

PROGRESS AND RECENT RESEARCH OF TRANSPORTATION MODES IN INDONESIA: A SYSTEMATIC LITERATURE REVIEW

Dessy Laresti Rahayu¹, Arif Ashari^{1*}, Adika Bisma Dwi Febriano¹, Muhammad A.I.
Wardoyo², Muhammad M.F. Pratama¹, Dwi Prasetya Adhi¹

¹ Department of Geography Education, Universitas Negeri Yogyakarta, Indonesia

² Geography Education Master Program, Universitas Negeri Yogyakarta, Indonesia

ARTICLE INFO	ABSTRACT
<u>Article history:</u> Received 23 May 2024 Revised 30 May 2024 Accepted 30 May 2024 <u>Keywords:</u> Transportation Geography, transportation modes, Indonesia	One of the main topics in the discussion of transportation geography is the mode of transportation. With its essential position, transportation modes have long received attention in various transportation geography studies. This paper presents information on the progress and trends of research topics on transportation modes with a geographical approach. This paper is a systematic literature review organized using the PRISMA approach. Search keywords were determined using the PICO method. The reviewed manuscripts were obtained from the Scopus database using the criteria of journal articles and research results, and they were in English. Two hundred seventy-four documents were collected since 1983, with peak productivity in 2020. One hundred ninety-nine articles were selected through the extraction process and continued with the review. In summary, this study offers new insights into the development trend of transportation mode studies in Indonesia.

A. INTRODUCTION

Discussing and debating transportation modes is one of the most essential parts of transportation geography. Rodrigue (2021) explains that transportation is a crucial component of the global economy in supporting the mobility of passengers and goods. It influences globalization through mobility, trade relations, business and social interactions, value chain organization, and manufacturing and distribution conveyances. With these various interests, Rodrigue (2024) further explains that transportation modes are essential components of transport

systems since they support mobility. The study of transportation modes over time is necessary to see the development of transportation itself and as a means of reflection for determining current and future transportation policies.

Transportation modes have long been a concern of scientists. Various authors worldwide have conducted multiple studies on this mode of transportation. Recent studies conducted by Zhao et al. (2022) studied various modes of transportation that impact the national economy in China. Meanwhile, Taghvaaee et al. (2022) studied transportation modes concerning



*Correspondence address: dessylaresti.2022@student.uny.ac.id

sustainable development goals. Further back, Khan et al. (2018) studied the impact of various modes of transportation on energy and economic growth. Attention to innovation and development of transportation modes has also received attention, namely multimodal (Seo et al., 2017; Archetti et al., 2022), as well as intermodal (Archetti, 2020). Discussions from time to time on various topics show that attention to this mode of transportation is extensive; therefore, it is necessary to have a study that summarizes the progress of studies on this mode of transportation.

In Indonesia, studying transportation modes is crucial because Indonesia has a large area with very complex geographical characteristics. As an archipelago with diverse geomorphological, geological, and climatic conditions, the transportation services needed are diverse. On the other hand, the population of Indonesia is also huge, so the demand for transportation is also very high, including the variability of the modes used. The problem is that studies that summarize the findings and achievements of previous studies on transportation modes in Indonesia have not been carried out much or have not appeared in the database of highly reputable publications. A survey of studies on transportation modes in Indonesia from time to time is needed to

provide a concrete picture that can support the progress of transportation itself.

In this paper, we present the results of a literature review of previous studies on transportation modes in Indonesia. This study has three specific objectives. First, the number of documents produced and their contributors over time must be identified. Second, I will find trends in transportation studies in Indonesia and classify them into stages of development. Last, it examines the research methodology used and the resulting outcomes. Based on the literature review results, this paper offers new insights into progress and recent research in Indonesia, published in a database of highly reputable international publications.

B. METHOD

This paper uses the systematic literature review (SLR) method. The SLR method starts by creating a research question with the PICO method: "In Indonesia, what is the progress of transportation mode research, both topics and methods used, on various types of transportation modes?". Referring to the PICO framework, the research question includes population, intervention, comparison, and outcome. The parameters of PICO can be seen in Table 1.

Table 1. Framework PICO for formulating study problems

P	I	C	O
Population	Intervention	Comparison	Outcome
Research on transportation modes in Indonesia	Outcomes of transportation research in Indonesia over time	Different types of transportation modes that are the subject of research in Indonesia	A summary of the progress of transportation research in Indonesia
How are transportation modes researched in Indonesia? Which regions were selected as study sites?	What progress has been made in transportation research in Indonesia over time?	How has research on different modes of transportation been conducted over time?	What are the achievements of transportation mode studies in Indonesia over time?

Source: modified from Mathley et al. (2014)

The next step is to determine the electronic search step in the database. This step was determined based on the

keywords identified from the problem formulation and the PICO framework created earlier.

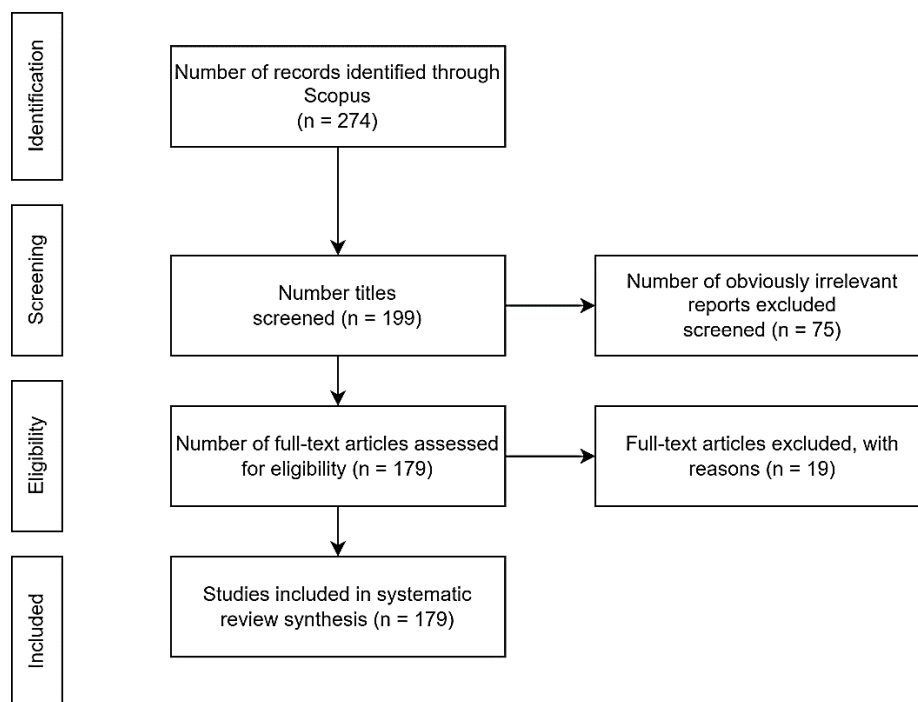


Figure 1. PRISMA flowchart of systematic literature review procedure

The keywords used in this study are (1) transportation modes, (2) road transportation, (3) air transportation, (4) railway transportation, and (5) maritime transportation. From these keywords,

boolean operators were determined for searching in the database, namely: "transportation modes" OR "road transportation" OR "air transportation" OR "railway transportation" OR

"maritime transportation" AND "Indonesia".

Furthermore, the criteria for inclusion and exclusion were determined. Articles included in the requirements are (1) research articles, (2) English language, and (3) country/territory limited to Indonesia/. Articles must ensure that they discuss topics relevant to the keywords used. The article is not used or excluded if it does not meet these criteria. There are two stages of exclusion. First, articles that are completely irrelevant because they are off-topic or the study area is outside Indonesia. Such articles were not used in the first stage of screening. Meanwhile, relevant articles in the discussion that do not quite meet the expected criteria will be categorized as excluded articles with reasons in the second stage. The data source for obtaining articles in this study was Scopus. The review procedure was conducted using the PRISMA method according to Figure 1.

C. RESULT AND DISCUSSION

C.1. RESULT

In this section, we describe the results of the systematic literature review that has been conducted. The results section describes the Scopus analysis and the development trend of transportation mode study topics in Indonesia. It emphasizes recent research and engages current issues in the last section. Scopus analysis provides some basic information

related to the literature reviewed, including the number of documents produced per year, contributing countries, authors' names, affiliated institutions of contributing authors, document categories, and subject area categories.

Studies on transportation modes in Indonesia indexed in the Scopus database began in 1983. However, the number is still very minimal. One year, there is only one publication, and even then, it only sometimes continues every year. Publications on transportation modes in Indonesia indexed in the Scopus database have continued since 2011 and have experienced a significant surge since 2016. This condition shows that studying transportation modes in Indonesia is relatively new.

Since this study is about transportation modes in Indonesia, Indonesia is the country that contributes the most to the publication of documents found in Scopus. However, there are also contributors from other countries, namely Japan, Malaysia, Netherlands, United Kingdom, Australia, United States, Norway, China, and Sweden. The top six affiliations of authors who published the most articles include Bandung Institute of Technology, the University of Indonesia, Gadjah Mada University, Sepuluh November Institute of Technology, and Telkom University. In addition to universities, the National

Research and Innovation Agency (BRIN) also contributes to transportation research in Indonesia. The types of documents obtained from Scopus are mostly articles (53.2%), followed by conference papers (43.1%), review papers (3.0%), book chapters (0.4%) and letters (0.4%). Subject areas vary widely. The top six subject areas are Social Sciences, Engineering, Environmental Sciences, Computer Sciences, Earth and Planetary Sciences, and Energy.

The most published articles are published through the IOP Conference Series: Earth and Environmental Science, Sustainability (Switzerland), and Lecture Notes in Civil Engineering. Analysis of the top seven authors shows variation in the number of documents produced. Irawan M.Z. is the top contributor with nine papers. Joewono T.B. and Belgiawan P.F. made significant contributions, with eight and six papers, respectively. Furthermore, Adriansyah N.M., Bastariato F.F., Hasibuan H.S., and Tarigan A.K.M. formed a group of authors with the same contribution, producing four documents each.

The keywords used in the study of transportation geography in Indonesia vary widely. The most common keyword is "Indonesia". In addition, there are five clusters of topics on transportation modes in Indonesia. The first cluster is transportation mode, with the keywords transportation, Jakarta, urban

transportation, traffic congestion, public transport, railway transportation, and others. The second cluster concerns air transportation, including airport, aircraft accidents, and maritime transportation. The third cluster is about road transportation with keywords including road and stress, gas emission, renewable energy, and energy utilization. The fourth cluster on civil aviation contains the keywords airline industry, service quality, covid-19, and others. The smallest cluster on transportation services is related to economics (Fig 2).

Studies on transportation modes conducted in Indonesia over four decades show trends and developments in the subject matter. In this study, we divide the development of transportation studies in Indonesia into four stages. The first stage is from 1983 to 1999, the second is from 2000 to 2010, the third is from 2011 to 2019, and the fourth is from 2020 to 2024. In the first stage, many transportation studies discuss transportation in urban areas and the development of land transportation for rural development.

These studies explain how the development of transportation for mobility access to the sale of farm products in rural communities to the market or urban areas. Some transportation studies in the first stage also discuss transportation regulations and planning to advance rural

impact of employment opportunities in rural communities and suburbs near the city, which will affect differences in employment opportunities.



studies include talking about customer satisfaction with public transportation services and facilities, various policies and management of public transportation services, and the selection of transportation modes for the distribution of goods. Not only the discussion on public transportation modes, but some studies also discuss the number and factors of motorcycle user accidents that occur in Bali, and there is even a discussion about the consideration of dump truck transportation routes in open mines. A study conducted in Bandung, Joewono and Kubota (2007) showed the

dissatisfaction of paratransit customers and urban public transportation users regarding the services and facilities provided, increasing the number of users of privately owned motor vehicles. Joewono and Kubota (2008) also discuss paratransit, where the findings of this study show that what may be necessary in developed countries has a different weight of importance for paratransit users.

In the third stage (2011-2019), studies on transportation in Indonesia experienced rapid development, focusing on various topics. Transportation studies in this period began to discuss transportation concerning disasters, including post-tsunami transportation recovery in Aceh (Matsumaru et al., 2012) and the impact of the 2010 Merapi eruption on aviation (Picquout et al., 2013). The issue of paratransit was also discussed during this period, but to a lesser extent (Tarigan et al., 2014). In addition, environmental problems have also begun to be addressed in this period, including air pollution (Ambarwati et al., 2016), NO₂ modelling in Padang City (Bachtiar et al., 2017), and ambient air quality in Jakarta (Kusumaningtyas et al., 2018).

The discussion on the environment reached its peak in 2020. This topic dominates Indonesia's study of transportation modes in the fourth stage, 2020-2024. Some studies on the

environmental impact of transportation in this era include PM 2.5 (Pratiwi & Haryanto, 2020), GHG reduction modelling in Surabaya (Pratiwi et al., 2020), the effect of CO₂ from transportation on the pedestrian environment (Aini & Shen, 2020), and carbon monoxide pollution during traffic hours (Kusumaningtyar & Vionalita, 2020).

Another topic that rose in the fourth stage besides the environment is sustainability and behavioural changes due to the COVID-19 pandemic. Many studies have examined the impact of the pandemic on transportation choices, such as increased bicycle use and interest in autonomous vehicles. In addition, significant attention has been paid to the development of sustainable public transportation, including studies on transit-oriented development (TOD) and renewable energy optimization. Other studies also explore the relationship between transportation infrastructure development, economic growth, and income inequality. Irawan et al. (2022), for example, is a study that investigates the impact of the COVID-19 pandemic on bicycle usage intentions in Yogyakarta, Indonesia. The results showed that changes in awareness due to COVID-19, especially related to the environment, the negative impact of motor vehicles, and climate change issues, were the most substantial factors

influencing cycling intentions. The positive effects of COVID-19 also significantly influenced subjective norms and perceived behavioural control, while attitudes towards cycling and perceived

benefits did not contribute significantly. The study's progress on transportation modes in Indonesia over four decades. The progress on transportation modes in Indonesia can be seen on Table 2.

Table 2. The progress on transportation modes in Indonesia

Stage 1 (1983—1999)	Stage 2 (2000—2010)	Stage 3 (2011—2019)	Stage 4 (2020—2024)
Transportation in urban areas, development of land transportation for rural development, regulation and transportation planning for the advancement of rural development	Public transportation services, public transportation policy, modes of transportation for distribution of goods	Transportation and disasters, transportation and the environment	Transportation and the environment, sustainability, and behaviour change due to the pandemic

Source: data analysis, 2024

C.2. DISCUSSION

The results of this study show that research on transportation modes has long been conducted in Indonesia. Searches on the Scopus database show that publications have been carried out since 1983, with a trend that has increased steadily, especially in recent years since 2016. This study found four stages of development of transportation studies in Indonesia with various topics that vary over time.

This study has similarities and differences with previous studies. Reviews of the development of transportation studies have been conducted by Jin et al. (2016), Pinjari (2019), and Stepniak et al. (2023). Compared to these various studies, there is a similarity in that all studies discuss

the topic of transportation from a geographic point of view, given that transportation has an extensive dimension and can be approached from various perspectives and fields of science.

Jin et al. (2016) conducted a study on the progress of research on transportation geography in China. This study found that transportation geography in China has experienced three evolutionary periods: foundation, systematization, and rapid development of the discipline. It has gradually become a relatively mature discipline. From 1930 to 1980, the development of transportation geography mainly consisted of the publication of theoretical texts. During 1980-2000, it gradually became a systematized discipline. Since

the beginning of the 21st century, transportation geography has focused mainly on exploring the impact of transportation on socio-economic development. Today, the study of transportation geography has brought significant developments in many areas, including transportation theory, distribution and facility planning, transportation flow and network analysis, mode evaluation, transportation planning, and urban transportation simulation and assessment.

Compared to the study of Jin et al. (2016), our findings are relatively more modest, and we still need to construct the field's development stage. The focus of this study is limited to the topic of transportation modes. Meanwhile, the study conducted by Jin et al. (2016) in China discusses transportation geography in general. In addition, the documents used are also more numerous. In contrast, this study uses fewer documents, and most were only published after 2016, when there was a massive surge in publications.

Pinjari (2019) briefly reviewed Recent Advances in Transportation Research. This study featured eight papers invited by leading researchers on the following topics: Traffic modelling and control in the context of CAV and irregular traffic, public transport systems, and car ownership in developing countries. The planning and operation of

bicycle sharing systems (BSS), new data sources for transportation planning and operation, and an overview of transportation planning and policy approaches typically used to address traffic congestion. Pinjari's study is different in that it reviews only eight selected papers to provide an overview of recent advances in transportation research. Meanwhile, our study explores and organizes the stages of development along with the topics discussed at each stage.

Finally, the study by Stepniak et al. (2023) found that recent European research and innovation have driven progress in public transport, particularly in digitization and transport planning and management. Progress in the electrification of public transport and the implementation of energy-efficient and pollution-reducing transportation solutions are steps towards achieving the European Green Deal targets. Proves that research and innovation in transportation can be essential in improving public transport services, encouraging desirable modal shifts, and making transport systems more efficient, inclusive, and environmentally friendly. The research by Stepniak et al. (2023) has a different scope, and this study focuses on current research and its impact. Meanwhile, our research is more about exploring and developing milestones. Compared to the research of Stepniak et al. (2023) and

Pinjari (2019), our study is closer to Jin et al. (2016) in terms of topic, methodology and results.

D. CONCLUSION

Transportation is an essential part of modern society. In this regard, the study of transportation is always relevant and should be discussed, including the mode of transportation. In this study, we managed to find that the study of transportation modes in Indonesia indexed in the Scopus database has been carried out over four decades. Various topics have been studied, discussed, and debated, colouring the development in those four decades. We have identified four stages of development: 1983-1999, 2000-2010, 2011-2020, 2011-2019, and 2020-2024.

This study still has some limitations for evaluation. It still focuses on Scopus-indexed publications, which are considered high-quality publications. However, many publications indexed in other databases can provide additional insight into studying transportation modes in Indonesia. Future SLR studies are highly recommended to evaluate documents outside of Scopus to expand the knowledge landscape regarding developing transportation modes in Indonesia.

BIBLIOGRAPHY

Aini, N. & Shen, Z. (2020). Design of tree planting pattern: impacting the road-air quality for pedestrians

from CO₂ dispersion emitted from transportation. *International Journal of Sustainable Society* 12(3): 185-201.

Ambarwati, L., Verhaeghe, R., Arem, B.V., & Pel, A.J. (2016). The influence of integrated space-transport development strategies on air pollution in urban areas. *Transportation Research Part D: Transport and Environment* 44: 134-146.

Archetti, C., Peirano, L. (2020). Air intermodal freight transportation: The freight forwarder service problem. *Omega* 94: 102040.

Archetti, C., Peirano, L., & Speranza, M.G. (2022). Optimization in multimodal freight transportation problems: A Survey. *European Journal of Operational Research* 299 (1): 1-20.

Bachtiar, V.S., Purnawan., Afrianita, R., Ritonga, S.H. (2017). Modelling of NO₂ Dispersion based on Receptor Position Due to Transport Sector in Padang City, Indonesia. *Journal of Environmental Science and Technology. Journal of Environmental Science and Technology* 10(5): 258-267.

Cervero, R. (1990). Accessibility and Third World Rural Development: A Case Study of Sumatra. The University of California Transportation Center. University of California Berkeley.

Jin, F., Wang, C., Cao, Y., Cao, X., Wang, J., Dai, T., & Jiao, J. (2016). Progress of research on

- transportation geography in China. *Journal of Geographical Sciences* 26: 1067-1080.
- Joewono, T.B. & Kubota, H. (2007). User satisfaction with paratransit in competition with motorization in Indonesia: anticipation of future implications. *Transportation* 34, 337–354.
<https://doi.org/10.1007/s11116-007-9119-7>.
- Joewono, T.B. & Kubota, H. (2008). Paratransit Service in Indonesia: User Satisfaction and Future Choice. *Transportation Planning and Technology*, 31(3), 325–345.
<https://doi.org/10.1080/03081060802087692>.
- Khan, H.U.R., Siddique, M., Zaman, K., Yousaf, S.U., Shoukry, A.M., Gani, S., Sasmoko., Khan, A., Hishan, S.H., & Saleem, H. (2018). The impact of air transportation, railways transportation, and port container traffic on energy demand, customs duty, and economic growth: Evidence from a panel of low-, middle-, and high-income countries. *Journal of Air Transport Management* 70: 18–35.
- Kusumaningtyar, D.A., & Vionalita, G. (2020). Air Pollution of Carbon Monoxide: A Case Study on City Traffic Jam. *Pollution Research* 39(4): 911–916.
- Kusumaningtyas, S.D., Aldrian, E., Wati, T., Atmoko, D., Sunaryo, S. (2018). The Recent State of Ambient Air Quality in Jakarta. *Aerosol and Air Quality Research* 18(9): 2343-2354.
- Leinbach, T.R. (1983). Rural Transport and Population Mobility in Indonesia. *The Journal of Developing Areas* 17(3): 349-364.
- Matsumaru, R., Nagami, K., & Takeya, K. (2012). Reconstruction of the Aceh Region following the 2004 Indian Ocean tsunami disaster: A transportation perspective. *IATSS Research* 36(1): 11-19.
- Methley, A.M., Campbell, S., Chew-Graham, C., McNally, R., Cheraghi-Sohi, S. (2014). PICO, PICOS and SPIDER: a comparison study of specificity and sensitivity in three search tools for qualitative systematic reviews. *BMC Health Services Research* Volume 14(579).
<https://doi.org/10.1186/s12913-014-0579-0>
- Picquout, A., Lavigne, F., Mei, E.T.W., Grancher, D., Noer, C., Vidal, C.M., & Hadmoko, D.S. (2013). Air traffic disturbance due to the 2010 Merapi volcano eruption. *Journal of Volcanology and Geothermal Research* 261: 366–375.
- Pinjari, A.R. (2019). Recent Advances in Transportation Research. *Journal of the Indian Institute of Science* 99: 549-551.
- Pratiwi, I.A., Prasetyo, E., & Ardiansyah, H.D. (2020). Greenhouse Gas (GHG) Emission Reduction Model in Surabaya. *Ecology, Environment and Conservation Paper* 26(3): 1342–1347.

- Pratiwi, D.A. & Haryanto, B. (2020). Effect of particulate matter 2.5 exposure to urinary malondialdehyde levels of public transport drivers in Jakarta. *Reviews on Environmental Health* 35(3): 295-300.
- Rodrigue, J.-P. (2021). Transport Modes and Globalization. in Vickerman, R. *International Encyclopedia of Transportation*. Elsevier.
- Rodrigue, J.-P. (2024). *The Geography of Transport Systems*, Sixth Edition. New York: Routledge.
- Seo, Y.J., Chen, F., & Roh, S.Y. (2017). Multimodal Transportation: The Case of Laptop from Chongqing in China to Rotterdam in Europe. *The Asian Journal of Shipping and Logistics* 33 (3): 155–165.
- Stepniak, M., Gkoumas, K., Santos, F.M.D., Grosso, M., & Pekar, F. (2023). Recent trends and progress in public transport innovation are in the scope of European research projects. *Transportation Research Procedia* 72: 4295-4302.
- Taghvaaee, V.M., Nodehi, M., Saber, R.M., & Mohebi, M. (2022). Sustainable development goals and transportation modes: Analyzing sustainability pillars of environment, health, and economy. *World Development Sustainability* 1: 100018.
- Tarigan, A.K.M., Susilo, Y.O., & Joewono, T.B. (2014). *Transportation Planning and Technology* 37(2): 200-218.
- Zhao, B., Wang, N., & Wang, Y. (2022). The role of different transportation modes in China's national economy: An input-output analysis. *Transport Policy* 127: pp. 92–102.