Journal Of Economics, Technology, and Business (JETBIS)
Volume 3, Number 6 June 2024
p-ISSN 2964-903X; e-ISSN 2962-9330

BIBLIOMETRIC ANALYSIS OF FLEXURAL PAVEMENT ROAD DAMAGE ON AIRPORT-PORT MAIN CORRIDOR ROADS USING THE PAVEMENT CONDITION INDEX (PCI) METHOD

Azzhara Amanda[1], Andri Irfan Rifai[2*], Yusra Aulia Sari[3], Susanty Handayani[4]
Universitas Internasional Batam[1,2,3], Universitas Trisakti, Indonesia[4]
Email: azzhara.amanda@gmail.com[1], andri.irfan@uib.ac.id[2], yusra@uib.ac.id[3], susantyhandayani@gmail.com[4]

KEYWORDS:
Highway, Road Damage, Pavement Condition Index (PCI), Rigid, Rigid Pavement, Rehabilitation, How PCI Works

ABSTRACT

Bibliometric analysis of the use of PCI methods on roads, main corridors, airports and ports is a network of research from around the world on related topics. The main objective of this study is to see trends that continue to develop in various points of view. By capturing various studies from 2000 to 2023 using Crossref sources, 1000 studies with related topics were produced. This research accompaniment uses the help of Publish or Perish, which is then processed in the VOSviewer application with the Research Information Systems (RIS) format. There is a reasonably broad relationship in research keywords produced with the dominance of rigid pavement keywords (299 studies), pavement condition index (112 studies), road damage (79 studies), rehabilitation (63 studies), and other keywords with different number variations. The results of the conclusion data regarding the development of research on pavement condition index continue to increase continuously, with the highest number in 2022 (86 studies).

INTRODUCTION

Along with the times, highways have become critical infrastructure in modern human life. A highway is a land transportation infrastructure used to mobilize various interests easily and quickly (Kazis, 2020). The quality and efficiency of highways directly impact daily life, the economy, and the environment. Highways are becoming the primary means of transportation world wide (Hancock et al., 2019). As a significant means of transportation, highways are important infrastructure development throughout the country (Cigu et al., 2018). Various countries worldwide are carrying out sustainable highway development to support various needs. Countries with the best road quality worldwide are the United Arab Emirates, Finland, Switzerland, the Netherlands, and Singapore.

One of the developing countries, Indonesia, also carries out road construction and repair yearly (Andani et al., 2019). It is also adapted to various kinds of national needs. Various sectors that are the background of road development and repair in Indonesia are the industrial sector, tourism, economy, and public welfare. One of the things that supports the success of a transportation mobilization system is good road conditions. Based on the 2021 Land Transportation Statistics report from the Central Statistics Agency (BPS), the total length of roads throughout Indonesia reached 546,116 kilometres (km) in 2021. Roads in good condition reach 232,644 km, or 42.6% of the total road length in Indonesia. Then 139,1,74 km of roads

were in moderate condition (25.49%), 87,454 km of roads were damaged (16.01%), and 86,844 km of roads were severely damaged (15.9%). Cumulatively, the length of all damaged roads in Indonesia in 2021 reached 174,298 km (31.91%) (Annur, 2023).

As one of the industrial cities in Indonesia, mobilization is one of the most essential needs in the development and progress, especially on the main corridor roads of airports and ports. By focusing on the main corridor roads of airports and ports to support industry tourism and community welfare, the city government continues to build and improve road infrastructure. Road construction carried out by the city government continues on an ongoing basis (Setiawati, 2023). This shows how vital road infrastructure facilities are in this city. In addition, the construction of highways is also adjusted to the level of vehicle volume passing from year to year (Hymel, 2019). With road infrastructure, the main corridors of airports and ports that are adequate and have good quality are also a form of effort to provide comfort and a smooth mobilization system for the community (Robinson & Thagesen, 2018).

One of the obstacles in the transportation mobilization process, such as accidents and traffic flow performance problems, is road damage (Redzuan et al., 2019). Road damage is a structural and functional condition that cannot provide optimal service for road users (Frangopol & Liu, 2019). Road damage can be caused by various factors, including the inability to withstand the weight of vehicle volume, poor drainage system, instability of soil conditions, non-optimal pavement planning, and lack of periodic road maintenance. Road damage is generally seen in cracks on the road surface (Maeda et al., 2018). One method that can be used to analyze the problem of road surface cracks is the Pavement Condition Index (PCI) method (Setiaputri et al., 2021).

This study aims to analyze various publication journals on interrelated mathematical digital literacy skills. The analytical methodology used in this study used bibliometric analysis. This analysis focuses on mapping citations, authors, research years, and publisher journals. The research that discusses the Pavement Condition Index (PCI) method on the main corridor roads of airports and ports will refer to publication journals collected using the Publish or Perish application from around the world and mapped using the VOSviewer application. The reference source of this study uses Crossref from the period 2000 to 2023, which is by the research theme using related keywords.

RESEARCH METHODS

Based on this research, the methodology used is identifying research journals from networks, information, and trends with parameter criteria by the research topic, namely the pavement condition index (PCI) method of civil engineering studies (Piryonesi & El-Diraby, 2020). Using developed technology, information can be easily obtained using centralization from various research sources world (Linnenluecke et al., 2020). The study will use bibliometric analysis to map the literature review and the information needed. Bibliometric analysis aims to provide a visualization of related, popular networks and research that continues to grow year after year (Liao et al., 2018). The results of the bibliometric analysis mapping will later be reviewed from the visual form of the network and period to density processed in the form of graphs and detailed data.

The research on the topic of road damage analysis of the main corridors of airports and ports using the Pavement Condition Index (PCI) method was reviewed based on various aspects, including aspects of the author, suitability of the topic, sources, countries, and citations. Quantitative data processing will transform the data collected into image and graphic visualization. The relationship between analysis and quantitative methods becomes very related because this research requires data that will produce numbers. Other supporting aspects used in this research method are keywords, which are highway, road damage, Pavement Condition Index (PCI), rigid, rigid pavement, rehabilitation, and how PCI works.

In this study, the Publish or Perish application was used to review various kinds of research from around the world using Crossref sources on October 22, 2023. The specified research year has also been set on this application for 2000 to 2023. The results of the data obtained are then imported into the Microsoft Excel application for data processing. In addition, to review more about the linkage between networks, the VOSviewer application is used. The output of the VOSviewer application produces the distribution of years of research carried out, density between studies, and visualization of research topic relationships (Ding & Yang, 2022).

RESULTS AND DISCUSSION

This bibliometric analysis research processes data using a database generated from the Publish or Perish application. The database results from a review of various keywords entered, including highway, road damage, Pavement Condition Index (PCI), rigid, rigid pavement, rehabilitation, and how PCI works. To ensure further the suitability of the results of the resulting review, this study also selects keywords generated by the Publish or Perish application to produce research that is most related to this research theme. This database is processed to conclude existing findings.

The data produced in this review process is needed to process results and make conclusions. These data include the number of citations, authors, titles, years, publishers, and other supporting data. Other data that is not generated from the results of the Publish or Perish application review must pass the further analysis stage to produce data from the country of the case study. Furthermore, the data is processed to be used as graphs, images, and tables using the help of the Microsoft Excel application. In addition to data from Publish or Perish, of course, it requires the results of an overview of the VOSviewer application to see the relationship, density, and year of distribution of research keywords.

Keyword Relationship Research

The first discussion discussed in this study is the relationship between keywords. This relationship was found based on the analysis results using the help of VOSviewer with data from Publish or Perish. The keywords displayed come from the results of the selection and relevance of the event on the Pavement Condition Index (PCI) topic. The visualization results can be seen below.

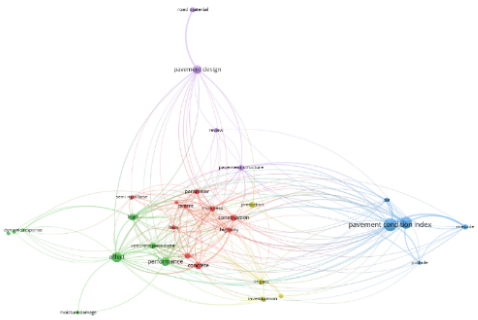

Figure 1
Keyword linkage network research

This linkage shows a wide variety of keywords that are related to each other. It can be seen in figure 1 that the most dominant keywords are found in the keyword "Pavement Condition Index (PCI)" with solid colours and the most extensive network, and other keywords such as "Pavement Design", "Effect", and other related but not too broad keywords. This shows the breadth of keywords on this study's main topic, which discusses the Pavement Condition Index (PCI), especially on the main corridor roads of airports and ports.

Distribution of Research Years

The database generated from the Publish or Perish application shows the distribution of research years. This data is then processed using the Microsoft Excel application to produce the following graph in figure 2. This data is converted into a graph to see the years of research conducted that fit the topic. Therefore, this graph can be easily observed about the development of research in the period 2000 to 2023.

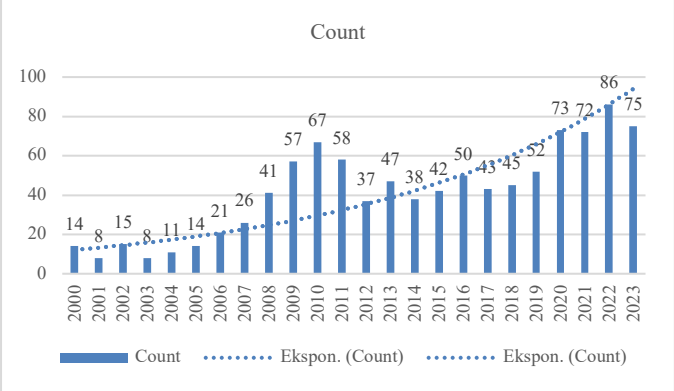

Figure 2
Distribution graph of research years

Based on the graph figure 2 describes the distribution of 1000 studies that occurred in the period 2000 to 2023. The data shows a significant change from 2007 to 2010. Another fact shows that 2022 is the highest year in the number of studies, with 86 studies. The rise and fall of the number of studies based on the following year period concludes that a research trend continues to develop from time to time.

Density between Keywords

The review results using the VOSviewer application are the density between research keywords. This result visualizes keywords entered and selected to produce the following image in figure 3. With keywords previously entered between highway, road damage, Pavement Condition Index (PCI), rigid pavement, rehabilitation, and how PCI works, it explains that the density of keywords produced varies. Understanding the form of density visualization can be considered in the colours displayed.

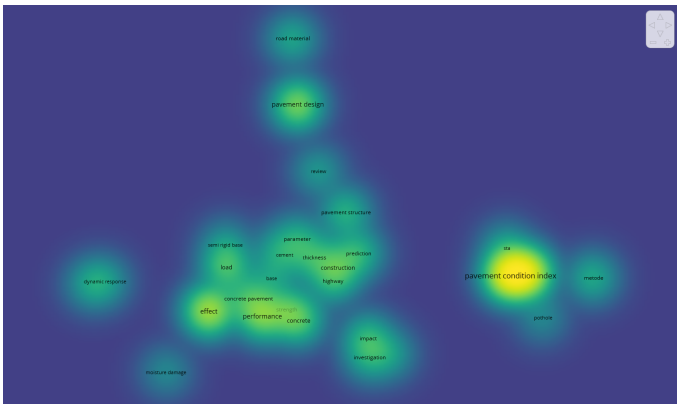

Figure 3
Visual keyword density research

It can be seen in figure 3 that the keyword Pavement Condition Index (PCI) is again the most dense keyword. This is explained by the deep yellow, indicating that the keyword is closely related to the research topic. Other keywords also explain the relationship with the research topic but have different density levels. However, of course, these keywords still have a relationship with each other, even though they have varying density scopes.

Author and Jumlah Similar Research

One of the databases generated from the review results using the Publish or Perish application is the author's name. The author's name data is accompanied by other supporting data, including similar studies discussing this topic. This data analysis shows the diversity of authors who discuss related topics in table 1. However, the study's authors summarized the highest number of similar studies to facilitate classification.

Tabel 1
Author Data and Several Similar Studies

Writer	Number of Similar Studies
Fujian Ni	7
Imad L. Al-Qadi	7
Musharraf Zaman	6
Robert Karlsson	6
Sigurdur Erlingsson	6
Yiqiu Tan	6
Ary Setyawan	5
Baoshan Huang	5
Emad Kassem	5
Halil Ceylan	5

Jorge A. Prozzi	5
Kamal Hossain	5
Andri Irfan Rifai	4
B.Shane Underwood	4
David Timm	4

It can be seen (Table 1.) that Fujian Ni and Imad L. Al-Qadi became the researchers with the highest number of similar studies (7 studies). In addition, the names of researchers with a similar number of researchers were followed by Musharraf Zaman, Robert Karlsson, Sigurdur Erlingsson, and Yiqiu Tan (6 studies); Ary Setyawan, Baoshan Huang, Emad Kassem, Halil Ceylan, Jorge A. Prozzi, and Kamal Hossain (5 studies); Andri Irfan Rifai, B. Shane Underwood, and David Timm (4 studies). In this case, many other researchers also discuss topics related to the number of diverse studies.

Research Topic Ranking by Keywords

Among the studies that have been successfully netted by the Publish or Perish application, of course, have a ranking order. The studies sorted in this ranking are the results of networking based on keywords adjusted to the research topic. The research ranking data can be seen below in table 2. This ranking is sorted based on many things, including the number of citations in a particular year period and the value of relevance to the research topic.

Table 2
Research Topic Ranking Data

Research Topics	Sum
Rigid Pavement	299
Pavement Condition Index (PCI)	112
Road Damage	79
Rehabilitation	63

The data in table 2 displayed the highest ranking order from various studies netted. This data explains the relationship between research keywords and topics. This ranking shows that research with the topic "Rigid Pavement" ranks first with 229, followed by "Pavement Condition Index (PCI)" with 112, "Road Damage" with 79, and "Rehabilitation" with 63. Many other studies need to be netted in these four big topics, but the research still has a connection with the big topic of this research.

Country Origin Research Case Studies

The diversity of research that has been successfully captured illustrates research from anywhere. This diversity displays a distribution of research topics from various parts of the world to describe ongoing research development. This data processing uses country classifications to determine where similar research is most widely discussed. The classification regarding the country of origin of the research case study can be seen as follows in table 3.

Table 3
Several Studies from Different Countries

Research Topics	Sum
Indonesian	116
China	11
United States	9
Qatar &; Switzerland	3
Africa, Australia, Canada, India, & Iraq	2
Argentina, Canada, France, Germany, Japan, Korea, Malaysia, Egypt, Nigeria, Portuguese, Russia, Saudi Arabia, Thailand, Timor-Leste, Yemen	1

Based on the data in figure 4, it is explained that the Indonesian state discusses the most research topics on the Pavement Condition Index (PCI). This is explained by data from 116 studies located in the country. In addition, there is China (11 studies); the United States (9 studies), Qatar and Switzerland (3 studies); Africa, Australia, Canada, India, and Iraq (2 studies); and Argentina, Canada, France, Germany, Japan, Korea, Malaysia, Egypt, Nigeria, Portuguese, Russian, Saudi Arabia, Thai, Timor-Leste, Yemeni (1 study) covering related topics. Other countries discuss similar topics, but the number is not significant. This concludes the development of research from various world countries that experience an increasing trend and spread so that the research topic on Pavement Condition Index (PCI) on the main corridor roads of airports and ports will continue to grow.

CONCLUSION

Research on the bending pavement damage analysis on airports and ports' main corridor roads using the Pavement Condition Index (PCI) method using bibliometric analysis. With this analysis, you can conclude similar research trends using various keywords related to the topic, with the help of the Publish or Perish application, which is used to review 1000 Research Information System (RIS) format studies from 2000 to 2023. This study concluded that the keywords "Rigid Pavement" and "Pavement Condition Index (PCI)" are the most dominant after passing the analysis process using the VOSviewer application. In addition, it was found that the results of the highest research year and research occurred in 2022, with a total of 86 studies. The distribution of case studies based on national origin is found in Indonesia, which has the highest number of studies with a total of 116 studies and followed by China (11 studies); United States (9 studies), Qatar &; Switzerland (3 studies); Africa, Australia, Canada, India, & Iraq (2 studies); and Argentina, Canada, France, Germany, Japan, Korea, Malaysia, Egypt, Nigeria, Portuguese, Russia, Saudi Arabia, Thailand, Timor-Leste, Yemen (1 study) covering the topic of Pavement Condition Index (PCI). The main conclusion of this study is that research trends on the Pavement Condition Index (PCI) continue to develop from year to year in various countries in the world and will continue to grow from time to time.

BIBLIOGRAPHY

Andani, I. G. A., Geurs, K., & La Paix Puello, L. (2019). Effects Of Toll Road Construction

On Local Road Projects In Indonesia. *Journal Of Transport And Land Use*, *12*(1), 179–199.

Annur, C. M. (2023). *No Title*. Databoks. Https://Databoks.Katadata.Co.Id/Datapublish/Preview/2023/04/17/31-Jalanan-Di-Indonesia-Rusak-Pada-2021

Cigu, E., Agheorghiesei, D. T., Gavriluță, A. F., & Toader, E. (2018). Transport Infrastructure Development, Public Performance And Long-Run Economic Growth: A Case Study For The Eu-28 Countries. *Sustainability*, *11*(1), 67.

Ding, X., & Yang, Z. (2022). Knowledge Mapping Of Platform Research: A Visual Analysis Using Vosviewer And Citespace. *Electronic Commerce Research*, 1–23.

Frangopol, D. M., & Liu, M. (2019). Maintenance And Management Of Civil Infrastructure Based On Condition, Safety, Optimization, And Life-Cycle Cost. *Structures And Infrastructure Systems*, 96–108.

Hancock, P. A., Nourbakhsh, I., & Stewart, J. (2019). On The Future Of Transportation In An Era Of Automated And Autonomous Vehicles. *Proceedings Of The National Academy Of Sciences*, *116*(16), 7684–7691.

Hymel, K. (2019). If You Build It, They Will Drive: Measuring Induced Demand For Vehicle Travel In Urban Areas. *Transport Policy*, *76*, 57–66.

Kazis, N. M. (2020). Transportation, Land Use, And The Sources Of Hyper-Localism. *Iowa L. Rev.*, *106*, 2339.

Liao, H., Tang, M., Luo, L., Li, C., Chiclana, F., & Zeng, X.-J. (2018). A Bibliometric Analysis And Visualization Of Medical Big Data Research. *Sustainability*, *10*(1), 166.

Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020). Conducting Systematic Literature Reviews And Bibliometric Analyses. *Australian Journal Of Management*, *45*(2), 175–194.

Maeda, H., Sekimoto, Y., Seto, T., Kashiyama, T., & Omata, H. (2018). Road Damage Detection Using Deep Neural Networks With Images Captured Through A Smartphone. *Arxiv Preprint Arxiv:1801.09454*.

Piryonesi, S. M., & El-Diraby, T. E. (2020). Data Analytics In Asset Management: Cost-Effective Prediction Of The Pavement Condition Index. *Journal Of Infrastructure Systems*, *26*(1), 4019036.

Redzuan, A. A., Anuar, A. N., Zakaria, R., Aminudin, E., Alias, N. E., Yuzir, M. A. M., & Alzahari, M. R. (2019). A Review: Adaptation Of Escape Route For A Framework Of Road Disaster Resilient. *IOP Conference Series: Materials Science And Engineering*, *615*(1), 12002.

Robinson, R., & Thagesen, B. (2018). *Road Engineering For Development*. CRC Press.

Setiaputri, H. A., Isradi, M., Rifai, A. I., Mufhidin, A., & Prasetijo, J. (2021). Analysis Of Urban Road Damage With Pavement Condition Index (PCI) And Surface Distress Index (SDI) Methods. *World Journal Of Innovation And Technology*, *2*(2), 82–91.

Setiawati, S. (2023). *No Title*. CNBC Indonesia Research. Https://Www.Cnbcindonesia.Com/Research/20230514102100-128-437121/Pembangunan-Jalan-Era-Sby-Dan-Jokowi-Siapa-Pemenangnya

A. S. D. Manurung And S. Sulaiman, "Performance Mix Asphalt Concrete Wearing Course With Addition Of Plastic Bottles Of Polyethylene Terephthalate," In IOP Conference Series: Materials Science And Engineering, Vol. 732, No. 1, P. 012022, 2020.

B. Mirchevska, C. Pek, M. Werling, M. Althoff And J. Boedecker, "High-Level Decision Making For Safe And Reasonable Autonomous Lane Changing Using Reinforcement Learning," In 2018 21st International Conference On Intelligent Transportation Systems

(ITSC), Pp. 2156-2162, 2018.
S. M. Piryonesi And T. E. El-Diraby, "Data Analytics In Asset Management: Cost-Effective Prediction Of The Pavement Condition Index," Journal Of Infrastructure Systems, Vol. 26, No. 1, P. 04019036, 2020.
A. Issa, H. Sammaneh And K. Abaza, "Modeling Pavement Condition Index Using Cascade Architecture: Classical And Neural Network Methods," Iranian Journal Of Science And Technology, Transactions Of Civil Engineering, Vol. 46, No. 1, Pp. 483-495, 2022.
J. M. Pinatt, M. L. Chicati, J. S. Ildefonso And C. R. G. D. A. Filetti, "Evaluation Of Pavement Condition Index By Different Methods: Case Study Of Maringá, Brazil," Transportation Research Interdisciplinary Perspectives, Vol. 4, P. 100100, 2020.
R. S. S. K. &. P. G. Kumar, "Evaluation Of Pavement Condition Index Using Artificial Neural Network Approach," Transportation In Developing Economies, Vol. 7, No. 2, P. 20, 2021.
A. D. H. Ali, K. Hossain And A. Hussein, "Modeling Pavement Performance Indices In Harsh Climate Regions," Journal Of Transportation Engineering, Part B: Pavements, Vol. 147, No. 4, P. 04021049, 2021.
A. Adritama And D. A. Restuti, "Analysis Of Road Damage Using The PCI Method:(Case Study On Tambak Osowilangon Road)," In Journal Of World Conference (JWC), Vol. 4, No. 2, Pp. 82-87, 2022.
Y. Nuhrat, "Moralities In Mobility: Negotiating Moral Subjectivities In Istanbul's Traffic," Mobilities, Vol. 15, No. 3, Pp. 325-340, 2020.
M. K. A. Kamarudin, N. Abd Wahab, R. Umar, A. S. M. Saudi, M. H. M. Saad, N. R. N. Rosdi And A. M. Ridzuan, "Road Traffic Accident In Malaysia: Trends, Selected Underlying, Determinants And Status Intervention," International Journal Of Engineering & Technology, Vol. 7, No. 4.34, Pp. 112-117, 2018.
H. A. Setiaputri, M. Isradi, A. I. M. A. Rifai And J. Prasetijo, "Analysis Of Urban Road Damage With Pavement Condition Index (PCI) And Surface Distress Index (SDI) Methods," WORLD JOURNAL OF INNOVATION AND TECHNOLOGY, Vol. 2, No. 2, Pp. 82-91, 2021.
R. Robinson And B. Thagesen, Road Engineering For Development, CRC Press, 2018.
A. S. A. &. V. V. Novikov, "Development Of Approach To Reduce Number Of Accidents Caused By Drivers," Transportation Research Procedia, Vol. 50, Pp. 491-498, 2020.
R. Robinson And B. Thagesen, Road Engineering For Development, CRC Press, 2018.
A. S. El-Wakeel, J. Li, A. Noureldin, H. S. Hassanein And N. Zorba, "Towards A Practical Crowdsensing System For Road Surface Conditions Monitoring," IEEE Internet Of Things Journal, Vol. 5, No. 6, Pp. 4672-4685, 2018.
G. Ochoa-Ruiz, A. A. Angulo-Murillo, A. Ochoa-Zezzatti, L. M. Aguilar-Lobo, J. A. Vega-Fernández And S. Natraj, "An Asphalt Damage Dataset And Detection System Based On Retinanet For Road Conditions Assessment," Applied Sciences, Vol. 10, No. 11, P. 3974, 2020.
H. M. Hammad, M. Ashraf, F. Abbas, H. F. Bakhat, S. A. Qaisrani, M. Mubeen And M. Awais, "Environmental Factors Affecting The Frequency Of Road Traffic Accidents: A Case Study Of Sub-Urban Area Of Pakistan," Environmental Science And Pollution Research, Vol. 26, Pp. 11674-11685, 2019.
P. Hazelton And B. Murphy, Understanding Soils In Urban Environments, Csiro Publishing, 2021.
T. K. I. D. M. A. &. Y. I. W. Taufikurrahman, "Study Of Road Surface Damage Due To Rainwater Puddles Using The Pavement Condition Index," Path Of Science, Vol. 8, No. 8, Pp. 3010-3018, 2022.
Z. P. Gao, Y. F. Jia, H. M. Guo, D. Zhang And B. Zhao, "Quantifying Geochemical Processes

Of Arsenic Mobility In Groundwater From An Inland Basin Using A Reactive Transport Model," Water Resources Research, Vol. 56, No. 2, P. 25492, 2020.
S. Mozaffari, O. Y. Al-Jarrah, M. Dianati, P. Jennings And A. Mouzakitis, "Deep Learning-Based Vehicle Behavior Prediction For Autonomous Driving Applications: A Review," IEEE Transactions On Intelligent Transportation Systems, Vol. 23, No. 1, Pp. 33-47, 2020.
P. Marcelino, M. D. Lurdes Antunes And E. Fortunato, "Comprehensive Performance Indicators For Road Pavement Condition Assessment," Structure And Infrastructure Engineering, Vol. 14, No. 11, Pp. 1433-1445, 2018.
F. L. &. W. S. S. Mannering, Principles Of Highway Engineering And Traffic Analysis, John Wiley & Sons, 2020.
O. Tengilimoglu, O. Carsten And Z. Wadud, "Implications Of Automated Vehicles For Physical Road Environment: A Comprehensive Review," Transportation Research Part E: Logistics And Transportation Review, Vol. 169, P. 102989, 2023.
F. L. &. W. S. S. Mannering, Principles Of Highway Engineering And Traffic Analysis, John Wiley & Sons, 2020.
T. ALI, "EVALUATION OF MAINTAINED ROADS USING PERFORMANCE BASED ROAD MAINTENANCE (A CASE OF ADDIS ABABA CITY ROAD)," 2019.