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ORIGINAL RESEARCH

Activity-Based Costing of COVID-19 RT-PCR Testing in Public Laboratories in Indonesia: Evidence for Tariff Setting

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Background: Reverse transcriptase–polymerase chain reaction (RT-PCR) testing has been central to Indonesia's COVID-19 response. However, limited empirical evidence exists on the actual cost of RT-PCR testing in public laboratories, raising concerns that regulated tariffs may not accurately reflect resource use, particularly in low- and middle-income settings.

Purpose: This study aimed to estimate the unit cost of COVID-19 RT-PCR testing and identify key cost drivers to inform evidence-based tariff setting and support the financial sustainability of public laboratories in Indonesia.

Methods: A micro-costing analysis using an Activity-Based Costing (ABC) approach was conducted across eight government-owned laboratories in Southeast Sulawesi, Indonesia. Costs were categorized into direct and indirect components, and the unit cost was calculated by dividing total operational costs by the average number of tests performed per month. One-way sensitivity analyses were performed to assess the influence of major cost components.

Results: The adjusted mean unit cost of RT-PCR testing was USD 21.02, based on an average testing volume of 5409 samples per month and total adjusted monthly operating expenditures of USD 100,973.89. Direct costs accounted for 92.58% of total costs, driven primarily by consumables (75.12%) and human resources (13.32%). Extraction kits and RT-PCR reagents were the most influential cost drivers in sensitivity analyses. The estimated unit cost exceeded the government-mandated RT-PCR tariff outside Java and Bali (approximately USD 17–18.5).

Conclusion: This study provides empirical evidence on the actual cost of COVID-19 RT-PCR testing in Indonesian public laboratories. The findings highlight a mismatch between regulated tariffs and real service delivery costs, underscoring the need for tariff adjustments that balance affordability for patients with financial sustainability for laboratories. Transparent cost information is essential to support evidence-based pricing policies and strengthen preparedness for future public health emergencies.

Keywords: healthcare cost analysis, activity-based costing, RT-PCR testing, COVID-19, tariff policy, resource allocation

Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic, caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), has placed unprecedented strain on health systems, societies, and economies worldwide.[1] Since its initial detection in Wuhan, China, COVID-19 has rapidly spread across the globe, including Indonesia.[2] Early and accurate diagnosis is a cornerstone of effective pandemic control. Reverse transcriptase–polymerase chain reaction (RT-PCR) testing remains the gold standard for COVID-19 detection due to its high sensitivity and specificity.[3] In Indonesia, RT-PCR testing forms the

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backbone of the national “testing, tracing, and treatment” (3T) strategy.[4] However, the delivery of RT-PCR testing requires specialized laboratory infrastructure, trained personnel, and a reliable supply of reagents, most of which are imported, resulting in substantial operational costs.[5]

To support pandemic response, the Indonesian government significantly increased the health sector budget, from IDR 97.9 trillion in 2020 to IDR 214.95 trillion in 2021, which included funding for RT-PCR testing for confirmed COVID-19 cases.[6] Conversely, tests requested for non-clinical purposes, such as travel, workplace clearance, pre-hospitalization screening, or personal preference, were largely financed through out-of-pocket (OOP) payments. This led to wide variation in RT-PCR test prices across facilities, ranging from IDR 1 million to IDR 4 million. To improve affordability and ensure financial protection, the government introduced a maximum tariff, initially set at IDR 900,000 and later reduced to IDR 275,000 for the regions of Java and Bali, and IDR 300,000 for regions outside Java and Bali in 2021.[7]

Despite this, concerns have emerged regarding whether the regulated price truly reflects the actual costs incurred in providing the service.[8] Misalignment between regulated tariffs and actual laboratory operating costs may compromise service quality,[9] and in resource-constrained settings, limit access to testing.[10] Accurate cost estimates form the basis of economic and financial evaluations,[11] and support evidence-based decision-making by policymakers and health system stakeholders, enabling more efficient resource allocation and improved health system performance.[12,13]

Identifying the actual cost of healthcare service provision is essential to ensure transparency and efficiency within health systems.[14] One reliable approach to obtain accurate cost data is Activity-Based Costing (ABC), which allocates costs based on specific activities and the resources they consume.[15] By linking costs to underlying processes, ABC enables the identification of cost drivers that contribute most substantially to overall expenditures.[16] Consequently, this approach has been widely applied in healthcare cost analyses across a range of services and interventions.

Despite its broad application, the use of ABC to estimate the cost of RT-PCR testing during the COVID-19 pandemic remains limited. Previous micro-costing study in other settings has shown that consumables, particularly extraction kits and PCR reagents, account for the largest share of RT-PCR testing costs.[17] To our knowledge, this study is the first to estimate the unit cost of COVID-19 RT-PCR testing in Indonesian public laboratories using an ABC micro-costing approach. Addressing this evidence gap is critical to support evidence-based tariff setting and cost-efficient regulation without compromising diagnostic service quality. Therefore, this study aims to estimate the unit cost of COVID-19 RT-PCR testing in Indonesian public laboratories using an ABC approach and to identify the key cost components influencing service pricing, thereby informing policies to enhance affordability, sustainability, and efficiency within the national health system.

Methods

Study Design

This study estimated the unit cost of COVID-19 RT-PCR testing using a micro-costing approach based on ABC.[18] Under this framework, all resources required to deliver RT-PCR testing were systematically identified, quantified, and valued to calculate the cost per test. Cost data were collected from eight government-owned laboratories in Southeast Sulawesi, Indonesia, that provided RT-PCR testing during the COVID-19 pandemic: Konawe Hospital Laboratory, Kendari City Hospital Laboratory, Bahteramas Hospital Laboratory, Dr. R. Ismoyo Kendari Level IV Hospital Laboratory, Benyamin Guluh Kolaka Hospital Laboratory, Muna Regency Public Health Laboratory, Bombana Regency Hospital Laboratory, and Baubau Hospital Laboratory. The costing encompassed the full RT-PCR testing workflow, including sample receipt, sorting, separation, ribonucleic acid (RNA) extraction, RT-PCR amplification, and result reporting. Across the participating laboratories, an average of 5409 RT-PCR tests were performed per month during the pandemic period.

Participants

Participants included healthcare workers and laboratory personnel directly involved in delivering RT-PCR testing services across the eight participating laboratories. These included laboratory supervisors, technical staff, logistics personnel, and administrative officers. No individuals under 18 years of age were included. As the analysis focused exclusively on operational and cost-related information, no patient-level or specimen-level identifiable data were collected.

Data Collection

Data on direct and indirect costs associated with RT-PCR testing were collected in 2024 using a structured questionnaire, covering the COVID-19 pandemic period from 2020 to 2022. Information was obtained from all participating laboratories that provided RT-PCR diagnostic services during the pandemic. Data collection was conducted through secure online forms distributed to each laboratory.

Costs were classified into direct and indirect components. Direct costs included consumables, human resources, laboratory equipment, laboratory instruments, and infrastructure. Consumables comprised laboratory materials (chemicals, RT-PCR reagents, extraction kits, glassware, and plasticware) as well as non-laboratory items (stationery and office supplies). Human resource costs covered professional staff, including laboratory supervisors and technical officers, in addition to logistics personnel. Laboratory equipment costs referred to RT-PCR machines, while laboratory instruments included supporting devices (eg, vortex mixers and centrifuges) and other equipment such as computer systems and laboratory furniture. Infrastructure costs reflected laboratory building rental. Indirect costs consisted of utility expenses, including electricity, water, internet, telephone services, and waste disposal. Additional expenditures related to laboratory instrument validation were also captured.

Estimated Unit Cost

The unit cost of COVID-19 RT-PCR testing was calculated using the average cost method, defined as total operational costs divided by the number of samples processed per month during the pandemic period. This approach captures the full economic cost of routine RT-PCR testing by incorporating both direct and indirect cost components. Standardizing costs on a per-sample basis facilitates comparison across laboratories with differing testing volumes and resource allocations.[19] The resulting estimate represents the average cost required to perform a single RT-PCR test under typical operational conditions during the COVID-19 pandemic.

Sensitivity Analyses

Sensitivity analyses were conducted to assess the robustness of the estimated unit cost and to identify cost components with the greatest influence on overall results. A one-way deterministic sensitivity analysis was performed, in which parameters from each cost category were varied independently while all other variables were held constant.[20] Each parameter was adjusted by ±25% from its base-case value to examine its impact on the total unit cost and to highlight components with the greatest level of uncertainty.[21] The outcomes of this analysis were visualized using tornado diagrams to facilitate comparison of the relative influence of individual cost components on unit cost estimates.

Data Analysis

All data collected from the participating laboratories were entered into Microsoft Excel for cost analysis. The unit cost of COVID-19 RT-PCR testing was calculated using an ABC micro-costing approach. Costs were converted from Indonesian Rupiah (Rp) to US dollars (USD) using the exchange rate applicable in July 2025. Consumable costs were calculated by dividing the total purchase cost of materials by the number of samples processed. Human resource costs were adjusted to reflect only the proportion of staff time attributable to COVID-19 RT-PCR testing. Costs for laboratory equipment and instruments were based on their original purchase prices and annualized over a useful life of three years, corresponding to the pandemic period. Infrastructure costs were excluded, as all laboratories operated in permanent government-owned facilities without rental charges. Utility costs were estimated by allocating total hospital utility expenditures according to the proportion attributable to laboratory operations. To ensure accuracy, adjusted costs were calculated by excluding extreme values (outliers) that could distort the results, thereby generating more estimates that better reflect routine operational costs.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Halu Oleo University, Kendari, Indonesia (Document No. 1127/UN29.20.1.2/PG/2024) and was conducted in accordance with the Declaration of Helsinki. Prior to participation, all eligible laboratory healthcare workers received clear information regarding the study objectives, procedures, and their role in the research. Participants were assured that all data collected would remain confidential and anonymous, with no personal identifiers recorded.

Informed consent was obtained electronically, as data collection was conducted online. Participants indicated their voluntary consent by checking an approval box and submitting the form before participation. This electronic consent procedure was reviewed and approved by the Ethics Committee as an acceptable alternative to written consent. Participants were informed of their right to withdraw from the study at any time without penalty or consequences.

Results

RT-PCR Testing Volume and Unit Cost Across Laboratories

This study analyzed RT-PCR testing costs using a micro-costing approach across eight government laboratories in Southeast Sulawesi, Indonesia. During the COVID-19 pandemic, the adjusted mean unit cost of RT-PCR testing was estimated at USD 21.02, incorporating both direct and indirect cost components. The participating laboratories conducted an average of 5409 RT-PCR tests per month, reflecting substantial testing activity throughout the study period.

Unit costs varied considerably across laboratories (Table 1). Konawe Hospital recorded the highest average monthly testing volume, whereas Baubau Hospital reported the lowest. Higher testing volume did not necessarily correspond to higher unit costs. Konawe Hospital reported one of the lowest adjusted unit costs (USD 8.55 per test), while Baubau Hospital had the highest adjusted unit cost (USD 36.30 per test). In several laboratories, including Konawe Hospital, Kendari City Hospital, Dr. R. Ismoyo Kendari Hospital, and the Muna Regional Public Health Laboratory, no differences were observed between crude and adjusted unit costs, indicating the absence of extreme values. In contrast, laboratories such as Bahteramas Hospital, Benyamin Guluh Kolaka Hospital, Bombana District Hospital, and Baubau Hospital showed notable differences between crude and adjusted costs, suggesting the presence of outliers that influenced average cost estimates. Adjusted unit costs therefore provide a more stable representation of typical RT-PCR testing expenditures during the pandemic.

Operating Expenditures of RT-PCR Testing

Monthly operating expenditures (OPEX) for RT-PCR testing varied substantially across the participating laboratories (Table 2). Differences were observed between crude OPEX and adjusted OPEX values in several laboratories after excluding extreme values. On average, monthly crude OPEX was USD 106,621.02, while adjusted OPEX amounted to USD 100,973.89.

Table 1 The Cost of RT-PCR Test

Laboratory	Number of RT-PCR Test Per Month	Cost Per Test (USD)	
		Cost	Adjusted Cost*
Konawe Hospital	12,000	8.55	8.55
Kendari City Hospital	11,220	10.73	10.73
Bahteramas Hospital	10,500	32.88	31.69
Dr. R. Ismoyo Kendari Hospital	6000	26.18	26.18
Benjamin Guluh Kolaka Hospital	3000	38.82	28.52
Regional health laboratory Muna	300	12.16	12.16
Bombana Hospital	154	18.88	13.88
Baubau Hospital	100	46.42	36.30
Mean		24.33	21.00

Note: *Without outlier.
Abbreviations: RT-PCR, Reverse Transcription Polymerase Chain Reaction; USD, United State Dollar.

Table 2 Operating Expenses of RT-PCR in the Laboratories

Laboratory	Number of RT-PCR Test Per Month	OPEX (USD)	OPEX Adjusted* (USD)
Konawe Hospital	12,000	102,600.00	102,600.00
Kendari City Hospital	11,220	120,390.60	120,390.60
Bahteramas Hospital	10,500	345.240,00	332,745.00
Dr. R. Ismoyo Kendari Hospital	6000	157.080,00	157.080,00
Benjamin Guluh Kolaka Hospital	3000	116,460.00	85.560,00
Regional health laboratory Kabupaten Muna	300	3.648,00	3.648,00
Bombana Hospital	154	2.907,52	2.137,52
Baubau Hospital	100	4.642,00	3.630,00
Average		106,621.02	100,973.89

Note: *Without outlier.
Abbreviations: RT-PCR, Reverse Transcription Polymerase Chain Reaction; USD, United State Dollar; OPEX, Operational Expenditure.

Bahteramas Hospital reported the highest operational expenditure for RT-PCR testing, with an adjusted monthly OPEX of approximately USD 332,745. In contrast, the lowest adjusted OPEX was observed at Bombana District Hospital, at approximately USD 2137.52. These variations reflect differences in testing volume and resource utilization across laboratories. Adjusted OPEX values provide a more representative estimate of routine operational expenditures by minimizing the influence of extreme cost observations during the pandemic period.

Cost Structure of RT-PCR Testing

The cost of RT-PCR testing was distributed across direct and indirect cost components, as summarized in Table 3. After adjustment, direct costs accounted for the majority of total expenditures (92.58%), while indirect costs represented 7.42% of the total unit cost.

Table 3 Direct and Indirect Cost Centers in Laboratories Among Various Cost Components for COVID-19 RT-PCR Tests During July to September 2024

Cost center		Cost		Cost Adjusted*	
		Average (USD)	Percentage (%)	Average (USD)	Percentage (%)
Direct cost	Consumable Material	16.51	67.83	15.79	75.12
	Human resources	3.96	16.27	2.80	13.32
	Laboratory equipment	0.84	3.45	0.84	4.00
	Laboratory instruments	0.03	0.12	0.03	0.14
	Infrastructure	0.00	0.00	0.00	0.00
	Sub-total	21.34	87.67	19.46	92.58
Indirect cost	Utility expenses	2.89	11.87	1.51	7.18
	Other	0.11	0.45	0.05	0.24
	Sub-total	3.00	12.33	1.56	7.42
Total Cost		24.34	100	21.02	100

Note: *Without outlier.
Abbreviation: USD, United State Dollar.

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Among direct cost components, consumable materials constituted the largest share, accounting for 75.12% of the adjusted total cost, followed by human resources at 13.32%. Laboratory equipment instruments contributed smaller proportions, at 4.00% and 0.14%, respectively. No infrastructure costs were recorded, as all laboratories operated within government-owned facilities without rental charges.

Indirect costs were primarily driven by utility expenses, which accounted for 7.18% of the adjusted total cost, while other indirect expenses contributed only a minor share (0.24%). Overall, the adjusted cost distribution indicates that consumables and personnel costs were the dominant components of RT-PCR testing expenditures across the participating laboratories.

Sensitivity Analysis of Cost Components

One-way sensitivity analysis identified the cost components with the greatest influence on the unit cost of RT-PCR testing (Figure 1). Among all parameters assessed, extraction kits had the largest impact on unit cost estimates, with values ranging from USD 19.19 to USD 22.85 when varied by ±25% from the base case. RT-PCR reagents were the second most influential component, producing unit cost estimates ranging from USD 19.36 to USD 22.68.

Personnel-related costs had a more moderate impact on unit cost variability. Variation in laboratory technician salaries resulted in unit cost estimates ranging from USD 20.69 to USD 21.35, while changes in laboratory manager and logistics personnel salaries produced narrower ranges. Utility-related parameters, including electricity, water, and internet costs, showed relatively limited influence on overall unit cost estimates.

Other cost components, such as laboratory equipment, consumables excluding reagents, instrument validation, and infrastructure-related costs, demonstrated minimal impact on unit cost variation. Building-related costs had no effect on unit cost estimates, reflecting the absence of rental expenses across all participating laboratories. The tornado diagram illustrates the relative contribution of individual cost parameters to variability in RT-PCR unit cost estimates.

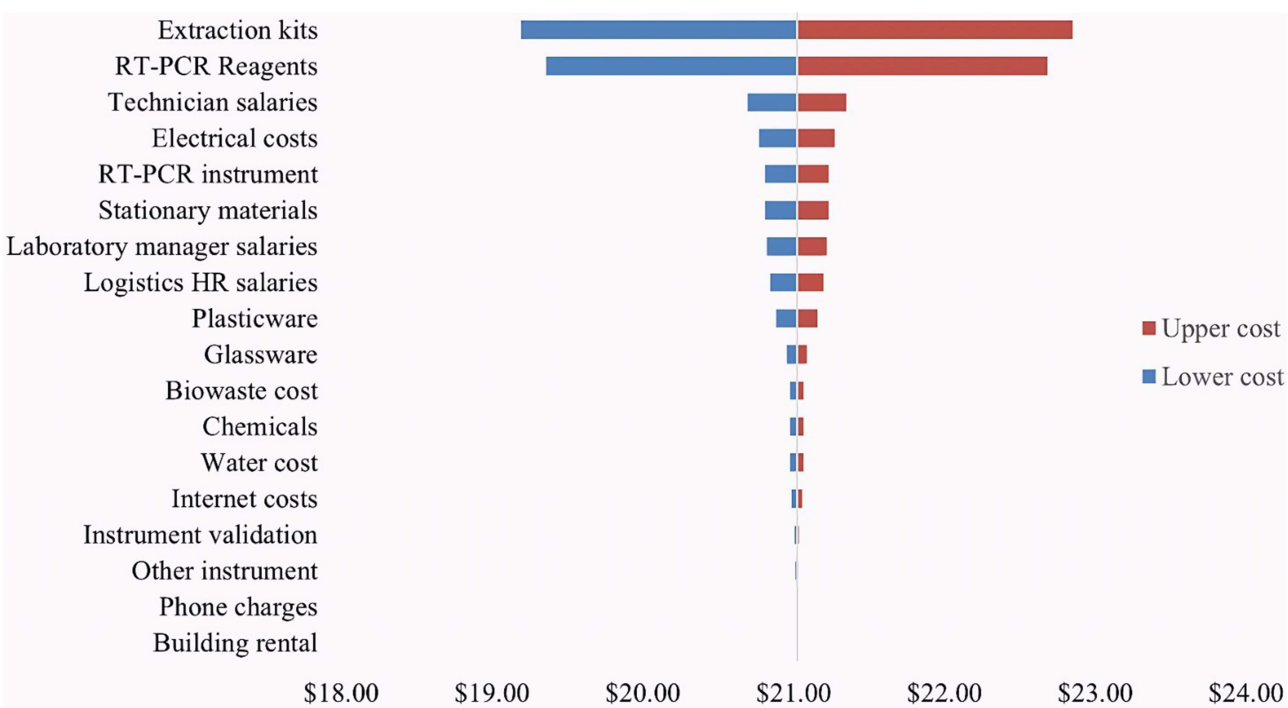

Figure 1 Tornado diagram of One-way sensitivity analysis of the component cost of RT-PCR. A red bar represents the effect on the cost of increasing a parameter value (+25%) from its reference value, while a blue bar represents the effect of reducing a parameter value (−25%).

Discussion

This study provides empirical evidence on the cost of COVID-19 RT-PCR testing in public laboratories in Southeast Sulawesi, Indonesia, using an ABC approach. The analysis shows that the adjusted mean unit cost of RT-PCR testing was USD 21.02, exceeding the government-regulated tariff outside Java and Bali. Direct costs accounted for the majority of total expenditures, driven primarily by consumable materials, particularly extraction kits and RT-PCR reagents, followed by human resource costs. Considerable variation in unit costs and operating expenditures was observed across laboratories, reflecting differences in testing volume and resource utilization. Sensitivity analysis further confirmed that consumables were the dominant cost drivers, while infrastructure-related costs had minimal influence on overall cost estimates.

Consumable materials were identified as the predominant cost driver, accounting for the largest share of total RT-PCR testing costs. This cost structure is consistent with evidence from other settings, where consumables accounted for up to 87% of total diagnostic costs, with medical supplies contributing more than half of total expenditure for RT-PCR and antigen-based testing. Studies have also reported laboratory consumables comprising 72.9% of overall costs and consumable medical equipment accounting for 33.6%, indicating reliance on high-cost recurrent inputs.[22–25] The elevated consumable costs observed during the COVID-19 pandemic have been attributed to emergency procurement without competitive tendering, global supply shortages, and restrictions on the reuse of personal protective equipment.[26,27] These findings underscore the financial vulnerability associated with dependence on imported reagents and kits, highlighting the need for strategies such as local production, pooled procurement, and regional supply-chain collaboration to enhance cost efficiency and resilience.

Human resource costs represented the second-largest cost component, driven primarily by laboratory technicians and supervisory staff involved in RT-PCR testing. The contribution of technical personnel was influenced by staffing levels and extended working hours required to manage sustained testing demand and ensure operational continuity during periods of staff quarantine. Comparable studies have reported substantial variation in the share of human resource costs, ranging from 10.3% to 65.6%,[17,23] depending on staffing models and workload intensity. Similar patterns have been observed in high-income settings, such as Canada, where large-scale RT-PCR testing and contact tracing required extensive personnel deployment and resulted in considerable recurrent expenditure.[28] These findings suggest that workforce planning, task optimization, and investment in automation where feasible may play a critical role in improving efficiency while maintaining service continuity during periods of surge demand.[29–31]

Utilities represented the third-largest cost component in this analysis, encompassing electricity, water, and other operational expenses such as internet services, telephone, and waste disposal. Among these, electricity accounted for the largest share, representing 6.49% of the total cost. Comparable studies have reported electricity as a measurable component of diagnostic operations, with annual energy expenditures ranging from USD 11,845 to USD 80,761, depending on hospital size.[32] The increased electricity demand during the COVID-19 pandemic has been attributed to the intensive use of energy-dependent laboratory equipment and enhanced infection prevention measures.[33,34] However, a key limitation of this study is that electricity costs were calculated based on total hospital consumption, without specific disaggregation for RT-PCR testing activities.

Laboratory-related components, including equipment, instruments, and other expenses such as instrument validation, contributed a relatively small proportion of total costs.[35] The procurement of RT-PCR machines did not significantly affect the overall budget, consistent with findings from other studies reporting that RT-PCR machines accounted for only around 0.38% of total costs.[17] Similar trends have been observed for other laboratory instruments. Conversely, some studies have demonstrated that RT-PCR testing can be conducted using simplified systems costing as little as USD 300, suggesting that capital investment in laboratory equipment can potentially be minimized under certain conditions.[36] In this study, laboratory infrastructure costs were calculated as 0%, reflecting the use of activity-based apportioning and the efficient utilization of existing laboratory space. The absence of additional infrastructure costs indicates that available facilities were fully optimized for COVID-19 RT-PCR testing without the need for new construction or rental.

These findings have significant implications for healthcare financing and policy. The costing of RT-PCR testing conducted in the Southeast Sulawesi region revealed a total cost of USD 21.02, which exceeds the government-mandated tariff for RT-PCR tests in Indonesia (IDR 275,000–300,000; approximately USD 17–18.5). This discrepancy highlights the need for efforts to control costs while maintaining laboratory sustainability, provided that inefficiencies in procurement and vulnerabilities in the supply chain can be effectively addressed. Cost-based pricing does not necessarily imply transferring the full cost burden to patients. Instead, governments can apply tiered reimbursement mechanisms, targeted public subsidies, or cross-financing through national health programs to ensure that essential diagnostic services remain affordable while laboratories receive adequate compensation.[37] Such approaches allow tariffs to better reflect real service delivery costs without compromising equitable access, particularly for vulnerable populations and in resource-limited settings.[38] Moreover, the availability of accurate cost data is essential for guiding resource allocation and ensuring that constrained health budgets are utilized efficiently across diagnostics, treatment, and preventive interventions.[39] Identifying the actual cost of RT-PCR testing not only informs evidence-based tariff setting but also promotes financial protection and equity of access.[40] Transparent and realistic costing safeguards patients from excessive out-of-pocket expenditures, while ensuring adequate reimbursement for providers to sustain service quality.[41] Incorporating empirical cost evidence into tariff design can help ensure equitable access to testing across regions, protect laboratory viability, and strengthen health system resilience in future outbreaks.[42–44]

This study has several strengths, including the application of an ABC micro-costing approach that enables a detailed and transparent estimation of both direct and indirect costs of COVID-19 RT-PCR testing, as well as the use of data from multiple government laboratories, which enhances the relevance of the findings for public-sector diagnostic services. The inclusion of sensitivity analysis further strengthens the robustness of the results by identifying key cost drivers and assessing uncertainty around cost inputs. Nevertheless, some limitations should be acknowledged. Cost data were collected retrospectively and relied on self-reported information from participating laboratories, which may be subject to recall bias or reporting variability. In addition, utility and overhead costs were not disaggregated specifically for RT-PCR testing and were allocated using proportional estimates, potentially introducing imprecision. The study was also limited to government laboratories in a single province, which may restrict generalizability to other regions or private-sector settings with different cost structures, procurement mechanisms, or testing volumes. Finally, costs were averaged over the pandemic period and may not fully capture temporal fluctuations in prices or testing demand.

Conclusion

This study provides new evidence on the cost of COVID-19 RT-PCR testing in Indonesian public laboratories using an ABC approach. The findings show that the unit cost of RT-PCR testing exceeded the government-regulated tariff, with costs driven mainly by consumable materials and human resources, while capital and infrastructure inputs played a limited role. The observed variation between estimated costs and regulated tariffs likely reflects differences in testing volume, procurement mechanisms, and reliance on imported reagents during the pandemic, as well as the effects of emergency supply conditions that limited price competition. Laboratories with lower testing throughput faced higher per-test costs, highlighting the influence of economies of scale on tariff adequacy. This misalignment underscores the need to incorporate transparent, cost-based evidence into tariff-setting to balance affordability with the financial sustainability of public laboratories. Incorporating empirical cost evidence into tariff-setting can help ensure that regulated prices more accurately reflect service delivery realities while supporting efficient resource allocation, protecting diagnostic capacity, and reducing reliance on cross-subsidization. Beyond the COVID-19 context, these findings highlight the importance of strengthening laboratory preparedness for future public health emergencies, while future studies should examine cost structures across private laboratories, additional regions, and post-pandemic settings to inform adaptive pricing and sustainable financing policies.

Data Sharing Statement

Cost data generated and analyzed during this study are available from the corresponding author upon reasonable request, subject to approval from the participating government laboratories and the Ethics Committee of Universitas Halu Oleo.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Halu Oleo University, Kendari, Indonesia (Document No. 1127/UN29.20.1.2/PG/2024) and conducted in accordance with the Declaration of Helsinki. Informed consent was obtained electronically; participants were required to read the online consent statement and confirm their voluntary agreement before proceeding with the survey. All information collected remained confidential and anonymous, and participants were informed of their right to withdraw at any time without penalty.

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Disclosure

The authors report no conflicts of interest in this work.

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