Research Article

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Calculation of the Equal Education Cost Index in Indonesia: Using the Relative Importance Regression and Winsorization Approach

Ferdi Widiputera[1,2*]

Wardani Rahayu[2]

Suryadi Suryadi[2]

Rumtini Rumtini[3]

[1]*Ministry of Education and Culture, Research and Technology, The Republic of Indonesia*
[2]*State University of Jakarta, Indonesia*
[3]*Universitas Terbuka Jakarta, Indonesia*
**Corresponding Author*

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Abstract

This study examines index calculations in determining the unit costs of equivalent education using an empirical approach. The composite index used in this study compares the Construction Cost Index (CCI) to Purchasing Power Parity (PPP). The current empirical literature requires further development on calculation and comparison methods for these two indices. The study employed data from the Indonesian Central Statistics Agency (CSA), including the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) data from 2021, as well as data on the allocation of School Operational Assistance (SOA) funds for non-formal education in 2022. The results indicate that the weight value of CCI is more substantial than that of PPP. The multiple regression analysis conducted with a relative importance approach reveals a favourable correlation between CCI and PPP, indicating a strong interrelationship.

Keywords: *Calculation, Composite Index, Non-Formal Education*

1. Introduction

The paradigm of education for poor and marginalized communities needs to shift. Efforts to equalize education should not only support individuals in disadvantaged conditions but also include those with limited access to educational resources (Sutisna, 2016). Every child's right to quality education in Indonesia is a principle that must be upheld. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) offers various options to facilitate both formal and non-formal education, including programs aimed at equality in education (Directorate of Community Education

and Equality Education, 2020). Since 2016, the government has been actively promoting the enhancement of equality education. This includes developing eligibility standards that institutions providing equality education must meet, which cover aspects such as the institution's legality, participant numbers, educator quality, governance, and infrastructure. The government also pays particular attention to the document management process for prospective students and educators.

To improve the quality of education in Indonesia, the government needs to develop effective policies focused on achieving specific objectives. The Indonesian government's policies in the education sector extend beyond legal regulations; they encompass the entire process of formulating strategic educational steps. These steps are based on a vision and mission to achieve educational goals within a specified timeframe.

The Education Operational Assistance (EOA) policy refers to financial and resource support provided by the government to educational institutions. This initiative aims to enhance education quality, increase accessibility, and maintain the operational continuity of these institutions. EOA can be provided at various educational levels, including primary, secondary, tertiary, equivalency, and non-formal education. The form of support varies based on local government policies and priorities.

In the context of equal education, EOA supplies financial support for implementing and maintaining equality education programs. This funding can cover school operational costs, teaching materials, teacher training, curriculum development, and other relevant components. Equivalent education encompasses programs designed for adults seeking access to complete their formal education at the primary or secondary levels, aiming to promote qualifications equivalent to a primary or secondary education diploma.

In addition to institutional improvements, the government is also offering operational support for gender education. A key focus of this policy is the non-physical Special Allocation Fund (SAF) 2022, initiated by Kemendikbudristek, which allocates operational support for gender equality education. This aid is distributed directly to educational institutions based on their regional needs. The success of this initiative is a significant achievement for Kemendikbudristek, as operational assistance is calculated using the Construction Cost Index (CCI) and the Student Index (SI) at the district or city level, which informs the provision of early childhood and gender equality education (Cabinet Secretariat, 2021). In 2021, the calculation of EOA for the Equality Program will be uniformly implemented across all districts and cities (see Table 1).

Looking ahead, the provision of EOA for the Equality Program will adopt a more tailored approach based on regional needs. This support will be more flexible and comprehensive, catering to the specific requirements of program organizers. According to a statement by Coordinating Minister for the Economy Airlangga Hartarto, "This program helps schools in its implementation and has a positive impact on improving the quality of education." The implementation of EOA in the Equality Program allows for flexible usage across various school needs, covering aspects like student admissions, school administration, enhancing the teaching process, staff welfare, subscription services, and other necessities. Additionally, EOA can support the limited implementation of Face-to-Face Learning (FFL), following guidelines established by the competent authority (Kemendikbudristek, 2021).

Beyond the allocations mentioned, the EOA policy in the Equality Program contributes positively by funding operational costs for Teaching and Learning Activities (TLA) in Package A, Package B, and Package C. Priority is given to individuals aged 7 to 21 years, encompassing the 12 years of compulsory education. This initiative is part of the government's commitment to improving human resource quality with a global perspective. The primary aim is to alleviate the burden on participants in this educational initiative while also ensuring that the needs of children whose education has been interrupted are met, allowing them to continue their studies. The EOA program in the Equality Program has been in effect since 2016, with funding for Package A amounting to IDR 970,000.00, Package B to IDR 1,400,000.00, and Package C to IDR 1,700,000.00 during the 2016-2018 period.

Table 1. Amount of Equivalent EOA Funds for Each Student per Year

No.	Education Unit that organizes Equal Education	Fund (Rp)/student/year
1	Package A is equivalent to Elementary School	Rp. 1,300,000.00
2	Package B is equivalent to Junior High School	Rp. 1,500,000.00
3	Package C is equivalent to Senior High School	Rp. 1,800,000.00

Source: Permendikbud Number 9 of 2021

One hindrance to implementing the Equality Operational Assistance (EOA) unit cost variant is the lack of sufficient statistical measures that significantly impact the education sector. Currently, the Construction Cost Index (CCI), provided by the Central Statistics Agency (CSA), is the only index available for calculating unit education costs. This index reflects the inflation rate of construction expenses in a specific location. Data on the CCI is gathered through price surveys focusing on materials, construction labor wage rates, and heavy equipment rental rates. The Ministry of Education, Culture, Research, and Technology (Kemendikbudristek) uses CCI data to compute the unit costs for school operational assistance, Early Childhood Education assistance, and various equality education initiatives in 2022. The relevance of the Construction Cost Index remains a debated topic among scholars and professionals, especially concerning unit costs in the education sector.

In this study, we compared CCI data with the realization of school activity plans and budgets, which include components of Implementation Operational Assistance (EOA), alongside data on Purchasing Power Parity (PPP), which refers to the ability to purchase goods and services. Correlation tests are necessary to construct a regression model that yields optimal and statistically significant results. After conducting these tests, the next step is to calculate the composite index. Once the composite index is successfully generated, we will determine the operational assistance unit cost (EOA) per district/city. Research is required to evaluate policy implementation, specifically to ascertain the EOA unit costs for equivalency education. The acquisition of unit costs should align with principles of fairness, completeness, and sustainability. This study focuses on meeting operational needs to generate maximum benefits, particularly when costs closely reflect the actual requirements of students in terms of diversity and nominal values, ensuring appropriate distribution.

The following section summarizes previous literature discussing terminology from different perspectives and the application of indices in unit cost calculations through an empirical approach in the context of equity education. This is followed by an explanation of the methodology used. The paper then describes the empirical study and the results obtained. The final section presents the conclusions and recommendations of this research.

2. Literature on Educational Equity and Unit Cost Indices

In this section, we review previous literature on terminology related to educational equity and the use of cost indices in calculating educational cost estimates. This review examines different perspectives on the definition of equity in education and explains how empirical analyses have been conducted in previous studies.

2.1 Equal Education Terminology

1. Informal education is a lifelong learning journey where individuals acquire attitudes, values, skills, and knowledge through various experiences and resources available in their environment. Specific resources include family, neighborhood circles, work and leisure activities, market interactions, access to library facilities, and content presented by mass

media. Informal education plays a fundamental role in shaping individual personalities and life trajectories over time.

2. Formal education follows a hierarchical and chronological sequence from primary to tertiary levels. This framework includes general academic programs, specialization programs, and full-time vocational and technical training institutions.
3. Non-formal education consists of structured educational activities outside the formal framework, which may operate independently or as part of a broader program. It aims to provide services to specific target groups and achieve defined educational goals (Bacquelaine & Raymaekers, 1991). This last definition is particularly relevant given the varying interpretations by different authors.

Non-formal education occurs outside the traditional school context, as explained by Adams et al. (2020), Werquin (2012), Jackson (2016), Kalenda (2015), and Kalenda and Kočvarová (2022). However, the concept of non-formal education is not new; it reflects pre-existing ideas approached differently. It can be understood from three core perspectives: process, system, and context (Zikargae et al., 2022). As a process, it emphasizes active participation in learning. In terms of system, non-formal education differs significantly from formal education across five dimensions: objectives, time, material, implementation, and control (Pienimäki et al., 2021). From a contextual perspective, it acknowledges the informal atmosphere that enhances learning dynamics, noting that not all participants are necessarily adults (Kedrayate, 2012).

Non-formal education can also be viewed as a structured learning process initiated by non-formal institutions within a set timeframe, aimed at providing students with knowledge and skills, supported by appropriate facilities (Milana & Nesbit, 2015). According to Gloria et al. (2014) and Willems (2015), non-formal education can take various forms, including:

1. Second-chance education for those unable to attend regular classes.
2. Youth clubs focusing on substantive education.
3. Adult education and training.
4. Community education addressing local needs.
5. Individual development plans involving cultural programs, sports, vocational training, and skill enhancement for the unemployed.

Providers of non-formal education may include public institutions, partnerships between the private sector and public entities, trade unions, media organizations, NGOs, and international organizations (Latchem, 2014).

In Indonesia, Law Number 20 of 2003 on the National Education System recognizes three educational pathways: formal, non-formal, and informal education. These pathways complement each other and enrich the educational system. Article 13, Paragraph 1 illustrates this principle, while Article 26 details non-formal education pathways. Article 26, Paragraph 3, emphasizes that non-formal education encompasses a range of forms, such as life skills, early childhood education, literacy programs, and equality education. This law provides a robust legal foundation for developing non-formal learning in Indonesia.

One significant form of non-formal education is equivalency education, defined as an organized system outside formal education boundaries with regular structures (Henschke, 1998; Gloria et al., 2014; Marques & de Freitas, 2016). It offers educational services to children unable to access formal education due to poverty, geographical remoteness, or developmental delays (Boyadjieva & Trichkova, 2022). The educational services include the Package A Program (equivalent to primary school), Package B Program (lower secondary), and Package C Program (upper secondary). These programs objectively assess educational outcomes without subjective evaluations, ensuring clear and concise information.

Moreover, the initiative by Herlyna et al. (2019) enables students to attend weekend classes without disrupting their work productivity. This educational initiative recognizes that access to education is a fundamental human right that persists throughout one's lifetime (Choi, 2021). Implementing equitable education is crucial as it adapts to various circumstances that restrict access

to formal education, such as financial limitations, time constraints from work, remote geographic locations, and socio-legal barriers (Munawwir & Hanip, 2021).

2.2 Unit Cost of Education

Education at all levels represents a significant policy focus for a country, involving substantial public expenditure (Dewi, 2019). From an economic perspective, education and training are valuable investments for the government, contributing to employment, productivity, and overall economic growth, which in turn influences Gross Domestic Product (GDP) and net social benefits (Griffin, 2016).

Cost refers to the expenses incurred in producing a specific product, measured from the producer's perspective in nominal currency (Ngadirin, 2011). Costs can fluctuate due to market dynamics, resulting in increases or decreases in value (Olajide et al., 2018). The term "cost" has various applications across contexts and relates to economic assets with intrinsic value (Fauzi, 2020). The cost function is essential for generating profits (Nurdiyanti, 2021). In educational institutions, cost encompasses all expenses necessary for delivering educational services (Budi, 2020). Costs consist of direct and indirect components; direct costs typically include materials and labor expenses directly associated with a specific cost object, while indirect costs cannot be precisely attributed to a single cost object (Novák et al., 2017).

According to Gaspersz (2003), costs reflect the efficiency of the production system from a managerial economics standpoint. Within the educational context, the cost approach views educational institutions as stakeholders that produce services encompassing expertise, skills, knowledge, character, and values (Hasibuan & Pendi, 2021). Educational institutions acquire human resources as inputs, developed through various educational and training processes to meet labor market demands. Ţaran-Moroşan et al. (2010) identify two key components of education costs: actual expenditure and opportunity cost incurred by individuals investing in education. Actual expenses include easily measurable investments such as tuition, books, and travel costs for educational purposes (Hariyanto, 2020).

Building on Mutegi's (2015) perspective, education costs involve the precise resources required to foster educated individuals (Dewi & Indrayani, 2021). Ferdi W. P. (2013) notes that in education, cost components consist of both direct and indirect costs. Direct costs include expenses for teaching activities, maintenance of learning facilities, transportation, and compensation for teaching staff, covered by the government, parents, or students. Indirect costs encompass missed opportunities, such as pocket money and educational equipment, and potential profits forfeited during the educational process.

Following Fironika's (2011) study, two aspects require analysis: the total cost of education and the cost per unit for each student. The cost per unit includes aggregate costs contributed by the government, parents, and the community to support education for one academic year in formal institutions. This concept provides an objective measure for effective fund allocation in educational settings (Wakhid, 2020). The unit cost of education is calculated by dividing the total expenditure incurred by the institution for a given period by the number of students (Fattah, 2009). Educational unit costs represent the operational expenses allocated by institutions divided by the number of active participants during a defined period, typically calculated within the academic year, which is divided into two semesters (Alwi, 2017).

Ekanem and Ekpiken (2013) define unit costs as calculated per unit, essential for education management in achieving predetermined goals. Identifying unit cost components includes per student cost, per graduate cost, program costs, tuition costs, material costs, and per capita education costs across various community settings. Unit costs are based on routine or operational costs associated with educational activities.

The aim is to obtain a cost per student unit, estimating the average cost incurred by each student over a specified time to obtain an education. This unit cost serves as a benchmark for

meeting the educational needs of each student. Understanding costs per unit, based on level and type of education, is invaluable for evaluating policy alternatives aimed at improving education quality (Anwar, 2018; Jaelani et al., 2021).

2.3 Reference Index for Calculating Unit Cost of Education

In addition to education inflation, an important economic indicator used as a reference in unit cost calculations is the economic index of each region. This index accounts for variations in price levels of goods and services in different areas.

1. Education Cost Index (ECI): Specified in Regulation (Permendiknas) No. 69/2009 by the Minister of National Education, the ECI is a spatial index comparing non-personnel operating costs of education between regions for a given period. Although it calculates the standard cost of education between districts/cities, it is outdated and no longer relevant as a reference guide.
   - Education Costs: Refers to the nominal amount in Rupiah spent to accommodate all resources needed for the education process.
   - Education Operational Costs: These expenditures acquire educational resources used within one year or less, including salaries for teaching staff, maintenance of infrastructure, and energy-related expenses.
   - Personnel Education Operational Costs: Expenses allocated to support the welfare and development of personnel involved in the learning process, such as educators and administrative staff.
   - Non-Personnel Education Operational Costs: Expenditures required for materials, equipment, and supplies used in the learning process.
2. Construction Cost Index (CCI): Compiled by the Central Statistics Agency (CSA), the CCI reflects the level of construction costs in a specific area. It compares the value of goods and services included in the CCI commodity collection across districts/cities or provinces. The CSA periodically updates the CCI annually.
3. Purchasing Power Parity (PPP): This economic concept, popularized by David Ricardo and Gustave Cassel, is based on the law of one price, which states that identical goods in two countries should have the same price when evaluated using the same currency.

Secondary data from these references for calculating unit costs are available for each Regency/City. The CSA updates the CCI and PPP data annually, considering local conditions. The government advocates using unit education costs based on regional factors in the future.

The calculation of educational costs is a critical area of research in educational economics, significantly influencing policy decisions and funding allocations. Two prominent indices utilized in this context are the Construction Cost Index (CCI) and Purchasing Power Parity (PPP). The CCI measures the relative cost of construction materials and labor over time, providing insights into the financial requirements for building and maintaining educational infrastructure. Studies, such as Siatan et al. (2024) have demonstrated that regional disparities in CCI can affect school funding and infrastructure development, highlighting the necessity for localized approaches to educational cost calculations. Conversely, PPP compares different countries' currencies through a "basket of goods" approach, allowing for a more accurate assessment of living standards and economic productivity. Research by Bahramian and Saliminezhad (2021) on Southeast Asian countries revealed that reliance on PPP can lead to more equitable funding distributions when adjusted for local economic conditions. The integration of CCI and PPP has been explored in various studies, including Fabre and Straub (2019), which assessed educational funding adequacy across states, finding that while CCI provided insights into infrastructure costs, PPP was essential for understanding the purchasing power of educational budgets. Other countries, like Finland, have adopted comprehensive funding models that consider construction and operational costs alongside socio-economic factors affecting student performance (Elasmay, 2022). This holistic approach contrasts with the segmented use of CCI and

PPP, suggesting that incorporating a wider range of variables may enhance the accuracy of educational cost assessments. Overall, the literature indicates a growing recognition of the importance of both CCI and PPP in educational cost calculations, yet there remains a need for further research that combines these indices with other relevant factors, such as regional economic conditions and socio-demographic variables. By situating the current study within this broader context, it becomes evident that the innovative approach of using relative importance regression and winsorization to calculate the Equal Education Cost Index (EECI) in Indonesia not only contributes to the existing body of knowledge but also addresses gaps in the empirical literature.

2.4 Regression Using Relative Importance and Winsorization Approach

The term "relative importance" refers to the process of quantifying the contribution of each predictor variable to a multiple regression model. The evaluation of relative importance is determined by the contribution of each predictor variable to the model's R^2 value. This means that the statistical R^2 value of the multiple regression model is subdivided into portions associated with each predictor variable (Groemping, 2006).

Generally, two common methods can be employed to address outliers in the data: the trimming method and the winsorization method. The trimming method involves removing observations with extreme values, thereby excluding them from the dataset. This method is most suitable for survey data with a large sample size, where outlier values do not accurately reflect the subject under investigation. If the outlier values accurately represent the subject being surveyed within a limited dataset and have a spatial dimension, deletion of these observations is not recommended. Instead, the winsorization method is preferred for handling these outliers. This method involves adjusting extreme x values downward and shallow values upward, while leaving moderate values unchanged (Chambers et al., 2000).

3. Method

3.1 Data Source

To calculate the Sustainable Development Index, certain criteria must be met by the variables and indicators used. These criteria include being issued by a legitimate agency, being published continuously, and being relevant to education costs. In accordance with these criteria, the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) will be employed as indicators when determining the Education Cost Index (ECI). Both the CCI and PPP are published by the Central Statistics Agency (CSA). The Sustainable Development Index model is validated against the Family Welfare Index and Gross Regional Domestic Product (GRDP) using target variables. In this context, data from the School Activity Plan and Budget Application (ARKAS) regarding school operational assistance funds is utilized.

In the study, we employed two advanced statistical techniques—relative importance regression and winsorization—to enhance the rigor and reliability of their analysis in calculating the Equal Education Cost Index (EECI) in Indonesia. The relative importance regression was selected for its suitability in assessing the contribution of the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) to the EECI, thereby facilitating a nuanced understanding of the influence of each predictor on the outcome variable. This method is particularly advantageous in contexts where multiple factors interact, as it provides a clearer picture of the relative weight of each variable, rather than merely presenting coefficients that may obscure their interdependencies. The utilization of relative importance regression allowed the authors to elucidate the significant role that the Construction Cost Index (CCI) plays in determining educational costs, thereby offering valuable insights for policymakers regarding the prioritization of indices in funding decisions. Conversely, winsorization was employed to address the potential influence of outliers in the dataset derived from

the Indonesian Central Statistics Agency for the years 2021 and 2022. This statistical technique entails the replacement of extreme values in the data set with the nearest values that fall within a specified percentile range, such as the 5th and 95th percentiles. The rationale for this choice was to mitigate the influence of outliers that could skew the results and lead to misleading conclusions about the correlation between CCI and PPP. By implementing winsorization, the authors ensured the robustness and reflective nature of their analysis, thereby facilitating more accurate estimates of the EECI. These methodological choices serve to reinforce the analytical framework of the study while also facilitating a more comprehensive grasp of the intricate dynamics at play in the context of educational funding in Indonesia.

3.2 Construction Cost Index (CCI)

The Construction Cost Index (CCI) is a spatial index that serves as a numerical representation of the comparison of construction costs in a district or city relative to a reference city. The CCI is derived from data collected through the Construction Feasibility Price Survey (CFP), an annual activity conducted by the Central Statistics Agency (CSA). The price data included in the CFP survey encompasses the costs of building materials, heavy construction equipment rental, and wages for construction services. In addition to these data, information regarding the realization of the Regional Revenue and Expenditure Budget at the district and city levels, as well as Detailed Unit Prices (Bill of Quantities - BoQ) from completed projects, is also gathered as weighting factors for the District/City Welfare Index (CCI) at both district/city and provincial levels. This data is obtained through simultaneous surveys conducted in all districts and cities in Indonesia, with an average sample size of 15 trader respondents in each district or city across four different periods: January, April, July, and October.

The interpretation of the Construction Cost Index (CCI) value is as follows: if the CCI value is 100, this indicates that, generally, the price of construction materials in a regency or city is similar to that of the reference city; if the CCI value is greater than 100, it indicates that the price of construction materials in the district or city is generally higher than in the reference city; conversely, if the CCI value is less than 100, it indicates that the price of construction materials in the district or city is generally lower than in the reference city. The CCI data used is from 2021, with the city of Makassar serving as the reference.

3.3 Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) refers to the purchasing power of individuals for goods and services. The PPP calculation involves the use of 96 types of commodities, which include 66 distinct food items and 30 types of non-food commodities. The writing is free of grammatical and spelling errors, and bias has been avoided throughout. The data used for PPP is from 2021, with South Jakarta as the reference city. Technical abbreviations employed are explained within the text. As indicated by the Construction Cost Index (CCI), which correlates the price of building materials with the cost of education, the prices of both food and non-food commodities that constitute the Gross Regional Domestic Product Per Capita (GRDP) Index are also believed to be correlated with education costs.

3.4 School Operating Assistance (SOA) Fund Usage Data

To verify the suitability of the Regency/ Construction Cost Index (CCI) and Gross Regional Domestic Product Per Capita (GRPD) as components of the synthesized Human Development Index (HDI), it is essential to establish a target variable that effectively captures education-related expenditures at the educational unit level. Since both the CCI and PPP focus on the district/city administrative unit level, the target variables must share the same unit basis. Therefore, the only viable choice for the target variable is to report data regarding the usage of School Operational Assistance Funds (SOA) by each

educational unit, as conveyed through the RKAS (Realization of School Activities and Budget) application. Details on the use of SOA funds extracted from RKAS are thoroughly explained, in alignment with the components outlined in Permendikbudristek Number 2 of 2022 regarding Technical Instructions for the Management of Operational Assistance Funds for Early Childhood Education, School Operational Assistance, and Operational Assistance for Implementing Equal Education (see Table 2). In addition to data on the usage of SOA funds, information regarding the number of students, teachers, and teacher status was also gathered.

Table 2. Components of Use of SOA Funds

Component	Information
Component 1	Acceptance of New Students
Component 2	Library Development
Component 3	Implementation of Learning and Extracurricular Activities
Component 4	Implementation of Learning Assessment and Evaluation Activities
Component 5	Implementation of Administration of School Activities
Component 6	Professional Development of Teachers and Education Personnel
Component 7	Power and Service Subscription Financing
Component 8	Maintenance of School Facilities and Infrastructure
Component 9	Provision of Learning Multimedia Tools
Component 10	Organizing Skills Competency Improvement Activities
Component 11	Organizing Activities to Support Graduate Absorption
Component 12	Honor Payments

3.5 *Analysis Stages*

The following are the stages of data analysis carried out.

a. Calculate the actual expenditure of School Operational Assistance (SOA) funds for each component per student. This calculation is carried out by dividing the value of each component by the number of students in each school as recorded in Table 3.

Table 3. Variables for Realization of Expenditure and SOA for Each Component per Student

No.	Variable	Unit
1	Component 1 per student	Rupiah/person
2	Component 2 per student	Rupiah/person
3	Component 3 per student	Rupiah/person
4	Component 4 per student	Rupiah/person
5	Component 5 per student	Rupiah/person
6	Component 6 per student	Rupiah/person
7	Component 7 per student	Rupiah/person
8	Component 8 per student	Rupiah/person
9	Component 9 per student	Rupiah/person
10	Component 10 per student	Rupiah/person
11	Component 11 per student	Rupiah/person
12	Component 12 per student	Rupiah/person
13	Total cost per student	Rupiah/person

b. Calculate the variable percentage of Civil Servant (PNS) teachers at each school.
c. Calculate the variable percentage of total honorarium (component 12) to total expenditure. This variable is calculated using the following formula:

Percentage of total honorarium = (Component 12/ Total Fees) × 100%

d. Filtering school data that will be used as a sample in calculating the composite index. In this case, there are 3 alternatives used, namely:

Alternative 1: Based on an analysis of the percentage of school expenditure on honorariums, the school data considered is schools that show a percentage of expenditure on honorariums of less than 30%.

Alternative 2: Based on the number and percentage of State Civil Service (ASN) teachers, with the minimum limit referring to the information listed in Table 4.

Table 4. Minimum Filtering Limit for Alternative 2

No	Level	Min. The number of students	Min. Percentage of Civil Service Teachers
1	Elementary School	336	80%
2	Junior High School	384	80%
3	Senior High School	324	80%
4	Vocational School	324	80%

Alternative 3: Based on the number and percentage of ASN teachers, the minimum limit is based on Table 5.

Table 5. Minimum Filtering Limit for Alternative 3

No	Level	Min. The number of students	Min. Percentage of Civil Service Teachers
1	Elementary School	504	70%
2	Junior High School	576	70%
3	Senior High School	432	70%
4	Vocational School	432	70%

e. Calculate the average realization of the use of School Operational Assistance (SOA) funds per component per student and per district/city area.
f. Combine data in stage e, with CCI and PPP data
g. Data exploration is carried out at stage f. The data exploration process includes creating a histogram of the Construction Cost Index (CCI) and Gross Regional Domestic Product per Capita (GRDP) variables, as well as calculating the correlation value between the average of each component per student with the CCI and PPP variables.
h. Determine a target variable (dependent variable) that reflects a proxy for variations in actual education unit costs: either per component or an aggregation of several relevant components. The target variable chosen is the one that has the highest correlation with the Construction Cost Index (CCI) and Gross Regional Domestic Product per Capita (GRDP) variables. At this stage, the CCI and PPP variables are explored with the aim of enabling handling steps if outlier values are detected.
i. Carry out linear regression analysis between components that have a high correlation with the CCI and PPP variables, then evaluate the R^2 value. A high R^2 value means that the model formed is able to explain the diversity of the target variable, namely the high component expenditure per selected student.
j. The best model is selected based on the highest coefficient of determination (R^2). After that, the relative importance weights were calculated for the Construction Cost Index (CCI) and Gross Regional Domestic Product per Capita (GRDP) variables. (Groemping, 2006).
k. The calculation of the Education Cost Index (ECI) for each district/city is carried out based on the relative importance weights that have been generated at stage j.

4. Results and Discussion

4.1 Data Exploration

Figure 1 displays a histogram for the CCI variable (Figure 1(a)) and the PPP variable (Figure 1(b)). Generally, the distribution patterns of these two variables are right-skewed, with several extreme observations (outliers).

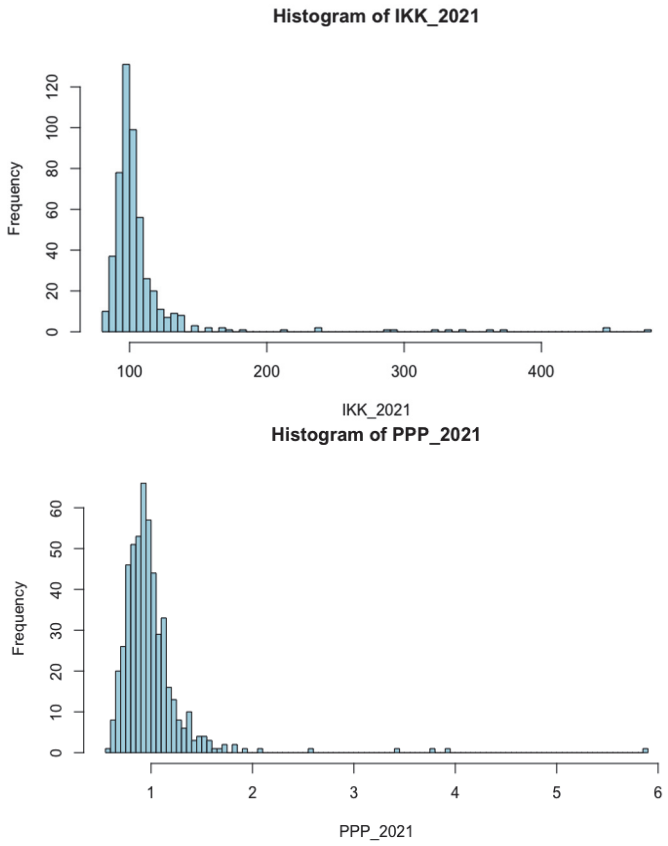

Figure 1. Histogram of Variables: (a) CCI, (b) PPP

In summary, the Construction Cost Index (CCI) variable ranges from a minimum of 80.99 to a maximum of 478.12, indicating a significant difference. Similarly, the Gross Regional Domestic Product per Capita (GRDP) variable has a range between 0.567 and 5.875, also showing a notable difference. In this study, outlier observations were addressed using the one-sided winsorization method (Chambers et al., 2000).

To apply the winsorization method, a cut-off value is established. For the CCI variable, the cut-off is set at K = 150, meaning that districts/cities with a CCI value greater than 150 will have their values adjusted to 150. For the PPP variable, the cut-off is set at K = 1.5, so districts/cities with a PPP value greater than 1.5 will have their values adjusted to 1.5. This choice of K values aims to create a more symmetrical data distribution for both the CCI and PPP variables (Figure 2).

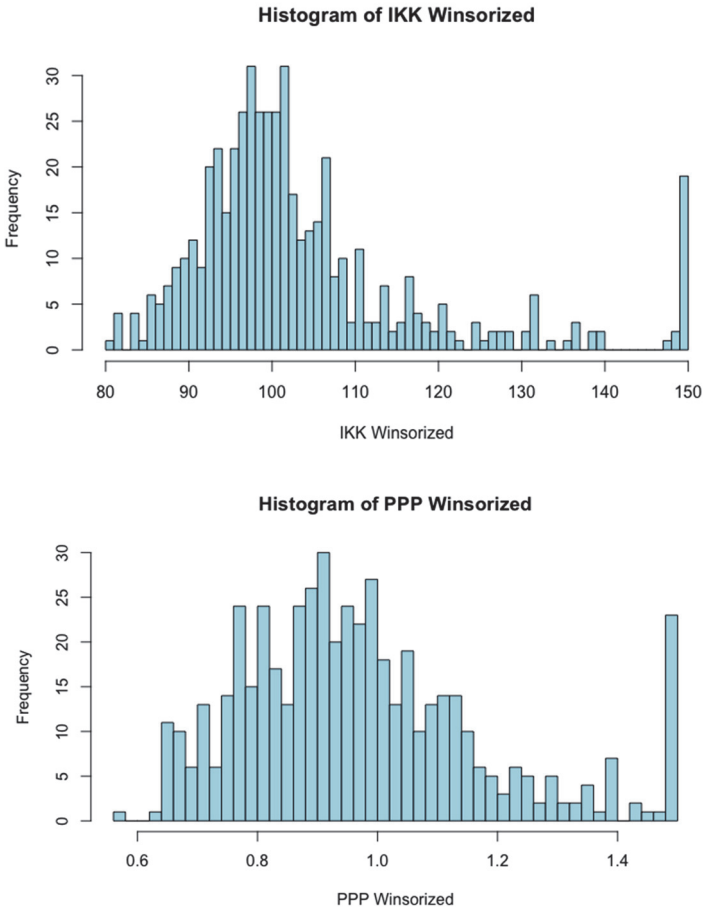

Figure 2. Histogram After One-sided Winsorization Process for Variables: (a) CCI, (b) PPP

Furthermore, the variables City Poverty Index (CCI) and Construction Cost Index (GRDP) which have gone through the winsorization process are also taken into account in determining the regression model used to form the composite index. This analysis approach was carried out on data from the Junior High School and Senior High School levels.

4.2 EOA Analysis Results

The number of schools included in the School Activity Plan and Budget Application (ARKAS), which are part of the Education Operational Assistance (EOA), is 196,978. The next step is to conduct the filtering process, with the following results:

4.3 EOA Analysis Results for CLC and SKB Levels

After filtering the levels of Community Learning Centers (CLC/PKBM) and Learning Center (LC/SKB), a total of 7,471 schools meeting the criteria were identified. Additionally, following the

aggregation process of average components per student per district/city, the results revealed that 501 districts/cities were included in this analysis.

Table 6 below presents the correlation values between the average of each component per student and the CCI and PPP variables, both before and after the winsorization process was applied.

Table 6. Correlation Value Between Each Component Average per Student on CCI and PPP for CLC and SKB Levels

Variable	CCI	CCI Winsor	PPP	PPP Winsor
Average Component 1 per student	0.160	0.142	0.272	0.220
Average Component 2 per student	0,000	-0.026	-0.024	-0.047
Average Component 3 per student	-0.054	-0.033	-0.113	-0.125
Average Component 4 per student	-0.057	-0.036	-0.100	-0.105
Average Component 5 per student	0.025	0.079	-0.055	0.089
Average Component 6 per student	-0.040	-0.050	-0.047	-0.045
Average Component 7 per student	-0.116	-0.087	-0.113	-0.129
Average Component 8 per student	-0.041	-0.047	-0.085	-0.033
Average Component 9 per student	-0.147	-0.126	-0.148	-0.174
Average Component 10 per student	-0.146	-0.106	-0.175	-0.181
Average Total Cost per student	-0.177	-0.122	-0.251	-0.234

Based on the table above, it can be seen that the correlation value between each component average and the PPP and CCI variables shows a relatively low level of correlation. Therefore, the decision was taken not to continue exploration at this stage.

4.4 EOA Analysis Results for CLC and SKB Levels with Alternative 1

At this stage, a filtering process is conducted at the Community Learning Centers (CLC/PKBM) and Learning Center (LC/SKB), levels, as previously done. Additionally, the first filtering criterion is applied: filtering out schools with a percentage of expenditure/realization for honoraria (component 10) of less than 20%. As a result, 1,225 schools met these criteria. After aggregating the average components per student per district/city, data were obtained from 341 districts/cities.

Table 7 below shows the correlation values between each average component per student and the CCI and PPP variables, both before and after the winsorization process.

Table 7. Correlation Value Between Each Component Average per Student on CCI and PPP for Alternative CLC and SKB level 1

Variable	CCI	CCI Winsor	PPP	PPP Winsor
Average Component 1 per student	0.083	0.094	0.056	0.124
Average Component 2 per student	0.068	0.086	0.003	0.029
Average Component 3 per student	-0.047	-0.030	-0.090	-0.142
Average Component 4 per student	0.008	0.032	-0.034	-0.047
Average Component 5 per student	0.014	0.078	0.010	0.138
Average Component 6 per student	-0.069	-0.095	-0.032	-0.032
Average Component 7 per student	-0.099	-0.070	-0.081	-0.104
Average Component 8 per student	-0.080	-0.068	-0.061	-0.050
Average Component 9 per student	-0.080	-0.032	-0.097	-0.033
Average Component 10 per student	-0.044	-0.053	-0.029	-0.075
Average Total Cost per student	-0.033	0.009	-0.078	-0.066

However, based on the table above, it can be concluded that the correlation value between each component average for the PPP and CCI variables indicates a relatively low level of correlation. This condition resulted in the decision not to continue further exploration at this stage.

4.5 EOA Analysis Results for All Levels

In this exploration, all levels of EOA were involved, namely Early Childhood Education, Community Learning Centers, and Learning Center (SKB), with a total of 196,978 schools. After that, at the aggregation stage, the average component per student per district/city was 514 districts/cities.

Table 8 below describes the correlation value between each average component per student and the CCI and PPP variables, both in conditions without the winsorization process and after the winsorization process has been carried out.

Table 8. Correlation value between each component average per student on CCI and PPP for all EOA levels

Variable	CCI	CCI Winsor	PPP	PPP Winsor
Average Component 1 per student	0.524	0.319	0.475	0.433
Average Component 2 per student	0.271	-0.010	0.118	0.061
Average Component 3 per student	0.008	-0.009	-0.001	-0.030
Average Component 4 per student	0.059	0.075	0.015	0.033
Average Component 5 per student	0.230	0.231	0.177	0.330
Average Component 6 per student	0.005	0.022	-0.048	-0.037
Average Component 7 per student	0.314	0.150	0.067	0.127
Average Component 8 per student	0.321	0.132	0.318	0.140
Average Component 9 per student	0.147	0.026	0.096	0.093
Average Component 10 per student	0.056	0.058	0.100	0.164
Average Total Cost per student	0.346	0.149	0.315	0.175

Based on the analyzed correlation values, the three component averages that demonstrate the strongest correlation are selected for the composite index formation process. These components are Average Component 1 per student, Average Component 5 per student, and Average Component 8 per student. Due to the significant correlation between the two, the modeling for the composite index was conducted using the CCI and PPP variables without applying winsorization. A linear regression analysis was then performed to investigate the relationships between the target variables of the selected components and their totals with the CCI and PPP variables.

Table 9 presents a summary of the regression analysis results for each selected component using the CCI and PPP variables, along with the associated R^2 values. The results indicate that the model including the target variable, Average Component 1 per student, shows the highest R^2 value at 31.16%.

Table 9. Estimated values of regression coefficients and coefficients of determination (R^2) calculated for a number of models that consider the predictor variables Construction Cost Index (CCI) and Purchasing Power Parity (PPP) at all levels of Educational Operational Costs (EOA).

Model	Y	Intercept	CCI	PPP	R^2
1	Comp. 1	-9281.83	100.95	16844.72	31.16%
2	Comp. 5	65028.39	56.04	21131.80	5.51%
3	Comp. 8	-402740	2184	248386	12.65%
4	Total Comp 1, 5, 8	-346993.6	2340.7	286362.3	15.44%

4.6 EOA Analysis Results for All Levels with Alternative 1

In this exploration, all levels of EOA were used, namely Early Childhood Education, Community Learning Centers, and Learning Center (SKB). This analysis was conducted by applying filter alternative 1, resulting in 86,008 schools. After aggregating the data based on the average component per student per district/city, a total of 508 districts/cities were included in this analysis.

Table 10 below presents the correlation values between each average component per student and the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) variables, both for those that have not undergone the winsorization process and for those that have.

Table 10. The correlation value between each average component per student and the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) variables has been calculated for all levels of Educational Operational Costs (EOA) using the first alternative model.

Variable	CCI	CCI Winsor	PPP	PPP Winsor
Average Component 1 per student	0.488	0.270	0.312	0.370
Average Component 2 per student	0.322	0.035	0.191	0.105
Average Component 3 per student	-0.007	-0.010	-0.017	-0.037
Average Component 4 per student	0.020	0.026	0.015	0.010
Average Component 5 per student	0.282	0.255	0.290	0.431
Average Component 6 per student	0.027	0.036	-0.001	0.018
Average Component 7 per student	0.349	0.152	0.117	0.170
Average Component 8 per student	0.166	0.091	0.174	0.069
Average Component 9 per student	0.207	0.074	0.168	0.197
Average Component 10 per student	0.234	0.075	0.204	0.161
Average Total Cost per student	0.036	0.013	0.025	-0.014

Based on the correlation values presented above, the two component averages that showed the highest correlation, namely Component Average 1 per student and Component Average 5 per student, were selected for the formation of a composite index. The modeling process for this composite index utilizes the CCI variable without applying the winsorization method, as well as the PPP variable, since both exhibit significant correlation values. Subsequently, linear regression analysis is conducted to investigate the relationship between the target variables derived from the selected components and their totals, using the CCI variable that has not undergone winsorization and the PPP variable.

Table 11 summarizes the regression analysis results for each selected component, involving the CCI variable (which has undergone the winsorization method) and the PPP variable. Additionally, the coefficient of determination (R^2) value is presented. These results reveal that the model involving the target variable, which includes the total of Average Component 1 and Average Component 5 per student, produces the highest R^2 value of 27.24%.

Table 11. Estimated regression coefficient values along with determination values (R^2) for several models that consider CCI and PPP predictor variables at all levels of Educational Operational Costs (EOA), with the first alternative model.

Model	Y	Intercept	CCI winsor	PPP	R2
1	Comp. 1	-22098.80	227.36	20460.89	25.72%
2	Comp. 5	-51639.4	1453.0	11290.7	19.08%
3	Total Comp 1.5	-73738.2	1680.3	31751.6	27.24%

Based on the data recorded in Table 9 and Table 11, the conclusion that can be drawn is that the most optimal model is model 1, which is recorded in Table 9. This regression model utilizes the target

variable in the form of an average of 1 component per student, with the variable predictor of CCI and PPP. This model was applied to data covering all Educational Operational Costs (EOA) levels and obtained a coefficient of determination (R2) of 31.16%. Therefore, based on this framework, the LMG method (Groemping, 2006) is used to identify the relative contribution of R^2, which is then calculated as the average of the sequence of predictor variables. The results of the composite index obtained based on this relative contribution are as follows:

$IBP = \beta_1 CCI + \beta_2 PPP$

ECI = (0.42 × CCI) + (0.58 × PPP)

The findings of the study reveal a significant weight of the Construction Cost Index (CCI) in determining the Equal Education Cost Index (EECI) in Indonesia, which carries important implications for future educational funding policies. Given that the CCI has been shown to have a stronger influence than Purchasing Power Parity (PPP), policymakers may need to prioritize infrastructure investments and construction-related expenditures when allocating educational resources. This could lead to a more equitable distribution of funding, particularly in regions where infrastructure development is lagging. However, relying predominantly on CCI as a primary determinant of educational costs presents potential limitations. For instance, while CCI provides valuable insights into the costs associated with building and maintaining educational facilities, it may not fully capture the complexities of educational quality and access. Factors such as teacher salaries, training, and student support services, which are critical for enhancing educational outcomes, may not be adequately reflected in the CCI. Additionally, the regional variations in CCI could lead to disparities in funding that do not necessarily align with the actual needs of students in different areas. Therefore, while the study's findings underscore the importance of CCI in educational funding, it is essential for policymakers to consider a more holistic approach that incorporates multiple indices, including PPP and other socio-economic factors, to ensure that funding decisions are equitable and responsive to the diverse needs of the educational landscape. By addressing these complexities, the discussion can provide a more nuanced interpretation of the results, highlighting the need for a balanced approach to educational funding that considers both infrastructure and the broader context of educational quality.

Indonesia is characterized by a wide range of economic conditions, geographic features and cultural contexts, which can lead to significant differences in both the costs associated with educational infrastructure and the purchasing power of households in different regions. For example, urban areas such as Jakarta may have higher CCI values due to increased construction costs driven by demand and limited space, while rural areas may have lower CCI values but face challenges related to accessibility and quality of materials. Similarly, PPPs can vary significantly across regions, reflecting differences in local economies, wage levels, and cost of living. By exploring these regional differences, the study could provide deeper insights into how education funding is allocated and whether it adequately addresses the unique needs of different areas. Understanding these disparities is critical to ensuring equitable educational outcomes, as regions with lower CCI and PPP may require targeted interventions to improve educational access and quality. Moreover, a nuanced analysis of regional disparities could inform policymakers about the need to adjust funding formulas to reflect local economic conditions, thereby promoting a more equitable distribution of resources that addresses the specific challenges faced by different regions. This consideration of regional variation would not only enrich the findings of the study, but also contribute to a broader understanding of the dynamics influencing education funding in Indonesia.

5. Conclusions

Overall, this study concludes that improvements are needed in managing Equality Education Operational Costs (EEOA), particularly in calculating the EOA index. This conclusion can be elaborated based on the focus of the study, which is explained as follows. From the various indicators considered, this research has resulted in the development of a composite index. The index consists of

the Construction Cost Index (CCI), which has previously been used in policy, and the Purchasing Power Parity (PPP), which serves as a balancing factor for the CCI. By integrating the Construction Cost Index (CCI), which emphasizes the physical dimension, and the Purchasing Power Parity (PPP), which focuses on the non-physical dimension, it is hoped that the composite index, namely the Education Operational Costs (EOA) index, can more effectively present the various prices influencing the EOA unit costs in each district/city.

The analysis included observing the correlation coefficient and the R^2 value in the regression between each indicator and the amount of expenditure per student on each component of SOA expenditure, derived from data from the School Activity Plan and Budget Application (ARKAS). The Construction Cost Index (CCI) and Purchasing Power Parity (PPP) used in preparing the EOA index underwent transformation using the winsorization method to reduce the asymmetry and right skewness inherent in these two indicators. If this transformation is not implemented, there is a risk that several districts/cities may exhibit excessively high EOA index values, which could impact regional allocations and the capacity of educational institutions to manage significant cost increases. Furthermore, this winsorization process contributes to an increase in the correlation coefficient and the coefficient of determination (R^2), indicating a closer relationship between the Construction Cost (CCI) and Purchasing Power Parity (PPP) with expenditure patterns in the educational environment.

6. Recommendations

Efforts are needed to determine the cost of the Equality Education Operational Costs (EEOA) unit to achieve fairness across different regions. This analysis proposes a cost magnitude framework that considers differences in unit cost based on geographic location. This scheme identifies EOA unit costs by accounting for variations in unit costs for each district/city. The EOA index calculation incorporates the Construction Cost Index (CCI) and Purchasing Power Parity (PPP) without subjective evaluations. Technical abbreviations will be explained upon first use. This revised approach is expected to outperform the current uniform (flat) scheme. The existing EOA unit cost calculation references the 2021 regular SOA unit costs, which consider only the CCI. Therefore, according to the EOA index calculation, which incorporates both the CCI and PPP, it is essential to re-evaluate the implementation guidelines based on the institution's level of activity and regional price increases.

The findings of the study present significant implications for practice, particularly in guiding policymakers on how to effectively allocate School Operational Assistance (SOA) funds in Indonesia. Given the demonstrated importance of the Construction Cost Index (CCI) in determining the Equal Education Cost Index (EECI), it is essential for policymakers to adjust SOA fund allocations to reflect the varying construction costs associated with educational facilities across different regions. One actionable recommendation is to develop a tiered funding model that accounts for regional disparities in CCI, ensuring that areas with higher construction costs receive adequate financial support to maintain and improve educational infrastructure. Additionally, policymakers should consider incorporating a formula that integrates both CCI and Purchasing Power Parity (PPP) to create a more comprehensive funding strategy. This could involve establishing a baseline funding level that is adjusted based on the local CCI and PPP, thereby addressing the unique economic conditions of each region. Furthermore, it would be beneficial to engage local stakeholders, including educators and community leaders, in the funding allocation process to ensure that the specific needs and challenges of each region are adequately represented. By implementing these recommendations, policymakers can enhance the effectiveness of SOA fund allocations, promote equitable access to quality education, and ultimately improve educational outcomes across Indonesia. Such practical applications of the study's findings would not only increase its relevance but also contribute to a more informed and responsive educational funding framework.

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