SDGs Achievement on Social Pillars: A Spatiotemporal Analysis of Education Participation in Indonesia for the 2015 to 2021 Period

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Abstract

Since 2015, education has become an important part of social pillars supporting Sustainable Development Goals (SDGs). The fourth goal of SDGs, quality education, emphasizes inclusive, equitable, and lifelong education. The Indonesian government has prioritized region-based sustainable development in its 2020-2024 Medium-Term National Development Plan (RPJMN). It has also emphasized the achievement of secondary and higher education levels in Human Resource (HR) development targets. This achievement can be realized if there is equal distribution of educational participation, starting from the primary to the tertiary level. This quantitative study aims to analyze and elaborate spatiotemporal insights at every level of education regarding the development of educational participation in Indonesia during the period of 2015 to 2021. Results have shown that there was a significant spatiotemporal development in the achievement of inter-level educational participation during this period. The implementation of regional-based education development needs to be optimized to achieve an inclusive distribution of educational participation among provinces.

Keywords: SDGs 2030, 2020-2024 RPJMN, Educational Participation, Spatiotemporal.

Abstrak

Sejak 2015, pendidikan menjadi salah satu bagian penting dalam pembangunan berkelanjutan (SDGs) pilar sosial. Tujuan ke-4 SDGs yaitu pendidikan berkualitas, penitikberatan pada pendidikan inklusif, merata, dan sepanjang hayat. Pemerintah Indonesia menekankan pembangunan berkelanjutan berbasis wilayah pada RPJMN 2020-2024. Pemerintah juga menekankan capaian jenjang pendidikan menengah ke atas pada highlight sasaran pembangunan SDM. Capaian tersebut dapat terwujud apabila terdapat pemerataan partisipasi pendidikan secara terstruktur dan berkesinambungan, mulai dari jenjang pendidikan SD hingga Perguruan Tinggi. Tujuan dari penelitian ini adalah menganalisis dan mengelaborasi insight secara spasiotemporal pada setiap jenjang pendidikan mengenai perkembangan capaian pembangunan dan pemerataan partisipasi pendidikan di Indonesia pada periode 2015 hingga 2021. Hasil penelitian menunjukkan bahwa terdapat perkembangan signifikan pada pola capaian partisipasi pendidikan antarjenjang dari periode 2015 hingga 2021. Pengimplementasian pembangunan pendidikan berbasis wilayah perlu dioptimalkan untuk mewujudkan pemerataan karakteristik partisipasi pendidikan antarprovinsi.

Kata Kunci: *SDGs 2030, RPJMN 2020-2024, partisipasi pendidikan, spasiotemporal.*

Introduction

Sustainable development is development that emphasizes future conditions by striking a balance between economic, social, and environmental aspects [1] [2]. Since 2015, the aspiration to realize sustainable development has been expressed in a general concept called the Sustainable Development Goals (SDGs)[3].

Education is an important aspect of the social pillars of sustainable development [4] [5] [6]. The

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[2] Peter P Rogers, Kazi F Jalal, and John A Boyd, *An Introduction to Sustainable Development* (Routledge, 2012).

[3] United Nations General Assembly, "Transforming Our World: The 2030 Agenda for Sustainable Development," *United Nations* (New York, 2015).

[4] Bappenas, *Metadata Indikator Sustainable Development Goals (SDGs) Indonesia: Pilar Pembangunan Sosial*, Bappenas (Jakarta, 2020).

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education aspect is contained in the fourth goal of SDGs, namely Quality Education. The goal in global terms is expressed by the tagline 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'[7] [8]. Economically, quality education will produce people who are more competent in knowledge and skills, which can optimize productivity and creativity at work and help empower the economy. Environmentally, quality education can increase awareness and concern for the environment, since environmental sustainability is closely related to various other aspects, including health. Economic progress and environmental sustainability will improve people's quality of life so that social welfare can be realized.

At the national scale, the 2020-2024 Medium-Term National Development Plan (RPJMN) has stipulated in the third of seven points the agenda of 'Improving Quality and Competitive Human Resources', expressed by the tagline 'Human beings are the main capital of national development towards inclusive and equitable development in all regions'[9]. Increasing the distribution of quality education services is one action that the government needs take to realize the third development agenda.

Prioritizing inclusive and equitable education in the 2020-2024 RPJMN is in line with Islamic guidelines regarding education and is also in line with the goals of quality education in SDGs. [10] In addition, the role of industry 4.0,

which describes various ways of integrating cyber technology both physically and non-physically in learning, is also quite large in achieving the SDGs. [11] [12] Islamic education in the Industrial Revolution 4.0 era is also expected to be able to form a skilled and knowledgeable Muslim generation to succeed in this global era in order to achieve the SDG goals.[13] In relation to RPJMN detail points, one of the highlights of the 2024 target in human resource development is that 49.8% of the workforce has upper secondary education or higher. This can be achieved if the implementation of education in Indonesia at every level of education can be felt equally in every region of the country and is sustainable from year to year.

Equity between regions is in line with point two of the development agenda that focuses on the region as the basis of development. Equitable distribution in the implementation of education can be illustrated through education participation data, namely Gross Enrollment Rate (GER) and Net Participation Rate (NER) sourced from Statistics Indonesia (BPS)[14] [15]. GER is the number of children who receive education at a certain level of education in a certain area, while NER is the number of children who receive education per level in a timely manner (Publication of Education Statistics, BPS, 2021). GER and NER have become indicators for measuring the achievement

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[9] Bappenas, *Rencana Pembangunan Jangka Menengah Nasional (RPJMN) 2020-2024* (Jakarta: Bappenas, 2019).

[10] A R Dariah, A R Hidayat, and R Abdullah, "Islamic Values in Sustainable Economic Growth Planning: The Case of Indonesia and Brunei Darussalam," in *Islam,*

Media and Education in the Digital Era (Routledge, 2022), 127–131.

[11] Mohammed Ali Berawi, "The Role of Industry 4.0 in Achieving Sustainable Development Goals," *International Journal of Technology* 10, no. 4 (2019): 644–647.

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[14] Dyah Setyaningrum, Ratna Wardhani, and Nurmali Agustina, "The Fulfillment of the Quality Education in Indonesia Based on Sustainable Development Goals Indicators," *Review of Integrative Business and Economics Research* 10 (2021): 35–42.

[15] Aji Primanto and Gunawan Undang, "Impact Evaluation Of The Road Infrastructure Development Policy In Improving The Quality Of Education Services In Indonesia," *Jurnal Mantik* 5, no. 4 (2022): 2332–2339.

of education development in the 2030 SDGs, namely targets 4.1 and 4.3.

The Indonesian government has emphasized region-based sustainable development in the 2020-2024 RPJMN.[16] [17]The government has also emphasized the achievement of secondary and higher education levels in its Human Resource (HR) development targets. This achievement can be realized if there is an equal distribution of educational participation in a structured manner, starting from primary to tertiary education levels. However, there is no research that provides insight into education participation in Indonesia in a spatiotemporal manner for each level of education. For example, the study entitled "Analisis Angka Partisipasi Kasar Pendidikan Anak Usia Dini (PAUD) di Seluruh Indonesia" analyzed the condition of GER in a spatiotemporal manner between provinces in the 2015 to 2018 period, but only at one level of education, namely early education[18]. In another study, entitled "Analisis Kualitas Penduduk Berdasarkan Indikator Pendidikan di Provinsi Kalimantan Utara Tahun 2018-2019", analyzed the condition of GER at each level of education and over time in the 2018-2019 period, but only for one province, namely North Kalimantan[19].

Given this background, this study aims to analyze and elaborate spatiotemporal insights at every level of education in regard to the development of educational participation in Indonesia during the 2015–2021 period. The

purpose of this research can be detailed as follows:

1. In summary:
   a. Describes the developments in education participation per level in the 2015 to 2021 period.
   b. Test the significance of developmental achievements in education participation per level in 2021 compared to 2015.
2. In detail:
   a. Describe and elaborate on the distribution of education participation conditions between provinces and their development from 2015 to 2021.
   b. Map the grouping of provinces based on the overall characteristics of inter-level education participation in the 2021 period.

The spatiotemporal analysis of developments in participation per education level is expected to provide insight for the government as a basis for regional-based sustainable development to make the implementation of the 2020-2024 RPJMN and SDGs 2030 successful. Through the equal distribution of quality education, it will create people with good character and qualified competencies; to integrate support of sustainable development in economic, social, and environmental aspects; so that a Madani Indonesian society, a civilized society in building, living, and interpreting life[20], can be realized.

Research Method

The data used in this study is secondary data. These data cover the provincial level during the 2015-2021 period and were sourced from BPS. Spatial data in the form of a ".shp" file for the Indonesian provincial level was obtained through the tanahair.indonesia.go.id page[21]. The quantitative research method was chosen based on the type of used data that variates in spatial and temporal aspects. This way we can explore

[16] Dani Darmawan, "The Process of Formulating A Strategic Plan for The Implementation of Vocational Education in Indonesia," in *The 5th International Conference on Research of Educational Administration and Management (ICREAM) 2021*, vol. 5, 2022, 134–140.

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[19] Analisis Kualitas et al., "Analisis Kualitas Penduduk Di Kalimantan Utara Berdasarkan Indikator Pendidikan Tahun 2018-2019" (2018).

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educational development in Indonesia between space and time.

We use two variables to measure educational development. First, the Gross Enrollment Ratio (GER) as an indicator that shows the comparison between the number of people who are still in school at a certain level of education (regardless of the age of the population) to the number of people who meet the official requirements for the population of school age at the same level of education.[22] [23]Second, the Net Enrollment Ratio (NER) as an indicator that shows the proportion of the population in a certain education level age group who are still in school to the population in that age group.[24] [25]GER is the parameter or representation of the level of educational participation, meanwhile, NER can reflect the opportunity to accept education promptly.

The analysis used in this study consists of four stages of analysis. The stages and analysis techniques are as follows:

1. Descriptive Analysis (Data Exploration and Boxplot)

Descriptive Statistical Analysis is an important stage in a study to explore and provide an overview of data[26]. As an initial stage, a descriptive analysis was conducted to obtain an overview of developments in education participation from 2015 to 2021 in aggregate from a spatial and time point of view. The analysis is presented through a data summary table and boxplot visualization.

2. Inferential Analysis (Paired t-test)

Paired t-test is part of inferential analysis used to test the significance between two interrelated or paired data[27]. In this study, paired t-test was used to test the significance of changes in the development of education participation. The null hypothesis posits that there is no difference in the average development of educational participation between provinces in 2021 compared to 2015; the alternative hypothesis is that there is a difference in the average development of educational participation between provinces in 2021 compared to 2015. The significance level used is an alpha of 5 percent. Analysis was conducted on interprovincial pairwise participation data for 2021 compared to 2015.

3. Descriptive Spatial Analysis (Thematic Maps)

Descriptive spatial analysis was carried out using visualization in the form of thematic maps. Thematic maps can present and visualize data more attractively and are easier to understand[28]. Thematic maps are used to describe the distribution of education participation conditions between provinces and their development from 2015 to 2021. The GER or NER data per education level in 2015 is mapped into five quantiles. Furthermore, at each level, a thematic map is formed for 2016 to 2021, using the 2015 quantile basis. This analysis can map the distribution of educational participation achievements across provinces at each level of education.

4. Cluster Analysis (Hierarchical Cluster)

Cluster analysis is an analysis that aims to classify objects into relatively homogeneous

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[22] Zulfikar Hasan and Saifunnajar Saifunnajar, "The Impact of Gross Enrollment Ratio (GER) of Tertiary Education in Indonesia on the Literacy and Inclusion Index: A Case Study Of Islamic Finance in Indonesia," *Al-Amwal: Jurnal Ekonomi dan Perbankan Syari'ah* 13, no. 2 (2021): 203–214.

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[24] Katherine Merseth King et al., "How Well Are We Measuring Access to Early Childhood Education?," *Annual review of comparative and international education 2019* (2020).

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[28] Martijn Tennekes, "Tmap: Thematic Maps in R," *Journal of Statistical Software* 84 (2018): 1–39.

groups based on a set of variables studied [29]. Cluster analysis can classify objects based on their similar characteristics[30]. Characteristics of objects in a cluster have a high degree of similarity, while characteristics between clusters have a low degree of similarity. In this study, the cluster analysis method used is the hierarchical method with ward linkage.

Cluster analysis was carried out to map the grouping of provinces based on the overall characteristics of education participation at each level. The locus used is 34 provinces in Indonesia for the 2021 period, as an evaluation tool regarding the final achievements of inter-level education development in each region.

Finding and Discussion
Descriptive Analysis (Data Exploration and Boxplot)

Descriptive analysis is used to explore the development of education participation conditions from 2015 to 2021 in aggregate. Descriptive analysis is the initial stage in providing insight from a spatial (interprovincial) and temporal (between years) perspective. The analysis is presented through a data summary table and boxplot visualization.

1. **Primary Education**
   (Elementary School or SD)

Table 1. Summary of GER for Primary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
sd2015	21.31	95.15	116.46	110.5974	4.36125	19.021
sd2016	19.59	94.74	114.33	109.5491	3.83921	14.740
sd2017	22.11	92.94	115.05	109.0376	4.06510	16.525
sd2018	22.50	94.47	116.97	109.2888	4.31864	18.651
sd2019	23.01	91.94	114.95	107.9924	3.99647	15.972
sd2020	22.13	91.27	113.40	106.8191	3.81237	14.534
sd2021	20.48	93.07	113.55	106.6906	3.66013	13.397

[29] J Supranto, *Analisis Multivariat : Srti Dan Interpretasi* (Jakarta: Rineka Cipta, 2004).
[30] Ahmad Ansori Mattjik et al., "Sidik Peubah Ganda Dengan Menggunakan SAS" (2011).
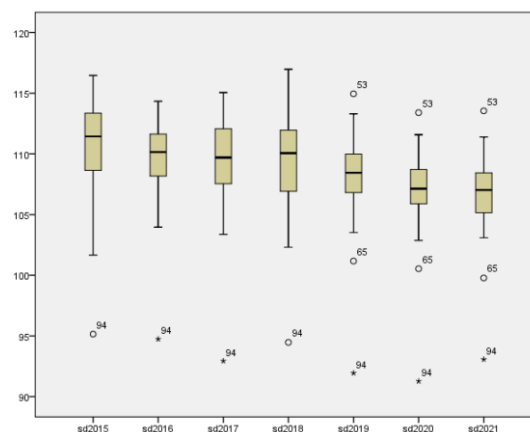

Figure 1. GER for Primary Education in Indonesia (2015-2021)

If viewed spatially (between provinces), based on Table 1, the GER between provinces for the primary level has a fairly large variance (13 to 19 percent), this indicates that there are inequality or differences in the distribution of elementary school participation across provinces in Indonesia. Based on Figure 1, it can also be seen that there are fairly large tails in the boxplot, which indicates inequality between provinces. If viewed temporally (between years), we see a downward trend in the primary education GERs from 2015 to 2021.

Papua Province (code 94) has always been the province with the lowest primary education GERs every year (bottom outlier). North Kalimantan (code 65) has also been a bottom outlier in the last three years, although it is not as low as the GER of Papua. On the other hand, East Nusa Tenggara Province has had the highest GER in the last three years (top outlier). The low achievement of GER shows the inequality of primary education participation in that province. However, the highest primary education GERs does not necessarily indicate the best participation, because there are GERs of more than 100 percent, which can be due to the large number of students who go to school, not at the appropriate age for education (late entry or early entry).

Furthermore, an analysis based on NER data was carried out to complement the limitations of GER analysis of primary education.

Results of primary education NER analysis can be seen in Table 2 and Figure 2.

Table 2. Summary of NER for Primary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
sd2015	20.67	78.56	99.23	95.9868	3.55020	12.604
sd2016	20.55	78.66	99.21	96.1282	3.54346	12.556
sd2017	20.46	78.83	99.29	96.5071	3.56792	12.730
sd2018	20.36	79.14	99.50	96.8838	3.59483	12.923
sd2019	20.34	79.19	99.53	96.9674	3.56037	12.676
sd2020	20.25	79.34	99.59	97.0391	3.52214	12.405
sd2021	19.06	80.38	99.44	97.1497	3.37346	11.380

Based on Table 2, from a spatial (interprovincial) perspective we still see a fairly large variance (around 12 percent), which further emphasizes the disparity in elementary school participation between provinces. From a temporal perspective (interannual), primary education NERs shows an average upward trend from year to year, which indicates that more and more elementary school students are attending school at the appropriate age. This is also the reason for the downward trend in primary education GERs, because more and more elementary school students are attending school on time according to age, showing a positive aspect of primary education participation.

Figure 2. NER for Primary Education in Indonesia (2015-2021)

Based on Figure 2, in terms of NER, Papua (code 94) is still the province with the lowest primary education enrollment every year (bottom outlier). Other provinces that have been the bottom outliers several times are North Kalimantan (code 65), Central Sulawesi (code 72), and West Papua (code 91).

2. Lower-Secondary Education (Junior High School or SMP)

Table 3. Summary of GER for Lower Secondary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
smp2015	27.24	73.59	100.83	90.7400	5.91603	34.999
smp2016	27.08	72.07	99.15	89.4703	5.28464	27.927
smp2017	17.54	81.20	98.74	89.8500	4.50709	20.314
smp2018	22.78	80.17	102.95	90.9932	4.92037	24.210
smp2019	20.14	78.11	98.25	89.3350	4.79446	22.987
smp2020	22.22	79.25	101.47	90.8703	4.55553	20.753
smp2021	21.53	79.37	100.90	91.2603	4.61819	21.328

Figure 3. GER for Lower-Secondary Education in Indonesia (2015-2021)

If viewed spatially (interprovincial), based on Table 3, the GER between provinces for lower-secondary level shows a fairly large variance (more than 20 percent). The variance is larger when compared to the primary level. This indicates that there is a greater disparity in junior high school education participation. Based on Figure 3, we see that there is a large gap at boxplot tails, which indicates inequality between provinces. If viewed temporally (interannual), we see that the GER for lower-secondary education tends to fluctuate from 2015 to 2021, which is followed by an increasing trend in the last three years.

Papua Province (code 94) has better educational participation conditions at the lower secondary level by only occupying the bottom outlier position for three years, namely in 2015, 2016, and 2019. In 2020 and 2021, Gorontalo Province (code 75) has the lowest GER, which indicates that the pandemic has had a fairly strong impact on junior high school education participation in this province.

Furthermore, an analysis of lower-secondary education was carried out based on NER data. Results of the analysis can be seen in Table 4 and Figure 4 below.

Figure 4. NER for Lower-Secondary Education in Indonesia (2015-2021)

Table 4. Summary of NER for Lower-Secondary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
smp2015	31.34	54.21	85.55	75.6126	6.42414	41.270
smp2016	31.47	54.26	85.73	75.8056	6.44442	41.531
smp2017	30.18	56.13	86.31	76.3226	6.26870	39.297
smp2018	29.29	57.09	86.38	76.7474	6.17287	38.104
smp2019	29.56	57.19	86.75	77.3162	6.19379	38.363
smp2020	29.31	57.95	87.26	77.9279	6.19540	38.383
smp2021	29.18	57.93	87.11	78.2435	6.22522	38.753

Based on Table 4, in spatial terms (interprovincial) we see a high variance up to around 40 percent in lower-secondary NERs, followed by a low minimum NER score (below 60%). This shows that there is a high disparity between provinces regarding the number of junior high school residents who attend school on time at the appropriate age. Temporarily (interannual), lower-secondary education NERs shows an average upward trend from year to year. This shows that although there are still gaps between provinces, every year the number of junior high school students who attend school at the appropriate age has slightly developed well.

Based on Figure 4, in terms of NER, only Papua Province (code 94) has extremely low participation in lower-secondary education and becomes the bottom outlier every year. This shows that Papua has high inequality compared to other provinces. Only about 50 percent of the Papua junior high-school-age population can get school facilities on time at the age of 13-16 years.

3. Upper-Secondary (Senior High School or SMA)

Table 5. Summary of GER for Upper-Secondary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
sma2015	28.16	66.97	95.13	80.8829	6.88505	47.404
sma2016	28.53	66.85	95.38	83.5456	6.69610	44.838
sma2017	31.57	67.94	99.51	85.1076	6.57532	43.235
sma2018	31.01	65.07	96.08	82.7909	6.45160	41.623
sma2019	24.99	72.92	97.91	86.4921	6.13837	37.680
sma2020	24.96	73.35	98.31	87.0832	6.10332	37.251
sma2021	22.20	75.05	97.25	87.7032	6.02989	36.360
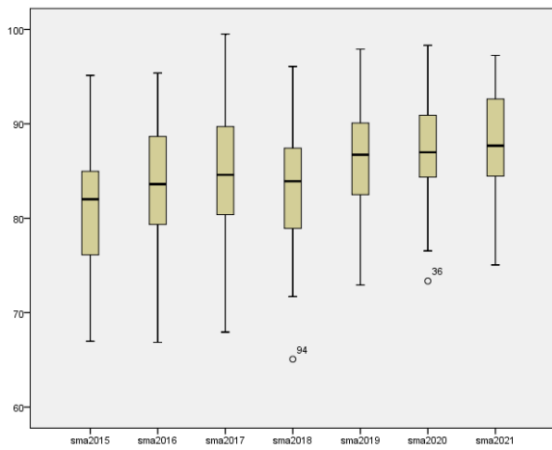
Figure 5. GER for Upper-Secondary Education in Indonesia (2015-2021)

Table 6. Summary of NER for Upper-Secondary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
sma2015	28.31	43.22	71.53	60.7306	6.14118	37.714
sma2016	28.44	43.27	71.71	60.9826	6.16860	38.052
sma2017	28.92	43.48	72.40	61.3856	6.09472	37.146
sma2018	28.69	44.31	73.00	61.7415	6.09432	37.141
sma2019	28.69	44.32	73.01	61.9209	6.14385	37.747
sma2020	28.72	44.73	73.45	62.3212	6.16245	37.976
sma2021	30.41	44.41	74.82	62.6032	6.22763	38.783

If viewed spatially (interprovincial), based on Table 5, the GER between provinces for upper-secondary level has greater variance when compared to primary and lower-secondary levels. Variance in upper-secondary GER reached 36 to 47 percent. This shows that the higher the level of education, the higher the inequality of education participation between provinces. This is also becoming a challenge for the government in implementing the 12-year compulsory education program and distributing it regionally.

Based on Figure 5, we see a larger gap in boxplot tails, which supports an indication of higher inequality between provinces. At the high school level, there are only two lower outliers, namely Papua (code 94) in 2018 and Banten (code 36) in 2020. This is indicated by the fact that the level of inequality in upper-secondary education participation has occurred more thoroughly in each province. If viewed temporally (between years), we see that upper-secondary GERs tend to fluctuate from 2015 to 2021, which is followed by a slight upward trend in the last three years.

Furthermore, an analysis of upper-secondary education was carried out based on NER data. Results of the analysis can be seen in Table 6 and Figure 6 below.

Based on Table 6, in spatial terms (interprovincial), we still see a high variance of almost 40 percent, followed by a lower minimum NER value (around 40 percent). This shows that there is a high disparity between provinces regarding the number of high school students who attend school on time in the 17–19-year range. Temporarily (interannual), the upper-secondary NERs show an average upward trend from year to year, which indicates a slightly better achievement of upper-secondary education development.
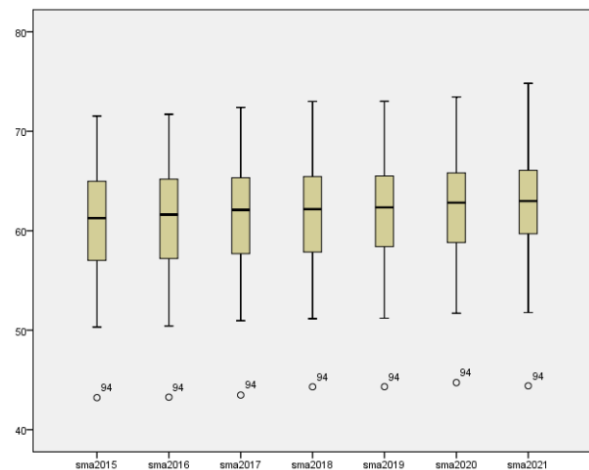

Figure 6. NER for Upper-Secondary Education in Indonesia (2015-2021)

Based on Figure 6, in terms of NER, as with the case at the lower-secondary level and at the upper-secondary level, Papua Province (code 94) also shows extremely lower education participation, being the bottom outlier every year. This shows that Papua Province experiences high inequality compared to other provinces in the participation of senior high school at the appropriate age. Only about 40 percent of the

Papua school-age population can get upper-secondary education on time at the age of 17-19.

4. Tertiary Education (University)

Table 7. Summary of GER for Tertiary Education in Indonesia (2015-2021)

Variable (1)	Range (2)	Minimum (3)	Maximum (4)	Mean (5)	Std. Dev. (6)	Variance (7)
pt2015	53.70	11.13	64.83	28.3962	10.60086	112.378
pt2016	51.03	14.48	65.51	30.7400	10.23047	104.663
pt2017	55.09	15.01	70.10	33.2050	10.76615	115.910
pt2018	57.40	13.20	70.60	33.3212	10.64809	113.382
pt2019	58.87	14.27	73.14	33.5894	10.75133	115.591
pt2020	59.96	14.73	74.69	34.1424	10.85507	117.833
pt2021	59.67	15.23	74.90	34.3926	10.67716	114.002
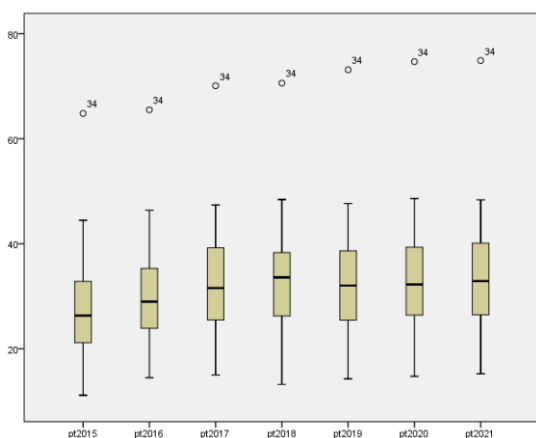
Figure 6. GER for Tertiary Education in Indonesia (2015-2021)

Tertiary education (*Higher education* in Indonesian) is an optional but important education because it improves human resource competencies. If viewed spatially (interprovincial), based on Table 7, the GER between provinces for tertiary education level shows a large variance of more than 100 percent. The minimum value for tertiary education participation is only around 10 percent and is very unequal when compared to the maximum value which reaches more than 70 percent annually. This shows a very high disparity between provinces in the efforts to improve human resource competencies through tertiary education. This is also a challenge for the government in pursuing various strategies to empower regional education development and

open opportunities for equal participation in tertiary education.

DI Yogyakarta (code 34) is the province with the largest tertiary education participation, reaching more than 70 percent annually (top outlier). This is why Yogyakarta is known as a student city, because of the high rate of participation in pursuing tertiary education.

At the tertiary education level, there is no NER calculation. This is related to the optional (not mandatory) characteristics of tertiary education participation. As a result, it cannot be limited to a certain age level as an age-appropriate category. The definition of on-time school-age level is only found in primary and secondary education, which is part of the government's 12-year compulsory education program.

Inferential Analysis (*Paired t-test*)

Paired t-test was conducted at each level of education. The test was conducted in pairs between education participation in 34 provinces from 2021 (current conditions) to 2015 (the beginning of the SDGs).

1. Primary Education (Elementary School or SD)

Table 8. Results of Paired t-test for Primary Education Participation (2021 to 2015)

Variable (1)	Mean (2)	df (3)	t-statistics (4)	p-value (5)
GER	-3.90676	33	-12.552	.000
NER	1.16294	33	13.125	.000

The results of the primary education paired t-test, both for GER and NER, obtained a p-value of 0.000 which is smaller than the 5% alpha value, meaning that both reject H0. Thus, there is a change in the average GER and NER for primary education in 2021 compared to 2015.

The negative sign on t-statistics of the GER variable indicates that the average change that occurred is a decrease compared to 2015. However, the t-statistics of the NER variable have a positive sign, indicating an increase in the primary education NER among provinces in

2021 compared to 2015. This means that regionally (between provinces), there is a significant increase in the proportion of students who receive age-appropriate primary school education in 2021 compared to 2015. It reflects a better development in the achievement of educational participation, in accordance with the 4th goal of SDGs.

2. Lower-Secondary Education (Junior High School or SMP)

Table 9. Results of Paired t-test for Lower-Secondary Education Participation (2021 to 2015)

Variable (1)	Mean (2)	df (3)	t-statistics (4)	p-value (5)
GER	.52029	33	.854	.399
NER	2.63088	33	18.345	.000

For GER, a p-value of 0.399 is obtained which is greater than the 5% alpha value, meaning that it failed to reject H0. Thus, there is no significant average change between GER for lower-secondary education in 2021 compared to 2015. A positive sign on the t-statistics value indicates an increase of GER in 2021, but that increase is not significant.

In the NER variable, a p-value of 0.000 is obtained which is smaller than the 5% alpha value, which that H0 is rejected. So, there is a significant average change between lower-secondary NER in 2021 compared to 2015. A positive sign on the t-statistics value indicates that in 2021, there has been an increase in the number of junior high school students who can receive age-appropriate education in the age range of 13-16, with an average increase per province of 2.63 percent.

These two results show positive developments in the achievement of lower-secondary education participation regionally (interprovincial). The development of education in each province, in general, has been able to increase the achievement of lower-secondary participation in 2021 compared to 2015, in line with the 4th goal of SDGs.

3. Upper-Secondary Education (Senior High School or SMA)

Table 10. Results of Paired t-test for Upper-Secondary Education Participation (2021 to 2015)

Variable (1)	Mean (2)	df (3)	t-statistics (4)	p-value (5)
GER	6.82029	33	8.959	.000
NER	1.87265	33	16.828	.000

Based on a paired t-test of upper-secondary education, both for GER and NER, we see a p-value of 0.000 which is smaller than the 5% alpha value, meaning that both reject H0. Thus, there is a significant average change, both for GER and NER in upper-secondary education in 2021 compared to 2015.

A positive sign on both t-statistics values indicates an increase in upper-secondary education participation, both in terms of GER and NER. In 2021, between provinces, we see an increase in the percentage of the population receiving high school education by 6.82 percent compared to 2015. There is also an increase in the number of high school students who can receive age-appropriate education in the age range of 17-19, with an average increase per province of 1.87 percent.

The combination of these two results shows the integrated success of the interprovincial government in supporting the implementation of SDGs through increasing upper-secondary education participation. This achievement is in line with the development targets set in the 2020-2024 RPJMN, namely, to increase the proportion of human resources with secondary education or higher.

4. Tertiary Education (University or PT)

Table 11. Results of Paired t-test for Tertiary Education Participation (2021 to 2015)

Variable (1)	Mean (2)	df (3)	t-statistics (4)	p-value (5)
GER	5.99647	33	13.857	.000

In the GER variable for tertiary education, a p-value of 0.000 is obtained which is smaller than the 5% alpha value, which means that H0 is rejected. Thus, there is a significant average change between tertiary education GERs in 2021 compared to 2015. A positive sign in the value of t-statistics indicates that in 2021, there has been an increase in the number of residents who were able to receive tertiary education, with an average increase per province of six percent.

This shows that, in general, the interprovincial government in Indonesia has been able to encourage the population to increase competence and competitiveness through tertiary education (higher education). This has become a benchmark for the government programs (such as LPDP, which are special scholarships for eastern regions, etc.) that are enacted to increase equal opportunities for tertiary education, in line with the SDGs goals for inclusive and equitable education.

Descriptive Spatial Analysis (Thematic Maps)

Descriptive spatial analysis is used to describe the development of SDGs indicators on educational participation in a spatiotemporal manner.[31] [32]This analysis is presented in the form of a thematic map. GER is the main indicator of SDGs to measure the achievement of education participation. However, at primary and lower-secondary levels, we see GER values that are greater than 100 percent. Thus, the NER data will be used as a proxy. Meanwhile, at upper-secondary and tertiary levels, the main indicator (GER), will be used. For each education level, 2015 participation data is mapped into five quantiles. Furthermore, at each level of education, a thematic map is formed annually from 2016 to 2021, using the 2015 quantile basis.

[31] Javier Álvarez-Otero and María Luisa De Lázaro y Torres, "Education in Sustainable Development Goals Using the Spatial Data Infrastructures and the TPACK Model," *Education Sciences* 8, no. 4 (2018): 171.

[32] Marta Sapena et al., "Estimating Quality of Life Dimensions from Urban Spatial Pattern Metrics," *Computers, Environment and Urban Systems* 85 (2021): 101549.

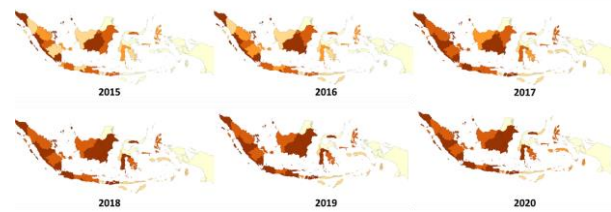1. **Primary Education** (Elementary School or SD)

Figure 8. Thematic Map of NER Development in Primary Education

Based on Figure 8, we see a change in the NER for primary education between provinces from year to year. More provinces are colored dark brown, indicating that the development of NER for primary education is getting better. This means that more and more elementary school age population can receive elementary school education on time at the age of 7-12. The latest achievement of education participation at the primary level can be seen on the thematic map in Figure 9 below.

Figure 9. Thematic Map of NER in Primary Education 2021

Based on Figure 9, more than half of the provinces in Indonesia have reached the top quantile with a primary NER of more than 97.93 percent. Meanwhile, there are only four provinces where the NER for primary education is still below 95 percent, namely Papua, West Papua, Central Sulawesi, and North Kalimantan. In general, education participation at the primary level is quite high and evenly distributed across provinces in Indonesia. However, there is still a dominance of the moderate to low quantile category in eastern and central Indonesia. These regions must be prioritized for primary education development.

Figure 10. Percentage of Change in Primary Education NER (in 2021 compared to 2015)

Based on Figure 10, we see that all provinces have experienced an increase in primary education NER in 2021 compared to 2015. Provinces that experienced the highest increase (> 1.56 percent) were South Sumatra, Jambi, Central Java, South Sulawesi, Maluku, and Papua. Despite having a high increase in NER compared to 2015, Papua Province is still in the lowest quantiles of primary education NER in 2021.

2. **Lower-Secondary Education** (Junior High School or SMP)
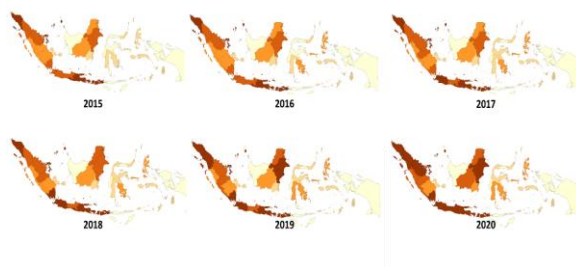
Figure 11. Thematic Map of NER Development in Lower-Secondary Education

Based on Figure 11, we see a change in the achievement of the NER for lower-secondary education between provinces from year to year. More provinces are colored dark brown, indicating improvement in the development of the lower-secondary education NER. This means that more and more junior high school age population can receive junior high school education on time at the age of 7-12. The latest achievement of education participation at the lower-secondary level can be seen on the thematic map in Figure 12 below.

Figure 12. Thematic Map of NER in Lower-Secondary Education 2021

Based on Figure 12, we see that as many as 15 provinces have reached the top quantile with NER values of more than 80 percent. The highest quantile of NER achievement is dominated by provinces in the islands of Java and Sumatra. All provinces on Java Island are included in the top quantile. The provinces of Bali, West Nusa Tenggara, and East Kalimantan are also included in the top quantile. Meanwhile, the provinces in the lowest quantile, with less than 71.5 percent of NER, are West Kalimantan, East Nusa Tenggara, Southeast Sulawesi, Gorontalo, Papua, and West Papua. In general, education participation at the junior high school level still needs to be increased. Even in the top quantile, around 20 percent of the junior high school age population are still not covered by participation in junior high school education.
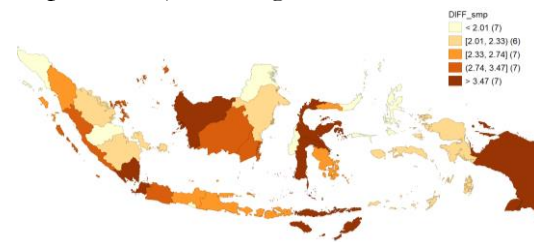

Figure 13. Percentage of Change in Lower-Secondary Education NER (in 2021 compared to 2015)

Based on Figure 13, for lower-secondary education, it can be seen that all provinces experienced an increase in the achievement of NER compared to 2015. The percentage of increase in the NER at this education level is higher than at the primary education level. The increase in NER at lower secondary education levels can reach more than 3.47 percent in the top quantile. Provinces that experienced the highest increase (> 3.47 percent) were Lampung, Banten,

West Kalimantan, East Nusa Tenggara, West Sulawesi, Central Sulawesi, and Papua. Despite having a high NER increase, the provinces of Papua, West Kalimantan, and East Nusa Tenggara are still included in the lowest quantile of lower-secondary education NERs in 2021.

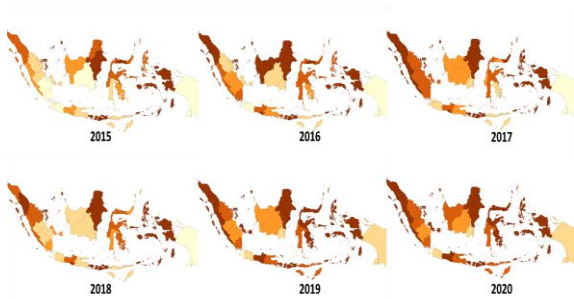### 3. Upper-Secondary Education (Senior High School or SMA)

Figure 14. Thematic Map of GER Development in Upper-Secondary Education

Based on Figure 14, we see relatively large changes in the achievement of upper-secondary education GERs between provinces from year to year. This is marked by a significant change from the dominance of light-colored provinces in 2015 to the dominance of dark-colored provinces in 2020. This means that the condition of high school education participation has developed relatively fast in each province. The latest achievement of education participation at the upper-secondary level can be seen on the thematic map in Figure 15 below.

Figure 15. Thematic Map of GER in Upper-Secondary Education 2021

Based on Figure 15, we see that provinces fall into the lowest category. All provinces have achieved a GER of 74.39 percent or more. Moreover, as many as 20 provinces have entered

the high category with upper-secondary GERs achievement of more than 86.52 percent. This supports the previous statement that relatively rapid development in upper-secondary GERs per province has occurred since 2015. Four provinces fall into the second-lowest quantile category, namely Banten, DKI Jakarta, West Java, and Papua Provinces. The inclusion of three provinces in Java Island in the low category of GER indicates that inequality in educational development can also occur in economically developed regions.
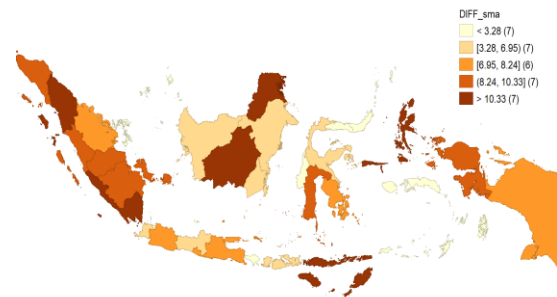

Figure 16. Percentage of Change in Upper-Secondary Education GER (in 2021 compared to 2015)

Based on Figure 16, we see that all provinces have experienced an increase in the GER for upper-secondary education compared to 2015. The percentage of increase in the GER for upper secondary education is relatively high, reaching more than 10.33 percent in the top quantile. Provinces that experienced the highest increase (> 10.33 percent) were North Sumatra, Bengkulu, Lampung, East Nusa Tenggara, North Kalimantan, Central Kalimantan, and North Maluku. Those seven provinces have succeeded in increasing the GER significantly until they are no longer in the categories of low GER. This is especially the case for the provinces of Central Kalimantan and Lampung, which in 2021 are included in the high category from being in the lowest category in 2015. These two provinces can be used as benchmarks for other provinces in their efforts to increase education participation rapidly.

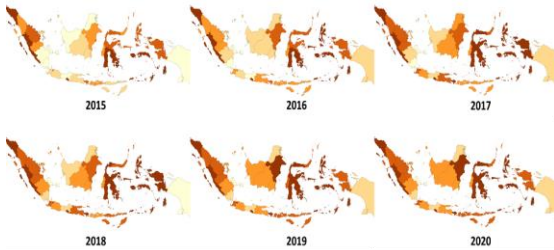### 4. **Tertiary Education** (University or PT)

Figure 17. Thematic Map of GER Development in Tertiary Education

Based on Figure 17, we see at the tertiary level relatively large changes in the achievement of GER between provinces from year to year. This is marked by a significant change from the dominance of light-colored provinces in 2015 to the dominance of dark-colored provinces in 2020. This means that the condition of tertiary education participation has developed relatively fast in each province. The latest achievement of education participation at the tertiary level can be seen on the thematic map in Figure 18 below.
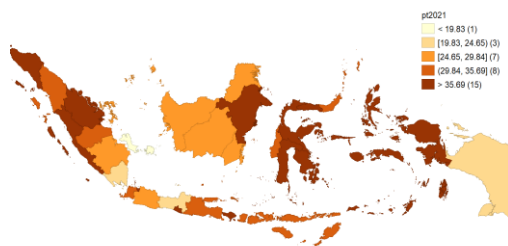
Figure 18. Thematic Map of GER in Tertiary Education 2021

Based on Figure 18, we see that only one province is included in the lowest category, namely the Bangka Belitung Islands. A total of 20 provinces have been included in the high category with GER for tertiary education of more than 35.69 percent. The highest participation in tertiary education is dominated by the provinces in the Eastern Indonesia region and the Central Indonesia region. This shows the success of the government's program in equalizing higher education opportunities for the eastern region.

Meanwhile, on the other hand, only two provinces on Java Island were included in the highest quantile, namely DI Yogyakarta and DKI Jakarta. Moreover, Central Java became a province with a fairly low GER for tertiary education (second quantile), along with two other provinces, namely Lampung and Papua. This shows that similar to upper secondary education, inequality in tertiary education is also experienced on the island of Java.
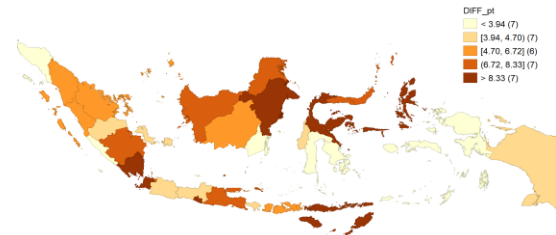

Figure 19. Percentage of Change in Tertiary Education GER (in 2021 compared to 2015)

Based on Figure 19, we see that all provinces have experienced an increase in the achievement of GER for tertiary education in 2021 compared to 2015. The percentage increase in GER for tertiary education is relatively high, reaching more than 8.33 percent in the top quantile. Provinces that experienced the highest increase (>8.33 percent) were Lampung, Banten, DI Yogyakarta, East Nusa Tenggara, East Kalimantan, Central Sulawesi, and North Maluku.

Cluster Analysis (Hierarchical Cluster)

Cluster analysis was used to map provinces based on recent achievements in inter-level education participation rates. This grouping can be used as a benchmark for inclusive and equitable education achievement in 2021, in accordance with the objectives of the SDGs; as well as the basis for determining development priority areas. The analysis was carried out using the hierarchical cluster method with ward linkage.

1. **Gross Enrollment Ratio (GER)**

Figure 20. Thematic Map of 2021 GER Clustering Results

Table 12. Characteristics of 2021 GER Clustering Results

Cluster (1)	Primary Education GERs (2)	Lower-Secondary Education GERs (3)	Upper-Secondary Education GERs (4)	Tertiary Education GERs (5)
1	93.07	81.68	75.05	20.04
2	105.5	**95.54**	90.5	**74.9**
3	104.70	94.72	85.37	31.22
4	**108.78**	87.20	85.55	30.98
5	108.48	92.20	**94.54**	39.88

Based on Figure 20 and Table 12, we see five clusters formed, reflecting the grouping of GER characteristics in 2021. Cluster 1 (light blue) can be categorized as an educationally disadvantaged region because it is the cluster with the lowest GER characteristics for each level of education. Cluster 1 members only consist of one province, namely Papua.

Furthermore, cluster 2 (dark blue) can be categorized as an educationally advanced region, because it is the cluster with the highest characteristics in lower-secondary education and tertiary education and relatively good characteristics in primary and upper-secondary education. This cluster only consists of 1 province, namely DI Yogyakarta.

Cluster 3 (light green) can be categorized as an area with the potential of becoming advanced in terms of education because it has moderate GER characteristics compared to other clusters and has relatively high GER characteristics in lower-secondary and tertiary education. This cluster dominates the provinces on Java Island, with five out of six provinces included in this cluster. The total members of this cluster are 12 members consisting of Riau Province, Riau Islands, Lampung, Banten, DKI Jakarta, West Java, Central Java, East Java, Bali, North Kalimantan, North Sulawesi, and Central Sulawesi.

Cluster 4 (dark green) can be categorized as an educationally developing area. Cluster 4 has moderate GER characteristics compared to other clusters, with the highlight of being the highest in primary education GERs but has relatively low GERs for upper-secondary education compared to other clusters. This shows that the higher the level of education, the lower the achievement of education acceptance by the population in the fourth cluster provinces. This cluster consists of 11 provinces, namely Jambi, South Sumatra, East Nusa Tenggara, West Kalimantan, Central Kalimantan, South Kalimantan, South Sulawesi, Southeast Sulawesi, West Sulawesi, and Gorontalo.

Cluster 5 (pink) can be categorized as an educationally advanced area, along with cluster 2. Cluster 5 has the characteristics of the highest GER for upper-secondary education, the second highest GER for tertiary education, relatively high GER for primary education, and moderate GER for lower-secondary education. This cluster consists of nine provinces, namely Aceh, North Sumatra, West Sumatra, Bengkulu, West Nusa Tenggara, East Kalimantan, Maluku, North Maluku and West Papua.

Cluster 2 together with cluster 5 can be categorized as developed regions, because they have high characteristics in tertiary and upper-secondary education participation, which reflects the prioritization of increasing the competence of quality of human resources, in line with the development agenda in the RPJMN 2021-2024 and SDGs 2030. Clusters with developed characteristics tend to spread out almost on every island. As a reference, the government can designate provinces in clusters 2 and 5 as development axis for the surrounding areas.

Based on the results of cluster analysis, we see that in terms of educational participation, areas with unequal and developing characteristics are not only concentrated in Eastern Indonesia. This reflects the government's success in developing education in eastern Indonesia. However, on the other hand, it poses a challenge for the government to map more deeply the conditions of interprovincial education

characteristics to determine the priority areas for education development appropriately.
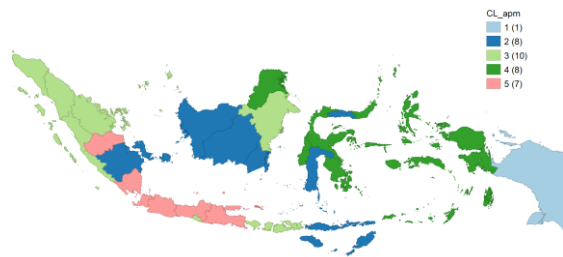
2. Net Enrollment Ratio (NER)

Figure 21. Thematic Map of 2021 NER Clustering Results

Table 13. Characteristics of 2021 NER Clustering Results

Cluster (1)	Primary Education NERs (2)	Lower-Secondary Education NERs (3)	Upper-Secondary Education NERs (4)
1	80.38	57.93	44.41
2	98.03	74.23	57.07
3	**98.50**	**83.15**	**69.38**
4	95.52	75.01	63.74
5	98.48	82.41	60.54

As a complement to the GER clustering, the NER data is clustered. NER clustering aims to map the provincial groups with the best characteristics and worst or unequal characteristics in age-appropriate compulsory education participation. Results of this clustering can be seen in Figure 21 and Table 13.

Cluster 1 (light blue) has unequal characteristics with the lowest NER at all levels of education. Cluster 1 only consists of Papua Province. The higher the level of education, the higher the inequality of age-appropriate school participation experienced by that province. Only 44.41 percent of the Papua population aged 17-19 years receive upper-secondary education facilities at the appropriate age.

Meanwhile, cluster 3 (light green) is the cluster with the best achievement of age-appropriate school participation. These clusters can be categorized as pilot areas that have successfully implemented the 12-year compulsory

education program. Cluster 3 consists of 10 provinces, namely Aceh, North Sumatra, West Sumatra, Riau, Riau Islands, Bengkulu, DI Yogyakarta, Bali, West Nusa Tenggara and East Kalimantan. Meanwhile, the other 23 provinces have moderate characteristics of age-appropriate school participation.

Conclusion

Based on descriptive analysis, in terms of time, the participation rate at each level of education (primary to tertiary level) has experienced significant development during the period 2015 to 2021. This reflects the success of the Indonesian government in realizing the fourth goal of SDG 2030. However, the higher the level of education, the percentage of participation will be lower the level of education below it.

From a spatial perspective on thematic maps, there are still disparities in educational participation between provinces. Papua Province experiences the highest inequality at every level of education. At the primary and lower-secondary education levels, inequality in education participation tends to be concentrated in eastern Indonesia. Meanwhile, at the upper-secondary and tertiary education levels, inequality is also experienced by provinces in western Indonesia, including in the islands of Java and Sumatra. DI Yogyakarta is a province with an excellent level of education participation, both at the primary, secondary, and tertiary education levels.

The regional-based education development strategy needs to be implemented in an integrated and sustainable manner by the government, as shown by the results of cluster analysis. The government can form an educational axis in each adjacent regional group. The axis province will become the center of educational development in the surrounding area. This will support the results of this study which shows that each adjacent region (e.g., an island) usually has one or more provinces with good and stable characteristics of educational participation between years.

The concept of regional-based education development can be supported by the implementation of pentahelix coordination mechanism. Pentahelix (quintuplehelix) is a coordination framework that combines simultaneous collaboration between government, academia, business sector, society, and media[33]. Pentahelix coordination mechanism can realize the development of educational participation in a more structured, integrated, equitable, and sustainable manner; in line with the fourth goal of SDGs 2030 and the 2020-2024 RPJMN development agenda.

This research has focused on exploring educational development. Regarding future research, we can combine educational development with the other variables to measure the impact of educational development on socio-economic conditions. Panel data modelling can be used to measure impact in terms of spatial and temporal aspects.

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