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# Infrastructure competitiveness of regencies and cities in Java Island

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## Abstract

Regional infrastructure competitiveness is highly influential in regional development. This research aims to: (1) compile the infrastructure competitiveness index for regencies or cities in Java, (2) assess the level of infrastructure competitiveness disparity between regencies or cities, and (3) analyze the relationship between the regional infrastructure competitiveness index and economic growth. In investigating the regional infrastructure competitiveness index, five infrastructure groups were assessed, namely social infrastructure, information technology, transportation, economy, and culture. The infrastructure competitiveness between regions (regencies and cities) was determined by scoring and standardization. The Gibbs & Martins index was used to measure the infrastructure competitiveness gap. Meanwhile, the relationship trend between the infrastructure competitiveness index and regional economic growth was analyzed using crosstabs. For the competitiveness of regional infrastructure in Java, this research observed spatial variations between regencies or cities. Besides, the regional infrastructure competitiveness index is not distributed concentrically and tends to have a diffuse pattern. Different distributions of the competitiveness index were also observed in every group of infrastructure. In general, clusters of high infrastructure competitiveness were observed in each province on the island of Java. The Gibbs & Martins index measurement illustrates Java's high regional infrastructure gap. The gap is due to the infrastructure in development centers and activity centers not being accompanied by infrastructure development in the hinterland areas. The social infrastructure has the highest level of inequality. Besides, this research also found a different relationship between infrastructure competitiveness and economic growth in the provinces.

**Keywords:** competitiveness; infrastructure; economic growth

## 1. Introduction

As a system, infrastructure refers to a physical system that provides transportation, irrigation, drainage, buildings, and other public facilities needed to meet basic human needs, both social and economic needs (Grigg, 1988). In the system, infrastructure consists of interdependent parts in the form of facilities and infrastructure (Turner, 2018). The infrastructure's main functions include coordinating with the environmental system and supporting the social and economic systems. The availability of infrastructure impacts the existing social and economic system in the community. Therefore, it is crucial to regard infrastructure as a foundation for policy making process (Kodoatie, 2005).

Infrastructure development is the key to the success of regional development. Various development activities are in dire need of infrastructure support. The existence of infrastructure will encourage the development progress of different sectors while increasing regional competitiveness (Komarova, Zjablova, & Denmukhametov, 2014; Palei, 2015).

Adequate infrastructure development will facilitate the central and regional governments to explore various local potentials. Indonesia is a country with abundant potential resources, both natural and cultural resources. However, those resources have not been supported by adequate infrastructure (Weya, Nopeline, & Damanik, 2021). Therefore, enhancing Indonesia's infrastructure development remains to be a challenge, especially the development of regional potential (Respitari, 2021).

Competitiveness in a country or region is not only determined by its natural resources but also by the availability of its physical infrastructure in the aspects of transportation, energy, and other supporting infrastructure (Jovanoviã & Ivana, 2016; Kornita, Ettika, & Tampubolon, 2022). Infrastructure development is crucial as it affects the region's expansion progress. According to global competitiveness measurement or known as the Global Competitiveness Index conducted by the WEF (World Economic Forum), in 2019, Indonesia was ranked lower than Singapore, Malaysia, and Thailand, in the ASEAN region. The poor infrastructure is a significant factor in Indonesia's low level of competitiveness.

Even though it only functions as a proponent, infrastructure is vital for sustainable development activities (Khurriah & Istifadah, 2019). Without proper infrastructure services, such as transportation networks, energy, telecommunications, housing, and other infrastructure, development activities will not operate smoothly. Investment in infrastructure encourages the growth of various economic activities (Mubin, 2019). Economic activities supported by good infrastructure services can increase the intensity and efficiency of the economy.

Infrastructure carries positive effects on economic growth (Calderón & Servén, 2014; Nugraha, Prayitno, Situmorang, & Nasution, 2020). In the short term, infrastructure development opens job opportunities in the construction sector, and in the medium term, it increases efficiency and productivity in related sectors. Meanwhile, in the long term, infrastructure development promotes economic growth (Calderon & Servén, 2004; Simon & Natarajan, 2017), helps reduce poverty, improves the quality of life, and supports the development of the economy.

Various studies related to infrastructure have been carried out in Indonesia. Novitasari, Drestalita, and Maryati (2020) surveyed the impact of infrastructure in the DIK Jakarta area, Banten Province, and West Java Province. The results of his study show that several infrastructures affect economic growth. Road length, number of hospital facilities, and waste treatment facilities positively influence the Gross Domestic Product (GDP) share. Besides that, the existence of road infrastructure, sanitation, and the presence of secondary schools have increased the Human Development Index (HDI). The research was also conducted by Wulandari (2021) in the East Java region, who found that spending on the development of elementary and junior high schools and spending on the provision of essential services had a positive effect on economic growth, while spending on referral health services had no significant impact. Seprillina, Yusida, Narmaditya, and Chung (2021), who researched the effects of the construction of toll road gates in Malang, showed that the existence of toll road gates has yet to be able to increase people's income and expenses. Different from the results of research by Respitari (2021), which explains that road, irrigation, and health infrastructure are essential to encourage economic growth.

Infrastructure development supports numerous activities (Makmuri, 2017). Infrastructure is a container as well as a catalyst of development. The availability of infrastructure increases community access to resources, enhancing efficiency and productivity and leading to the economic development of an area (Seidu, Young, Robinson, & Ryan, 2020). The development of a region is primarily determined by the existence and support of infrastructure that can increase its competitiveness. Therefore, a study on the competitiveness of regional infrastructure is essential to gain an illustration of its infrastructure development and availability.

The measurement of competitiveness can be carried out by determining the index by comparing it relative to other regions. In general, the regional infrastructure competitiveness index aims to measure local governments' development performance. In detail, this study aims to: (1) compile an index of the infrastructure competitiveness of regencies and cities on the island of Java, (2) analyze the level of regional infrastructure competitiveness gap between those regencies and cities, and (3) analyze the trend of the relationship between the regional infrastructure competitiveness index and the economic growth. In the current development environment, the study of infrastructure competitiveness is quite pertinent as the Indonesian government strives for infrastructure development in various regions to improve and facilitate the fulfillment of different community needs while encouraging investment growth. Thus, it is anticipated that this study will serve as the foundation for subsequent policy development to enhance regional competitiveness in accordance with the circumstances of each district/city on the island of Java.

## 2. Method

This study used a quantitative method by utilizing secondary data to measure the infrastructure competitiveness index. The competitiveness of the regional infrastructure represents the availability and attainment of infrastructure services to support various activities and fulfill community needs. The analysis was carried out in all regencies and cities in the Java Island area, except for the Special Capital Region of Jakarta. The Special Capital Region of Jakarta is not included in the study because it will definitely have far higher infrastructure than the regencies and cities. The measurement of competitiveness was carried out by determining the index by comparing it relatively between one region and another. Meanwhile, for the infrastructure, this research assessed five infrastructure groups, namely social, information technology, transportation, economy, and cultural infrastructures. The assessment included the type and quantity of infrastructure.

Furthermore, to determine the competitiveness of infrastructure between regions (regencies and cities), this research used a scoring indicator. The indicator was then used to assess the five infrastructure groups. To score each infrastructure group, standardization of each indicator was required since the scores were later added up to produce a total score. By using a standardized formula, the existing scores were then converted into a value range of 0-5. The highest score was converted to five, while the lowest value was converted to zero. The scores between them were converted proportionally between 0-5. After being standardized, these values were added up to obtain a total score reflecting the Regional Infrastructure Competitiveness Index. The formulation for compiling standardization is presented in Formula 1.

$$S = \frac{Si - S1}{Sh - S1} \times 5 \quad (1)$$

Information:

S = standardized value

Si = score from regency or city

Sl = lowest score from all regencies or cities

Sh = highest score from all regencies or cities

To measure the level of infrastructure competitiveness gap Gibbs & Martins index is used because it can assess the gap in infrastructure competitiveness measurement between regions. The Gibbs & Martins index formula is shown in Formula (2).

$$GMI = 1 - \frac{x^2}{(\sum x)^2} \quad (2)$$

Information:

GMI = Gibbs & Martins Index

X = Observation Value

The Gibbs & Martins Index value that closes to one represents a wider regional infrastructure competitiveness gap between regencies or cities. Further, this research also used crosstabs to analyze the relationship between the infrastructure competitiveness index and regional economic growth. For the data, this research used the 2019 statistical data published by the Central Bureau of Statistics in 2020.

### 3. Results and Discussion

#### 3.1. Regional Infrastructure Competitiveness Index of Regencies and Cities in Java

Infrastructure development is one of the vital aspects of accelerating the national development process. The existence of excellent infrastructure encourages the smooth operation of socioeconomic activities, accelerating regional growth and competitiveness (Mendoza, 2017). However, the availability and quality of infrastructure in the regions vary, illustrating the different competitiveness of infrastructures (Prihatin & Gravitanian, 2021). This section will discuss the infrastructure competitiveness index in Java by regencies and cities. However, this research excluded the Jakarta Provincial Government area because, as the capital city of the Republic of Indonesia, it presents more excellent infrastructure than other regions. The regional infrastructure competitiveness index measurement was assessed from five infrastructure groups, namely social, information technology, transportation, economy, and cultural infrastructure. Those five groups of infrastructure were selected due to their important roles and their need for improvement and equitable distribution to better support national development.

Our data processing and mapping showed that the classification of the regional infrastructure competitiveness index in Java tends to have a diffuse pattern rather than being concentrically dispersed, as presented in Figure 1. Some regencies or cities in each province exhibit high, medium, or low competitiveness indexes. However, different dominance of competitiveness categories was observed between provinces. In West Java Province, the regencies and cities are mainly in the moderate and high competitiveness classes, while East Java Province is dominated by low and medium classes. For Banten Province, most of the regencies and cities have a low competitiveness class, while Central Java Province presents a

relatively evenly distributed competitiveness between high, medium, and low classes. In general, the highest competitiveness was observed in West Java Province, while the worst competitiveness is in Banten Province based on the description of the dominance of the competitiveness class. The distribution of the regional infrastructure competitiveness index is presented in Figure 1.



**Figure 1. Map of Regencies and Cities Infrastructure Competitiveness Index in Java Island (Except Jakarta Provincial Government) in 2019**

Generally, several regencies and cities have high regional infrastructure competitiveness. Regencies with high regional infrastructure competitiveness include Bogor, Sukabumi, Bandung, Garut, Bekasi, Banyumas, Kebumen, Klaten, Semarang, Bantul, Sleman, Malang, Banyuwangi, Sidoarjo, Tangerang, and South Tangerang Regencies. For urban areas, those with high competitiveness include the cities of Bogor, Bandung, Bekasi, Depok, Surakarta, Yogyakarta, Malang, Surabaya, and Tangerang. These regions have sufficient infrastructure types capable of fostering the growth of different industries. Additionally, local governments have made various efforts to develop their regional infrastructure, encouraging regional growth and meeting community needs. Besides, the development of various types of infrastructure is also induced by stimulation from various leading sectors that drives the regional economy. Business actors and investors also contribute to the progression of infrastructure in the area, along with the urban development project.

In addition, it is important to note that many regencies and cities still lack regional infrastructure competitiveness. The regions with low regional infrastructure competitiveness in West Java Province included West Bandung Regency, Pangandaran Regency, Tasikmalaya City, and Banjar City. The West Bandung and Pangandaran regencies are newly expanded

regencies, so their infrastructure progression will take time. Meanwhile, the Tasikmalaya and Banjar Cities have complex infrastructure problems that require sufficiently large budgets.

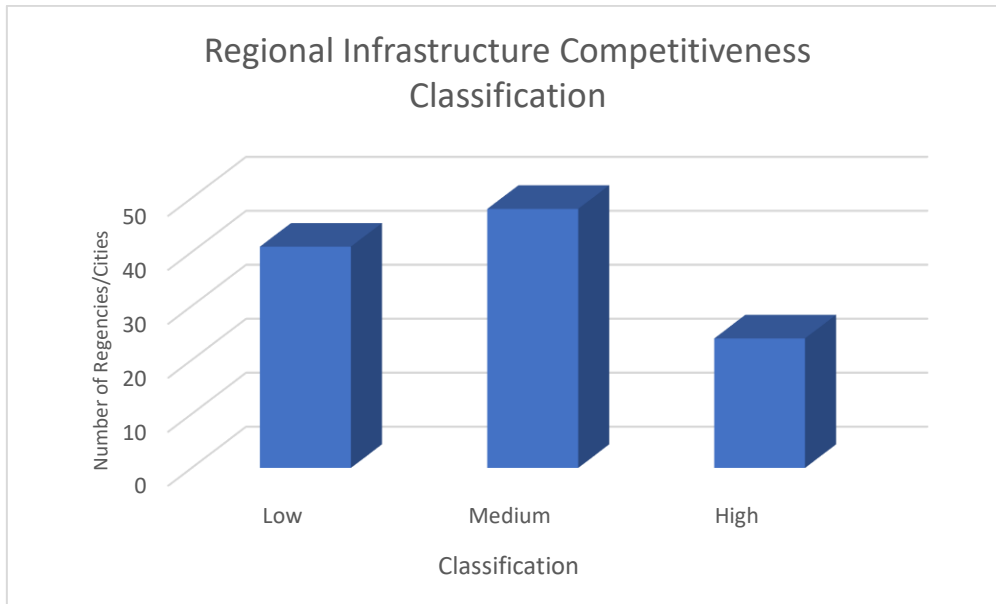
In Central Java, the regions with low regional infrastructure competitiveness are Purworejo, Wonosobo, Sukoharjo, Grobogan, Blora, Rembang, Pati, Demak, Kendal, Batang, Pekalongan, Pemalang Regencies, and Pekalongan City. Some of these areas are constrained by natural physical factors, but others face limited budgets for infrastructure development. The regions with low regional infrastructure competitiveness in the Special Region of Yogyakarta Province are Kulonprogo and Gunungkidul Regencies. Both of those areas have tough topography, lowering their infrastructure expansion. The low investment affects infrastructure development.

East Java Province has the highest number of regions with low infrastructure competitiveness. Those regions are Ponorogo, Tulungagung, Kediri, Lumajang, Bondowoso, Situbondo, Probolinggo, Jombang, Nganjuk, Madiun, Ngawi, Tuban, Gresik, Bangkalan, Sampang, Pamekasan Regencies, and Probolinggo, Pasuruan, Mojokerto Cities. Given that East Java Province has a vast territory, infrastructure development is difficult as it is costly. Besides, some of those regions also have a low regional gross domestic product, limiting their ability to finance their infrastructure.

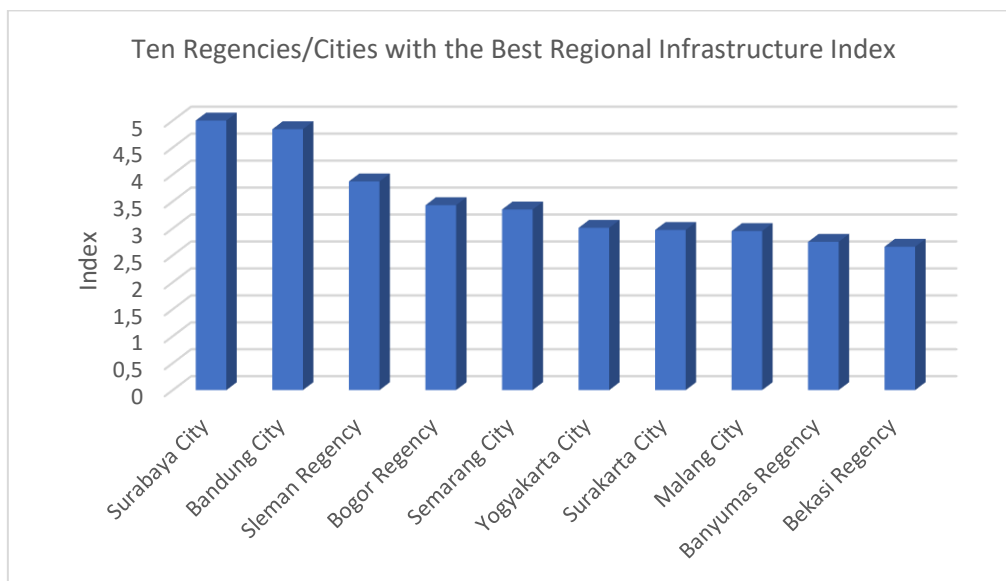
Furthermore, many regencies and cities in Banten Province also have relatively low regional infrastructure competitiveness, such as the Regencies of Pandeglang, Lebak, Serang, and Serang City. In those areas, their physical condition becomes the main obstacle, along with their inability to provide funding for the infrastructure development. In addition, the ability to manage infrastructure development is also estimated to be a factor causing the low competitiveness of regional infrastructure in Banten Province.

The regencies and cities in Java mostly have a medium and low regional infrastructure, as presented in Figure 2. Thus, various measures are required to improve their regional infrastructure competitiveness. The physical characteristics of the land, such as topography and soil types, become obstacles to some regions on the island of Java. Therefore, particular concerns and attempts are required to expand the infrastructure of these areas to encourage regional economic progression. In some areas with a minimum regional gross domestic product, cooperation with the private sector and state-owned enterprises are necessary to boost the ability to finance regional infrastructure.

The regional infrastructure competitiveness index accumulates the index values of social, information technology, transportation infrastructure, economic, and cultural infrastructure. Our statistical data suggested that ten regencies and cities in Java with the best regional infrastructure index (except Jakarta Provincial Government), as illustrated in Figure 3. The Java cities, such as the city of Surabaya, Bandung, Semarang, Yogyakarta, Surakarta, and Malang, present better infrastructure than other areas, especially those related to information technology, transportation, and economic infrastructure. Meanwhile, due to the spatial urbanization of the major urban centers, Java regencies, including Sleman, Bogor, Banyumas, and Bekasi, have better infrastructure. In addition, the development of urban agglomeration-based infrastructure also encourages infrastructure improvements in their surrounding regencies, as experienced by Sleman and Bogor Regencies.



**Figure 2. Regional Infrastructure Competitiveness Index of Java (Excluding Jakarta Provincial Government) in 2019**



**Figure 3. Regions with the Best Regional Infrastructure Competitiveness Index in Java Island (Besides Jakarta Provincial Government) in 2019**

### 3.2. Regional Infrastructure Competitiveness Index Gap in Java

Various aspects of the gap have attained great regard during the development process, including the infrastructure gap. Experts measure the gap using several criteria, such as Gibbs & Martins's formula. Accordingly, this research evaluated the infrastructure gap in Java using the Gibbs & Martin formula, and the measurement results are presented in Table 1.

**Table 1. Infrastructure Gap in Java Island in 2019**

Infrastructure Group	Gibbs & Martins Score	Ranking Gap
Social Infrastructure	0.989899	1
Cultural Infrastructure	0.986576	2
Information Technology Infrastructure	0.986112	3
Economic Infrastructure	0.983264	4
Transportation Infrastructure	0.980274	5
Regional Infrastructure	0.985812	

The assessment results of the regional infrastructure gap in Java, using the Gibbs & Martins index, showed a score of 0.985812, illustrating the high regional infrastructure gap in Java. The gap is induced by the infrastructure development in the city centers not being accompanied by infrastructure development in the hinterland areas. Besides, service centers have grown as a result of the infrastructure being concentrated in provincial capitals and urban areas. However, the development of these service centers is not supported by the equitable distribution of infrastructure in other areas. The same situation is also reflected by the gap between the infrastructure competitiveness groups, where most of the regions are in the medium and low categories.

In contrast, the number of regions with high infrastructure competitiveness is still low. This limited number of high infrastructure competitiveness regions also illustrates the undeveloped and uneven distribution of service centers on the island of Java. In line with research findings, Prihatin and Gravitiyani (2021) revealed the infrastructure gaps between regions. This gap occurs due to imbalanced development growth between regencies and cities. The diversity of regional physical needs and financial capabilities also causes differences in conditions.

The measurement of regional infrastructure gaps involved social, information technology, transportation, economy, and culture infrastructure. Our results show varying disparities. Using the Gibbs & Martins Index, this research calculated the infrastructure gap from 113 regencies and cities on the island of Java. The results indicated that the highest inequality is in social infrastructure. Besides, many regions still face issues in the education and health infrastructure. In terms of number and quality, their educational and medical facilities continue to fall short of the needs of the populace. Meanwhile, sufficient education and health facilities are only found in the city referred to as student cities and in cities with referral health facilities.

A fairly high gap was also observed in cultural infrastructure and information technology since only a few regencies and cities prioritize aspects of culture and information technology. In general, places with a high concentration of historical structures and cultural attractions are those where cultural infrastructure is prioritized. In contrast, areas that prioritize information technology usually develop smart cities. The availability of cultural infrastructure is also associated with areas that rely on the tourism as its leading sector (Merlo & Michalak, 2021). Meanwhile, information technology infrastructure is mostly associated with the areas being major government centers.

Furthermore, the distribution of economic infrastructure and transportation is relatively more evenly distributed than social, cultural, and information technology infrastructure. The even distribution of economic and transportation infrastructure is



inseparable from the development of industrial, trade, and service activities on the island of Java. Almost all regions and cities have experienced the development of diverse economic activities, leading to the progression of various forms of infrastructure. The development of economic activities is inseparable from the availability of transportation infrastructure (Mendoza, 2017), as it enables the distribution of goods to and from various regions in Java. Thus, transportation infrastructure will advance alongside economic activity.

The infrastructure competitiveness of every regency and city in Java varies. The differences are also observed in every aspect of infrastructure competitiveness, as shown in Table 2. The index value provides an overview of the region's level of infrastructure competitiveness. The higher index value indicates higher infrastructure competitiveness. Table 2 shows an overview of the average infrastructure competitiveness index of regencies and cities in the Java province (except the Special Capital Region of Jakarta). The social infrastructure attains a higher average competitiveness index than other infrastructure, as indicated by the 2.36 average social infrastructure competitiveness index. Universally, regencies and cities in each province of Java have a respectable degree of social services and fair living circumstances. This condition is illustrated by the similar average index value from every province, with West Java obtaining the highest score.

In addition, different conditions can be seen in transportation infrastructure, which on average, has a relatively low index value of 0.92. Transportation infrastructure remains to be a problem in Java because some regencies and cities have unfavorable conditions, primarily for areas with hilly topography. Areas that have transportation problems due to hilly and even mountainous conditions include Garut, Tasikmalaya, Wonosobo, Gunungkidul, Wonogiri, Pacitan, and Jember Regencies. This issue in transportation infrastructure is also related to the inadequate quality of roads. Damaged roads are mostly found in every regency and city, especially in Banten Province. The greatest competitiveness of the transportation infrastructure was observed in the Special Region of Yogyakarta since it places a high priority on supporting land transportation infrastructure and facilities.

The greatest competitiveness of information technology infrastructure was also obtained by the Province of the Special Region of Yogyakarta, followed by the Provinces of West Java and Banten. Information technology infrastructure is vital to support various developing activities. The Special Region of Yogyakarta also has better infrastructure competitiveness than other provinces in the economic and cultural fields. The provincial infrastructure competitiveness index in Java is shown in Table 2.

**Table 2. Provincial Infrastructure Competitiveness Index in Java in 2019**

Province	Average Infrastructure Competitiveness Index					
	Social	Information Technology	Transportation	Economic	Cultural	Regional
West Java	2.69	2.35	0.66	1.38	1.65	1.75
Central Java	2.29	1.30	0.93	1.14	1.36	1.40
Special Region of Yogyakarta	2.43	2.78	1.80	2.00	2.00	2.20
East Java	2.24	1.37	0.69	1.02	1.11	1.29
Banten	2.14	2.08	0.53	0.90	1.38	1.41
Average	2.36	1.98	0.92	1.29	1.50	1.61

### 3.3. The Relationship between Regional Infrastructure Competitiveness and Economic Growth

Theoretically, infrastructure enhances regional economic growth. Irawan, Hartono, Irawan, and Yusuf (2012) and Seidu et al. (2020) illustrate that infrastructure can provide more impetus for developing various economic activities. Meanwhile, Barro (1990), Hardianti, Lubis, Ruslan, and Yolanda (2020), and Awan and Anum (2014) also added that adequate infrastructure increases the productivity of input usage, increases added value and reduces transportation costs triggering regional economic growth. However, this relationship does not always apply to all regions (Sebayang & Sebayang, 2020).

The comparison between regional infrastructure competitiveness index data and economic growth by province (except Jakarta Provincial Government) showed a varied pattern of relationships. The highest economic growth was found in the Special Region of Yogyakarta, which also has the highest average regional infrastructure competitiveness. This finding signifies that infrastructure in the Special Region of Yogyakarta has encouraged regional economic growth, as the Special Region of Yogyakarta reached the highest economic growth of 6.59%/year, above the economic development of other provinces, as listed in Table 3.

However, a different pattern of relationships is seen for the Province of West Java. West Java Province ranked 2<sup>nd</sup> after the Special Region of Yogyakarta in infrastructure competitiveness index value, but it has the lowest economic growth. Consequently, excellent infrastructure does not always generate business opportunities and enhance economic value. Occasionally, infrastructure investment requires time to promote economic growth (Sebayang & Sebayang, 2020). In contrast, East Java Province, which has the lowest competitiveness index, presents the second highest economic growth of 5.53%/year. This fact indicates that the infrastructure in East Java Province has supported various business ventures to encourage regional economic growth. Further, in Central Java and Banten Provinces, similar rankings of infrastructure carrying capacity and economic growth were observed, illustrating a balanced advancement of infrastructure and economic growth.

**Table 3. Regional Infrastructure Competitiveness Index and Economic Growth of Provinces in Java (Excluding Jakarta Provincial Government) in 2019**

Province	Regional Infrastructure Competitiveness Index		Economic Growth	
	Index	Ranking	(%/Year)	Ranking
West Java	1.75	2	5.02	5
Central Java	1.40	4	5.36	4
Special Region of Yogyakarta	2.20	1	6.59	1
East Java	1.29	5	5.53	2
Banten	1.41	3	5.37	3
Average	1.61		5.57	

The relationship between the regional infrastructure index and economic growth in the Special Region of Yogyakarta and East Java Province is linear with the opinion of Barro (1990) and Hardianti et al. (2020) that infrastructure is one of the determining factors of regional economic development. However, despite the fact that West Java Province's infrastructure is extremely competitive, its economy is still developing. It may be caused by inefficiently utilized infrastructure in West Java, lowering its ability to encourage economic growth. The different

infrastructure-economic growth relationships between provinces in Java are linear with previous studies that have been carried out in Indonesia, such as those conducted by Novitasari et al. (2020), Seprillina et al. (2021), and Wulandari (2021).

Interestingly, this research also found that the high competitiveness of infrastructure in Indonesia still tends to be concentrated in the central areas of development, not evenly distributed to the hinterland areas. Accordingly, it is necessary to improve infrastructure competitiveness, especially the social infrastructure, in non-central areas so that infrastructure competitiveness on Java's island can be more evenly distributed. Additionally, further efforts are needed to ensure that the existing infrastructure can further encourage economic growth by strengthening the integration of production and marketing.

#### 4. Conclusion

Our data showed a spatial variation of infrastructure competitiveness in regencies and cities in Java. The regional infrastructure competitiveness index is not distributed concentrically but tends to have a diffuse pattern. The distribution pattern of the competitiveness index varies following the type of infrastructure group. Most of the regencies and cities in Java have the medium and low regional infrastructure. Thus, numerous measures to improve the competitiveness of regional infrastructure are required in Java. Our estimation using the Gibbs & Martins Index shows a fairly high number, indicating a high level of regional infrastructure gap in Java. The gap is due to the infrastructure in development and activity centers not being accompanied by infrastructure development in the hinterland areas. The social infrastructure has the highest level of inequality. Besides, the provision of education and health infrastructure remains to be an issue in many regencies and cities. Different infrastructure competitiveness and economic growth relationship were also observed. In the Special Region of Yogyakarta and the Province of East Java, regional infrastructure has encouraged regional economic growth. However, in West Java Province, the regional infrastructure has not been able to promote regional economic growth. Future studies are suggested to examine infrastructure competitiveness development strategies to optimize the potential and integration of development on Java Island.

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