 0.7	0.000
		throughput	74.96	68.7 to 86.7	54.58	41.1 to 71.1	0.000
		Outpatient visit/ inpatient days	1.52	1.2 to 2.1	1.49	0.8 to 2.4	0.492
	Degree of specialisation	GP FTE	16.53	13 to 22.8	12.63	8.3 to 17.9	0.003
		Medical specialist FTE	9.63	6.3 to 16.7	7.37	3.1 to 16.2	0.277
		Surgical specialist FTE	6.61	5 to 9.8	5.00	2.8 to 9.8	0.207
		Major_spec_FTE	8.69	5.1 to 11.6	6.52	3.9 to 12	0.406
	Size and capacity	No of beds	165.50	132 to 228	116.50	77.5 to 189	0.002
		Class A & B	(15)	(53.6)	(39)	(22.7)	0.001
	Ownership	Public	(24)	(85.7)	(98)	(57)	0.004
		Profit	(2)	(7.1)	(34)	(19.8)	0.107
	Teaching	Teaching	(13)	(46.4)	(51)	(29.7)	0.078
	Case-mix	NCD disease	37.55	32.2 to 45.9	38.29	31.7 to 43.6	0.750
		Case index	0.94	0.8 to 1.2	0.91	0.7 to 1.2	0.772
		Patient 0-4 year	0.16	0.1 to 0.2	0.15	0.1 to 0.2	0.307
		Patient >65 year	0.12	0.1 to 0.2	0.10	0.1 to 0.1	0.023
	Experience	Age in year	54.00	33 to 74	32.00	19 to 61	0.014
	Financing	Askes insurance outpatient	0.29	0.2 to 0.3	0.28	0.2 to 0.4	0.992
		Company insurance outpatient	0.02	0 to 0.1	0.05	0 to 0.2	0.358

Group	Sub-group	Variable	High Performance (n=28)		Other (n=172)		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
		Poor insurance outpatient	0.31	0.2 to 0.5	0.19	0.1 to 0.3	0.004
		Other insurance outpatient	0.01	0 to 0	0.03	0 to 0.1	0.107
		No insurance outpatient	0.35	0.3 to 0.5	0.45	0.3 to 0.8	0.032
		Askes insurance inpatient	0.14	0.1 to 0.2	0.16	0.1 to 0.2	0.476
		Company insurance inpatient	0.02	0 to 0.1	0.07	0 to 0.2	0.132
		Poor insurance inpatient	0.43	0.3 to 0.6	0.39	0.2 to 0.5	0.221
		Other insurance inpatient	0.01	0 to 0	0.05	0 to 0.1	0.005
		No insurance inpatient	0.43	0.2 to 0.5	0.38	0.3 to 0.6	0.584
		Askes insurance bed days	0.15	0.1 to 0.2	0.16	0.1 to 0.2	0.554
		Company insurance bed days	0.02	0 to 0.1	0.05	0 to 0.2	0.257
		Poor insurance bed days	0.46	0.3 to 0.7	0.44	0.2 to 0.6	0.348
		Other insurance bed days	0.00	0 to 0	0.04	0 to 0.1	0.005
		No insurance bed days	0.36	0.2 to 0.5	0.33	0.2 to 0.6	0.588
		Askes insurance payment	0.17	0.1 to 0.2	0.13	0 to 0.2	0.101
		Company insurance payment	0.04	0 to 0.1	0.04	0 to 0.1	0.762
		Poor insurance payment	0.29	0.1 to 0.5	0.21	0 to 0.5	0.517
		Other insurance payment	0.03	0 to 0.1	0.12	0 to 0.4	0.034
		No insurance payment	0.35	0.2 to 0.5	0.45	0.3 to 0.7	0.168
	Pharmacy	Generic prop	0.55	0.3 to 0.8	0.55	0.3 to 0.7	0.698
		Non-generic prop	0.34	0.2 to 0.5	0.36	0.2 to 0.6	0.350
	Quality	Death rate	0.0096	0 to 0	0.0073	0 to 0	0.022
		Expected death rate	1.06	0.9 to 1.1	0.96	0.7 to 1.2	0.4
		Accredited	(22)	(84.6)	(100)	(58.5)	0.011
		No water-disruption	(11)	(39.3)	(67)	(39)	0.973
		No electricity-disruption	(10)	(35.7)	(43)	(25)	0.234

Group	Sub-group	Variable	High Performance (n=28)		Other (n=172)		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
		No medicine-disruption	(14)	(50)	(88)	(51.2)	0.909
		salary-late	(24)	(85.7)	(153)	(89)	0.618
		incentive-late	(16)	(57.1)	(107)	(62.2)	0.609
		Management-vac	(8)	(32)	(71)	(44.1)	0.255
		Doctor-vac	(13)	(52)	(98)	(60.9)	0.400
		Nurse-vac	(3)	(12)	(48)	(29.8)	0.063
		Tech-vac	(15)	(60)	(82)	(50.9)	0.398
		other-vac	(6)	(24)	(22)	(13.7)	0.179
		performance-more than once per week	(10)	(35.7)	(52)	(30.2)	0.561
		death-per year or more	(14)	(50)	(73)	(42.4)	0.454
		mentoring-no	(25)	(89.3)	(160)	(93)	0.486
		workhour_monitoring-no	(25)	(89.3)	(160)	(93)	0.486
External factors	Economic	Total household expend	208.22	164.9 to 294	271.15	205.9 to 360.8	0.008
		Gini index	0.35	0.3 to 0.4	0.35	0.3 to 0.4	0.902
		Pop prop in agriculture	0.47	0.2 to 0.7	0.43	0.1 to 0.7	0.371
		%Poor	0.06	0 to 0.1	0.04	0 to 0.1	0.018
	Health expenditure	Household health exp	24.98	11.6 to 39.7	25.81	14.5 to 34.8	0.54
		curative exp	14.72	7.4 to 27.1	15.71	9 to 26.5	0.670
		Preventive exp	2.34	1.6 to 3.6	2.80	1.9 to 4.1	0.234
		Pharmacy exp	2.33	1.7 to 4.4	3.39	2.3 to 5.4	0.049
	Market competition	Hospital/pop/1000	0.02	0 to 0	0.03	0 to 0.1	0.081
		Primarycare/pop/1000	0.50	0.4 to 0.6	0.55	0.5 to 0.7	0.045
	Education	Pop prop with highereducation	0.05	0 to 0.1	0.06	0 to 0.1	0.043
		%Pop with secondaryschool	0.32	0.3 to 0.4	0.39	0.3 to 0.4	0.045
		%Pop with primaryschool	0.45	0.3 to 0.5	0.37	0.3 to 0.4	0.022

Group	Sub-group	Variable	High Performance (n=28)		Other (n=172)		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
	Demographic	Population (in '000)	653.89	232.3 to 1111.5	393.08	214.1 to 1026.2	0.462
		Female prop population	0.50	0.5 to 0.5	0.50	0.5 to 0.5	0.307
	Health status	<5 mortality per 1000 population	0.06	0 to 0.1	0.07	0 to 0.1	0.702
		Maternal mortality per 1000 population	0.01	0 to 0	0.01	0 to 0	0.672
	Geography	Hospital easy	1.63	1.5 to 1.8	1.42	1.2 to 1.7	0.028
		Hospital difficult	0.15	0 to 0.3	0.07	0 to 0.6	0.866
		Primarycare easy	3.76	3.3 to 4.1	3.57	2.8 to 3.9	0.078
		Primarycare difficult	0.38	0.1 to 0.7	0.34	0.1 to 1	0.815
		Java and Bali	(18)	(64.3)	(61)	(35.5)	0.004
	Population health insurance%	Askes	0.09	0.1 to 0.1	0.13	0.1 to 0.2	0.018
		Jamsostek	0.03	0 to 0.1	0.05	0 to 0.1	0.133
		Private ins	0.01	0 to 0	0.02	0 to 0	0.045
		Company ins	0.01	0 to 0	0.01	0 to 0	0.241
		Poor ins	0.19	0.1 to 0.4	0.17	0.1 to 0.2	0.283
		Health fund ins	-	0 to 0	0.002	0 to 0	0.018
		Other ins	0.01	0 to 0	0.01	0 to 0	0.250

Supplementary table 3. Characteristics comparison between high and other performing Puskesmas

Group	Sub-group	Variable	High Performance		Other Performance		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
Internal factors	Unit cost	Outpatient unit cost	4.4	3.1 to 5.8	10.3	6 to 15.5	0.000
		Inpatient unit cost	45.2	36.1 to 77.9	120.2	83.7 to 173.1	0.000
		Bed-days unit cost	23.2	18 to 28.8	69.3	36.5 to 100.7	0.000
	Utilisation	ALOS	2.5	2.1 to 3.6	2.2	1.6 to 2.8	0.044
		bed_occ	0.6	0.4 to 0.8	0.2	0.1 to 0.3	0.000
		throughput	92.3	81.6 to 111.2	42.2	25.9 to 80.6	0.000
		Outpatient visit/ inpatient days	18.7	12.4 to 24	26.1	12.4 to 58	0.097
	Size and capacity	Doctor	2.0	1 to 4	2.0	1 to 4	0.745
		Nurse	14.0	11 to 18	11.0	7 to 21	0.318
		Midwife	12.5	8 to 21	12.0	5 to 16	0.390
		Other staff	15.0	8 to 18	13.0	8 to 21	0.880
		No of pustu	3.5	3 to 5.5	3.0	2 to 5	0.655
		No of beds	11.5	10 to 16	10.0	6 to 12	0.045
		24/7 emergency	(8)	(100)	(59)	(81.9)	0.189
		PM -open	(3)	(37.5)	(35)	(48.6)	0.550
		Poned	(2)	(16.7)	(20)	(24.1)	0.568
	Case-mix	Patient 0-4 year	0.1	0.1 to 0.1	0.1	0.1 to 0.2	0.370
		Patient >60 year	0.2	0.1 to 0.2	0.1	0.1 to 0.2	0.179
	Experience	Age in year	32.0	24 to 33	31.5	19 to 36	0.651
	Quality	Water-disruption	(2)	(16.7)	(20)	(24.1)	0.568
		No electricity-disruption	(4)	(33.3)	(9)	(10.8)	0.034
		No medicine-disruption	(5)	(41.7)	(33)	(39.8)	0.900
		salary-late	(7)	(58.3)	(59)	(71.1)	0.370

Group	Sub-group	Variable	High Performance		Other Performance		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
		incentive-late	(5)	(41.7)	(29)	(34.9)	0.650
		Management-vac	(7)	(58.3)	(60)	(72.3)	0.322
		Doctor-vac	(7)	(58.3)	(61)	(73.5)	0.276
		Nurse-vac	(3)	(25)	(21)	(25.3)	0.982
		Tech-vac	(7)	(58.3)	(67)	(80.7)	0.081
		other-vac	(7)	(58.3)	(51)	(61.4)	0.836
		performance-more than once per week	(1)	(8.3)	(1)	(1.2)	0.108
		death-per year or more	(2)	(16.7)	(33)	(39.8)	0.121
		mentoring-no	(5)	(41.7)	(64)	(77.1)	0.010
		workhour_monitoring-no	(5)	(41.7)	(64)	(77.1)	0.010
External factors	Health expenditure	Household health exp	18.0	11.8 to 34.8	15.9	9.7 to 30.4	0.419
		curative exp	11.6	8.1 to 22.3	11.8	6.5 to 19.6	0.515
		Preventive exp	2.3	0.9 to 3.4	2.1	1.1 to 2.7	0.487
		Pharmacy exp	2.3	2.1 to 3.2	2.6	1.4 to 3.1	0.515
	Economic	%Pop in agriculture	0.6	0.3 to 0.8	0.8	0.5 to 0.8	0.292
		Total household expend	181.4	178.4 to 286.1	243.7	183.2 to 288.8	0.133
		Gini index	0.4	0.3 to 0.4	0.3	0.3 to 0.4	0.217
		%Poor	0.1	0 to 0.1	0.1	0 to 0.2	0.893
	Market competition	Hospital/pop	-	0 to 0	-	0 to 0	0.189
		Primarycare/pop	0.5	0.4 to 0.7	0.6	0.5 to 1	0.060
	Education	%Pop with highereducation	0.0	0 to 0.1	0.1	0 to 0.1	0.606
		%Pop with secondaryschool	0.3	0.3 to 0.4	0.3	0.3 to 0.4	0.388
		%Pop with primaryschool	0.4	0.4 to 0.4	0.4	0.4 to 0.5	0.277
	Demographic	Population	46,075.5	31366 to 59680	24,629.0	15201 to 43829	0.008
		Population coverage	34,124.0	26643.5 to 38784.5	19,908.0	12446 to 33766.5	0.013

Group	Sub-group	Variable	High Performance		Other Performance		p-value
			Median (n)	IQR (%)	Median (n)	IQR (%)	
		Population density	600.9	203.4 to 1125	138.2	10.5 to 289.2	0.043
		Female % population	0.5	0.5 to 0.5	0.5	0.5 to 0.5	0.695
	Health status	<5 mortality /1000 pop	0.1	0.1 to 0.1	0.1	0 to 0.2	0.749
		Maternal mortality /1000 pop	-	0 to 0	0.0	0 to 0	0.215
	Geography	Hospital easy	1.8	1.6 to 2	1.8	1.1 to 2	0.566
		Hospital difficult	-	0 to 0.2	-	0 to 0.8	0.315
		Primarycare easy	3.9	3.6 to 4.6	3.5	2.5 to 4.3	0.084
		Primarycare difficult	-	0 to 0.6	0.4	0 to 1.4	0.069
		Jawa and Bali	(7)	(58.3)	(28)	(33.7)	0.099
		Urban	(4)	(33.3)	(15)	(18.3)	0.226
	Population insurance	Askes	0.1	0.1 to 0.1	0.1	0.1 to 0.1	0.262
		Jamsostek	0.0	0 to 0.1	0.0	0 to 0	0.239
		Private ins	0.0	0 to 0	0.0	0 to 0	0.991
		Company ins	0.007	0 to 0	0.005	0 to 0	0.189
		Poor ins	0.2	0.1 to 0.3	0.2	0.1 to 0.3	0.670
		Health fund ins	0.0	0 to 0	0.0	0 to 0	0.794
		Other ins	0.0	0 to 0	0.0	0 to 0	0.501