A Systematic Literature Review of Technology Transition for Electric Vehicles Using Bibliometrics Method

Roni Zakaria Raung[1)], Wahyudi Sutopo[2)], Muhammad Hisjam[3)]
1,2,3) Department of Industrial Engineering, Faculty of Engineering,
Universitas Sebelas Maret,Jl. Ir. Sutami, 36A,
Surakarta, Jawa Tengah, 57126
Indonesia

Djoni Hartono[4]
[4] Department of Economics, Faculty of Economics and Business,
University of Indonesia,
Pondok Cina, Kecamatan Beji, Kota Depok,
Jawa Barat,16424 Indonesia
ronizakaria@staff.uns.ac.id , wahyudisutopa@staff.uns.ac.id,
hisjam@staff.uns.ac.id, djoni.hartono@ui.ac.id

Abstract

This systematic literature review uses bibliometric methods with data from Scopus and Sciencedirect. This article aims to identify and analyze research trends, methods, and topics, as well as future research directions related to the growth of the technology transition market, especially electric motorcycles. The methodology used in this paper is a systematic literature review (bibliometrics). The data obtained from the search results in the database are 32 articles published from 2000 to 2023. Journal of Technological Forecasting and Social Change is the journal that has the most articles with a total of three articles, and the most active authors with at least two articles in the field of technological transition and electric vehicles are seven authors. Topics in the field of technology transition and electric vehicles market growth are grouped into eight groups, namely future market projections, policy analysis to reduce emissions, policy analysis related to technology transition, factors affecting the use of electric vehicles, energymanagement, electric vehicle market competition, electric vehicle charging infrastructure, and electric vehicle components. The output of this article will provide an overview of the future and further exploration of research opportunities and directions for projecting the market and analyzing the effectiveness of subsidy and incentive policies for electric motorcycles.

Keywords
Technology Transition, Electric Motorcycles, System Dynamics, Subsidy, Bibliography

1. Introduction

Transportation with conventional technology, known as Internal Combustion Engine (ICE), has contributed as the most significant contributor to global carbon emissions (IEA 2016) and accounts for half of the daily oil consumption (IEA 2015). This has become an environmental issue that has attracted the attention and focus of many parties, including the government. Along with these environmental issues, the development of zero-emission vehicles (ZEVs) has been urged by policies to reduce greenhouse gas emissions (Larson et al. 2014; Schuitema et al. 2013). Since then, the technology transition process from ICE to electric vehicles has been accelerated, as electric vehicles are believed to be the future ZEVs (Batlle 2011).

Several researchers have discussed topics relevant to the technology transition for electric vehicles or electric motorcycles. Struben's research has measured the willingness to consider the type of powertrain experiencing a technological transition from ICE to a powertrain with alternative fuels (Struben and Sterman 2008). Other studies build on Struben's research to forecast the market using various methods from dynamic systems, Markov models, and mixed-logit models (Deuten et al. 2020; Gomez Vilchez et al. 2013; Gomez Vilchez and Thiel 2020; Harrison et al. 2016, 2018; Jones et al. 2013; Pasaoglu et al. 2016). In addition, there are studies discussing policies for both electricvehicles,

the transition process, and carbon emission reduction (Fiorello et al. 2010; Harrison and Thiel 2017a, 2017b). This article aims to identify and analyze articles obtained from the database on research trends, research methods,

article topics, and future research directions related to the topic of technology transition market growth, especially electric motorcycles.

This article is composed of the initial section, namely an introduction related to the topic of technological transition market growth, especially electric motorbikes; the second section is a methodology related to the flow of systematic literature review; the third section is a statistical presentation of the results of articles obtained from the database which are then analyzed based on publication year, journal source, keywords (co-occurrence), author, and article topic, the last section describes the output obtained from this systematic literature review.

2. Methodology

The methodology used in this systematic literature review article is bibliometrics. Bibliometrics is one of the methods used to identify trends from several existing studies. The main objective of this research is to identify some of the most relevant research and recent trends based on information contained in the Scopus and ScienceDirect databases. Scopus is the most significant journal website that can be used to search the database of citations, papers, and research analysis (Riaman et al. 2022).

By classifying based on the specified keywords, then analyzing based on the most cited journals and the most prolific and influential authors relevant to future research (Contreras and Abid 2022). Thus, the findings obtained will be used as an opening for further research. The search conducted in this study uses regulations related to technology transition, electric vehicles or electric motorcycles. The rule used in this article is TITLE-ABS-KEY ("PTTMAM" OR "Technology Transition" AND "Electric Vehicles" OR "Electric Motorcycle"). In the search using these rules, 152 documents were obtained. Then classification based on limitations, document type, source type, language, and some relevant keywords resulted in 32 articles. The flow used in the systematic literature review is depicted in Figure 1.

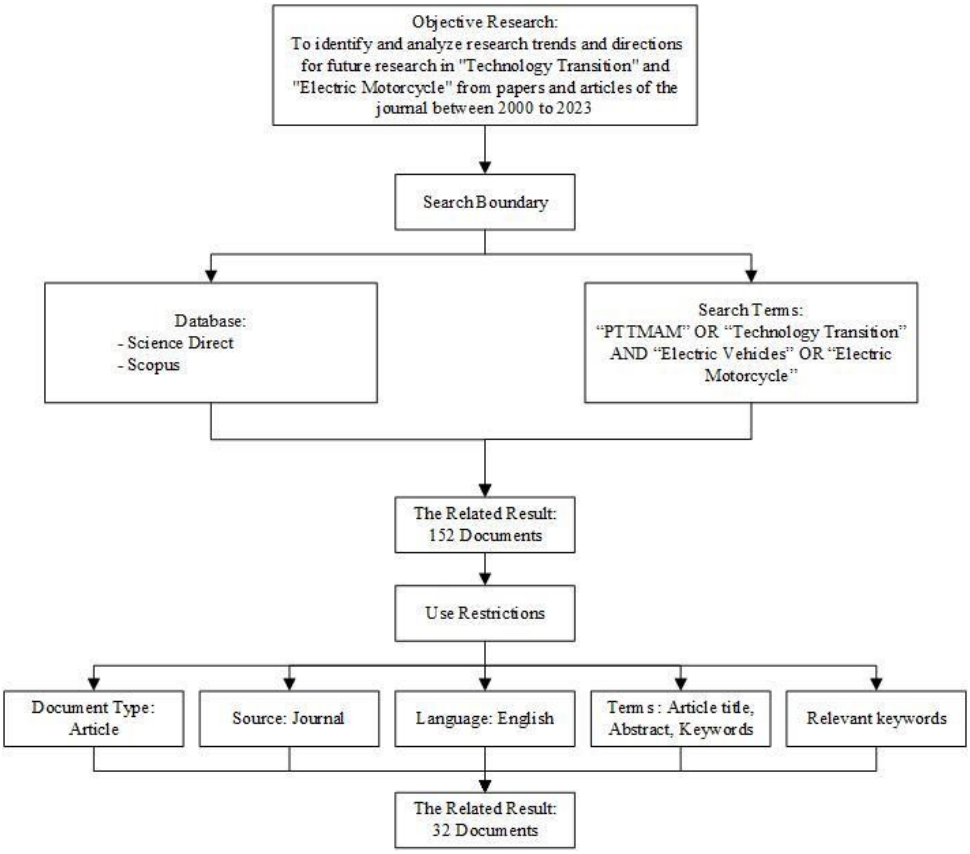

Figure 1. Flowchart methodology for the systematic literature review

After searching the database, the documents obtained were analyzed using VOSViewer software version 1.6.17. This software can read information from the article, such as the author, keywords, and year of publication (Contreras and Abid 2022).

3. Statistics Results

This section provides an illustration of number of articles by publication year and cite number of article, analysis based on co-occurence (keywords), analysis based on author, and topics of research of articles.

3.1 Number of Articles by Publication Year and Cite Number of Article

This section describes the trend of articles from 2000 to the present and the journals that actively publish the most articles related to technology transition or electric motorcycle market growth. Based on the 32 articles that have been selected, there is an increase in the number of articles from year to year. A significant increase occurred from 2016 to the present, related to the growth of the technology transition market, especially electric motorcycles, as shown in Figure 2. This increase indicates that research on technology transition and electric vehicles is becoming an interesting topic for researchers.

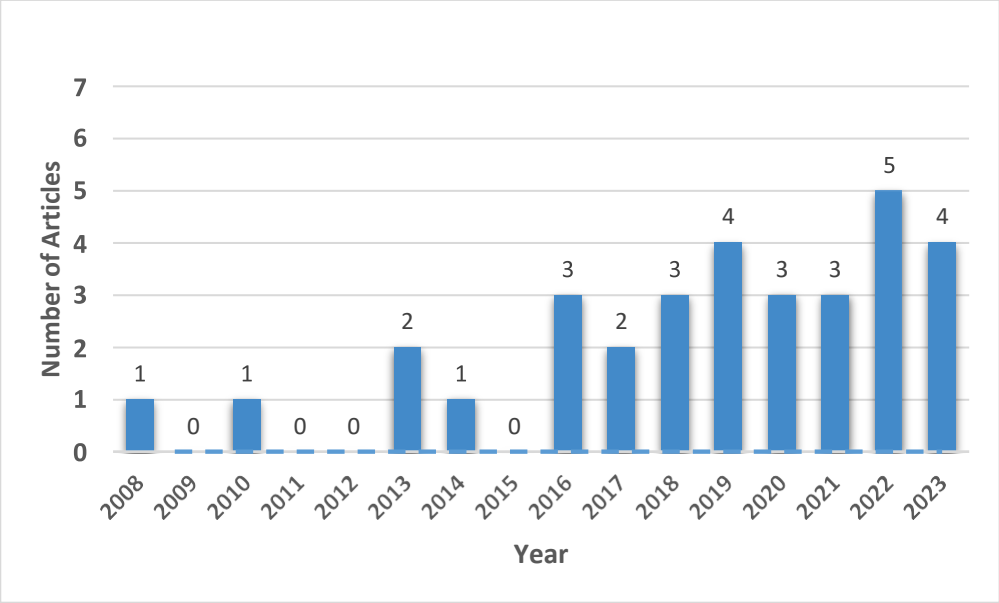

Figure 2. Number of Articles by Publication Year

Articles used in the systematic literature review were sourced from 26 journals, with 11 indexed in Q1, 7 in Q2, and 1 in Q3, namely the Polish Journal of Environmental Studies. Table 1 describes the number of individual articles used for each journal. Based on these details, articles related to technology transition or electric motorcycles market growth are primarily published in the Technological Forecasting and Social Change journal, namely three out of 32 articles.

Table 1. Cite Number of Articles from Each Journal

Journals	Quantity
Technological Forecasting and Social Change (Q1)	3
European Transport Research Review (Q2)	2
IEEE Transactions on Transportation Electrification (Q1)	2
World Electric Vehicle Journal (Q2)	2
Applied Energy (Q1)	1

Applied Mechanics and Materials (Q1)	1
Asian Economic Policy Review (Q2)	1
Energies (Q2)	1
Environmental Science and Technology (Q1)	1
European Journal of Operational Research (Q1)	1
Journal of Cleaner Production (Q1)	1
Journal of Simulation (Q1)	1
Journal of The Institution of Engineers (India): Series C (Q2)	1
Nature Communications (Q1)	1
Polish Journal of Environmental Studies (Q3)	1
Research Policy (Q1)	1
Sustainability (Switzerland) (Q2)	1
System Dynamics Review (Q2)	1
Wiley Interdisciplinary Reviews: Energy and Environment (Q1)	1
Others	7

3.2 Analysis Based On Co-Occurence (Keywords)

Further analysis was generated from the keywords assigned in the Scopus and Science Direct searches. The keyword analysis aims to find the growing trend of the research theme to be carried out so that opportunities or focus areas can be drawn on the research theme to be carried out. Figure 3. shows the relationship between keywords from the research and their occurrence.

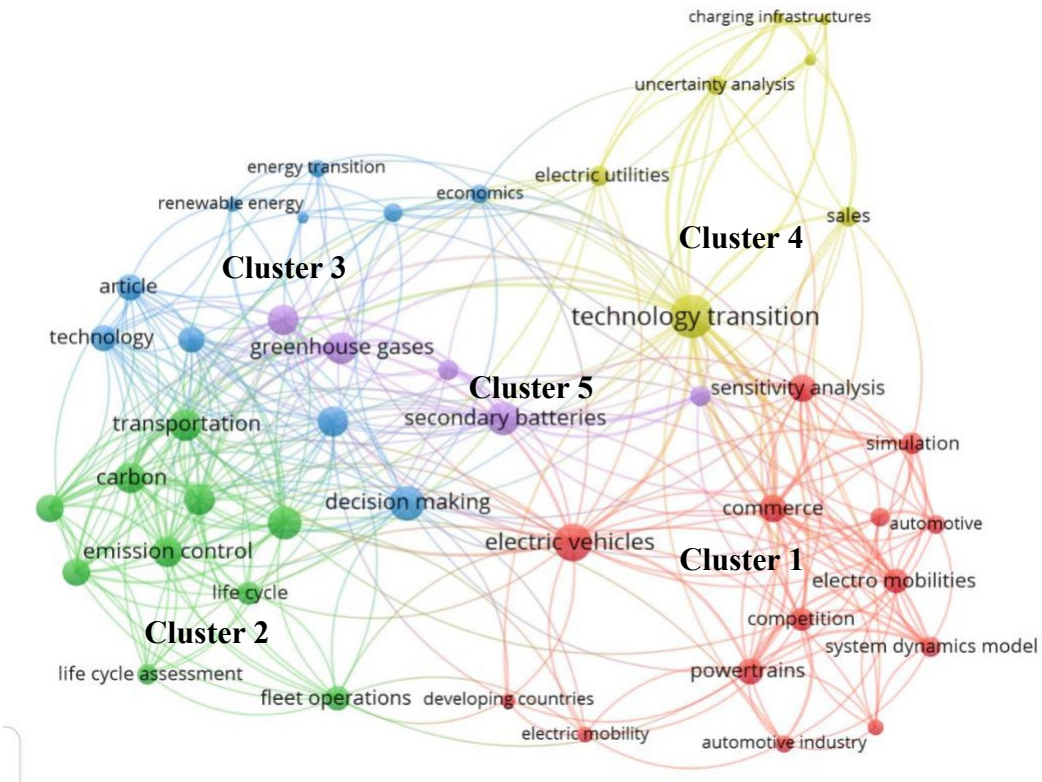

Figure 3. *Co-occurrence Network Visualization*

The results of the VOS viewer are divided into 5 clusters distinguished by color. Cluster 1 in red consists of 14 items focusing on electric vehicles. Cluster 2 in green consists of 10 items focusing on transportation and climate change.

Cluster 3 in blue consists of 10 items focusing on decision-making and technology. Cluster 4 in yellow consists of 7 items focusing on technology transition. Cluster 5 in purple consists of 5 items focusing on greenhouse gases.

The results of the VOS Viewer are shown in Table 2. There are 46 keywords obtained, with the minimum number of co-occurrences of a keyword is 2. The five most frequently used keywords in this study include technology transition (Occ. = 11, TSL = 57), electric vehicles (Occ. = 8, TSL = 31), transportation (Occ. = 4, TSL = 31), climate change (Occ. = 4, TSL = 31), and greenhouse gases (Occ. = 4, TSL = 31). These keywords are important in determining the research topic of transition technology and connecting the branches of science. Table 2. Summaries of Co-Occurrence Keywords.

Table 2. Summaries of Co-Occurrence Keywords

Keyword	**Occ**	**TLS**
CLUSTER 1 (Red)		
Automobile manufacture	2	8
Automotive	2	11
Automotive industry	2	10
Commerce	4	27
Competition	3	18
Developing countries	2	7
Electric mobility	2	8
Electric vehicles	8	31
Electro mobilities	3	24
Powertrains	3	21
Sensitivity analysis	3	22
Simulation	2	17
System dynamics	2	11
System dynamics model	2	16
CLUSTER 2 (Green)		
Carbon	3	30
Carbon emission	3	30
Climate change	4	31
Decarbonisation	2	23
Emission control	3	30
Fleet operations	2	15
Greenhouse gas	2	23
Life cycle	2	17
Life cycle assessment	2	11
Transportation	4	31
CLUSTER 3 (Blue)		
Article	2	18
Decision making	3	23
Economics	2	11
Electric vehicle	5	22
Energy transition	2	9
Plug-in electric vehicle	2	16
Policy analysis	2	10
Renewable energy	2	8
Technology	2	18
CLUSTER 4 (Yellow)		
Charging infrastructures	2	10
Electric utilities	2	12
Monte carlo analysis	2	10
Quality of services	2	10
Sales	2	13

Technology transition	11	57
Uncertainty analysis	3	15
CLUSTER 5 (Purple)		
Electricity production	2	12
Gas emissions	3	24
Greenhouse gases	4	31
Plug-in hybrid vehicles	2	13
Secondary batteries	3	26

*TSL = Total Strength Link

Analysis Based on Author

The following analysis will illustrate the interaction of authors from several articles and journals that have been cited. Thus, the analysis results using VOS Viewer software obtained ten authors in 3 clusters. Figure 4 shows the author network output results from several articles and journals.

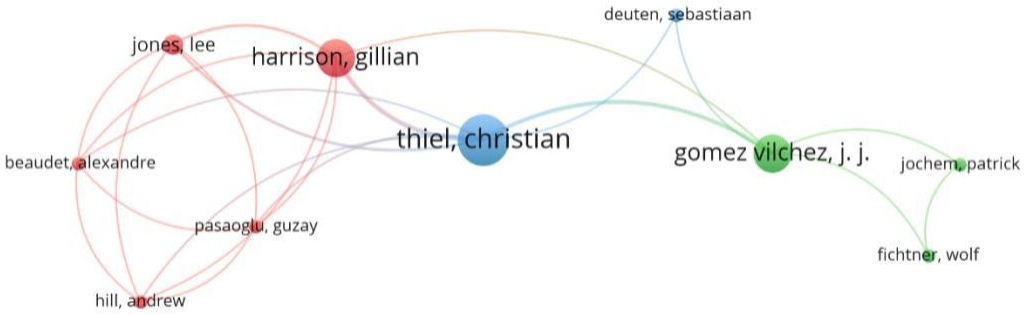

Figure 4. *Co-authorship Network Visualization*

Figure 4 shows the authors who actively researched the growth of the technology transition market, especially electric motorcycles, between 2008 and 2023. They authored at least 1 document as the main author or co-authors. These authors include Alexandre Beaudet, Andrew Hill, Christian Thiel, Deuten Sebastian, Gillian Harrison, Guzay Pasaoglu, Jonathan J. Gomez Vilchez, Lee Jones, Patrick Jochem, and Wolf Fichtner. Christian Thiel and Gillian Harrison have collaborated to co-author five documents. Table 3 shows in detail the number of published articles for each author.

Table 3. Summaries of Co-Authorship Keywords

No	Author	Number of articles	TLS
1	Alexandre Beaudet	1	5
2	Andrew Hill	1	5
3	Christian Thiel	8	15
4	Deuten Sebastian	1	2
5	Gillian Harrison	5	11
6	Guzay Pasaoglu	1	5
7	Jonatan J. Gomez Vilchez	5	8
8	Lee Jones	2	7
9	Patrick Jochem	1	2
10	Wolf Fichtner	1	2

3.3 Topics of Research of Articles

This section categorizes the 32 articles into topics on technology transition and electric vehicles. The articles are grouped into eight topics relevant to technology transition and electric vehicles. The topics for each article can be seen

in Table 4. Based on the analysis of the topics of the 32 articles, the most discussed topics are market trend projections, carbon emission policy analysis, and policy analysis for technology transition, with a total of 7 articles. This can support future research opportunities and directions related to these topics.

Table 4. Topics research in technology transition and electric vehicles or electric motorcycle

No	Topics	Article
1	Projection Future Market Trends	(Deuten et al. 2020; Gomez Vilchez et al. 2013; Gomez Vilchez and Thiel 2020; Harrison et al. 2016, 2018; Jones et al. 2013; Pasaoglu et al. 2016)
2	Policy Analysis for Carbon Emissions	(Fiorello et al. 2010; Gomez Vilchez and Thiel 2019; Höltl et al. 2018; Jenn 2023; Meckling & Biber 2021; Roy et al. 2022; Xue et al. 2023)
3	Technology Transition Policy Analysis	(Brozynski & Leibowicz 2020; Harrison & Thiel 2017a, 2017b; Shah et al. 2022; Y. Song et al. 2020; Yamamura et al. 2022; Zhao and Simic 2022)
4	Key Factors Impact EV Market	(Ashok et al. 2022; Chen 2014; Ehrnschwender et al. 2023; Struben & Sterman 2008)
5	Energy Management	(Cherif et al. 2021; Kannan and Hirschberg 2016; Zhang et al. 2023)
6	EV Industry Competition	(Helveston et al. 2019)
7	Charging Infrastructure of EV	(E. Ucer et al. 2019; E. Y. Ucer et al. 2018)
8	Component for Electric Vehicle	(Catuneanu et al. 2021)

State of The Art

This section analyzes the articles selected by researchers based on the closeness of the relevance of the article contentto the research topic, namely technology transition or electric motorcycle market growth. Table 5 is the state of the artto show the opportunities for researchers to conduct research in the future.

Table 5. State of The Art

No	Penulis, Tahun	Judul	Topik	Method	Objek	Negara Studi
1	Struben and Sterman (2008)	Transition Challenges for Alternative Fuel Vehicle and Transportation Systems	Determination of Willingness to Consider (WtC) in the Motor Vehicle Technology Transition Process	Sistem Dinamis	Electric Cars	UK
2	Gomez Vilchez et al. (2013)	EV Market Development Market Development Pathways–An Application of System Dynamics for Policy Simulation	Determination of EV market projections using dynamic systems based on Total Cost Ownership (TCO) value estimates and policy simulations.	Sistem Dinamis	Electric Cars	US, China, Germany, India, UK, France
3	Jones et al. (2013)	The Effect of Incentives and Technology on the Adoption of Electric Motorcycles: A Stated Choice Experiment in Vietnam	Determination of market share estimation by applying several different scenarios.	*Mixed Logit Model*	Electric Motorcycles	Vietnam

4	Chen (2014)	Applying Technology Acceptance Model to Explore The Adoption of Hydrogen-Electric Motorcycle in Taiwan	Determination of electric motorcycle market projections using the Technology Acceptance Model (TAM).	*Technology Acceptance Model* (TAM)	Electric Motorcycles	Taiwan
5	Pasaoglu et al. (2016)	A System Dynamics Based Market Agent Model Simulating Future Powertrain Technology Transition: Scenarios in The EU Light Duty Vehicle Road Transport Sector	Determination of the electric vehicle (EV) market in the EU using a dynamic system.	PTTMAM	Electric Cars	EU 28
6	Deuten et al. (2020)	Analysis And Testing of Electric Car Incentive Scenarios in The Netherlands and Norway	Analysis of the differences between the subsidy and incentive policies of the Dutch and Norwegian Governments and their impact on the Electric Vehicle industry and market in both countries.	PTTMAM	Electric Cars	Netherlands and Norway
7	Y. Song et al. (2020)	Scenario Analysis on Subsidy Policies for the Uptake of Electric Vehicles Industry in China	An analysis of the government's subsidy and incentive policies for the electric vehicle industry in China.	PTTMAM	Electric Vehicles Industry	China
	Future Research		Analysis of the Effectiveness of Subsidy and Incentive Policies on Electric Motorcycle Market Growth in Indonesia.	PTTMAM	Electric Motorcycles	Indonesia

In the articles above, it has been proven that the effect of subsidies and incentives on the market for both electric cars and electric motorcycles is significant. The government's most common subsidy schemes are vehicle purchase subsidies, R&D subsidies for industry, and facility subsidies for infrastructure providers. The duration and value of subsidies and incentives must be appropriate, as excessive subsidies and incentives can lead to ineffective and inefficient resource allocation. According to Y. Song et al. (2020), the subsidies can have two effects on the industry, namely (1) reducing R&D costs, increasing competition between companies and promotional activities, and increasing company profits called Crowding-In Effects; and (2) causing overproduction or Crowding-Out Effects. So, with this

analysis, the opportunity to develop research related to market projections and analysis of subsidy and incentive policies, especially for electric motorbikes in Indonesia, is still wide open.

4. Conclusion

The data collection results show that there are 32 research articles related to technology transition and electric vehicles from 2000 to 2023. The data analysis using VOS Viewer showed this study's five most frequently used keywords. These keywords are related to technology transition, electric vehicles, transportation, climate change, and greenhouse gases. The articles obtained were also categorized by topic, with most articles discussing future market projections, policy analysis to reduce emissions, and policy analysis related to technology transition. Based on the study's results, opportunities and directions for future research are (1) developing simulation models to project the electric motorcycle market and (2) analyzing the effectiveness of subsidy and incentive policies for electric motorcycles. Limitations of the bibliometric analysis in this article are attributed to the exclusion of other document sources such as PubMed or Web of Science.

References

Ashok, B., Kannan, C., Usman, K. M., Vignesh, R., Deepak, C., Ramesh, R., Narendhra, T. M. V, and Kavitha, C., Transition to Electric Mobility in India: Barriers Exploration and Pathways to Powertrain Shift through MCDM Approach, *Journal of The Institution of Engineers (India): Series C*, vol. *103*, no. 5 , pp.1251–1277. ,2022. https://doi.org/10.1007/s40032-022-00852-6

Batlle, C., A Method for Allocating Renewable Energy Source Subsidies Among Final Energy Consumers, *Energy Policy*, vol. *39*, no. 5 , pp.2586–2595. , 2011.

Brozynski, M. T., and Leibowicz, B. D., Markov Models of Policy Support for Technology Transitions, *European Journal of Operational Research*, vol. *286*, no. 3, pp.1052–1069., 2020. https://doi.org/10.1016/j.ejor.2020.03.066

Catuneanu, A., Burgers, J. G., Fleury, P., Zhang, W. J., and Ng, W. T., Practical Limits of Liquid Cooling Electric Vehicle Power Modules, *33rd International Symposium on Power Semiconductor Devices and ICs, ISPSD 2021*, vol. *2021-May*, , pp.379–382. , 2021. https://doi.org/10.23919/ISPSD50666.2021.9452221

Chen, H. S., Applying Technology Acceptance Model to Explore the Adoption of Hydrogen-Electric Motorcycle in Taiwan, *Applied Mechanics and Materials*, vol. *459*, , pp.494–498. , 2014.

Cherif, R., Hasanov, F., and Pande, A., Riding the Energy Transition: Oil beyond 2040, *Asian Economic Policy Review*, vol. *16*, no. 1 , pp.117–137. , 2021. https://doi.org/10.1111/aepr.12317

Contreras, F., and Abid, G., Social Sustainability Studies in the 21st Century: A Bibliometric Mapping Analysis Using VOSviewer Software, *Pakistan Journal of Commerce and Social Sciences (PJCSS)*, vol. *16*, no. 1 , pp.167–203. , 2022.

Deuten, S., Gomez Vilchez, J. J., & Thiel, C., Analysis and Testing of Electric Car Incentive Scenarios in the Netherlands and Norway, *Technological Forecasting and Social Change*, vol. *151*, , pp.119847. , 2020. https://doi.org/https://doi.org/10.1016/j.techfore.2019.119847

Ehrnschwender, D., Siddiki, S., Carley, S., and Nicholson-Crotty, S., Exploring Factors Shaping Transportation Electrification in American Cities, *Renewable and Sustainable Energy Transition*, vol. *3*, , pp.100054. , 2023. https://doi.org/https://doi.org/10.1016/j.rset.2023.100054

Fiorello, D., Fermi, F., and Bielanska, D., The ASTRA model for strategic assessment of transport policies, *System Dynamics Review*, vol. *26*, no. 3 , pp.283–290. , 2010.

Gomez Vilchez, J. J., Jochem, P., and Fichtner, W., EV Market Development Market Development Pathways–AnApplication of System Dynamics for Policy Simulation, *World Electric Vehicle Journal*, vol. *6*, no. 4 , pp.1030–1038. , 2013.

Gomez Vilchez, J. J., and Thiel, C., The Effect of Reducing Electric Car Purchase Incentives in the European Union, *World Electric Vehicle Journal*, vol. *10*, no. 4 . , 2019. https://doi.org/10.3390/wevj10040064

Gomez Vilchez, J. J., and Thiel, C., Simulating the Battery Price and the Car-Mix in Key Electro-Mobility Markets Via Model Coupling, *Journal of Simulation*, pp.242–259. , 2020. https://doi.org/10.1080/17477778.2020.1781556

Harrison, G., Gomez Vilchez, J. J., and Thiel, C., Industry Strategies for the Promotion of E-mobility Under Alternative Policy and Economic Scenarios, *European Transport Research Review*, vol. *10*, no. 2 . , 2018. https://doi.org/10.1186/s12544-018-0296-6

Harrison, G., and Thiel, C., Policy Insights and Modelling Challenges: The Case of Passenger Car Powertrain Technology Transition in the European Union, *European Transport Research Review*, vol. *9*, no. 3 , pp.1–14. ,

a2017.

Harrison, G., and Thiel, C., An Exploratory Policy Analysis of Electric Vehicle Sales Competition and Sensitivity to Infrastructure in Europe, *Technological Forecasting and Social Change*, vol. *114*, , pp.165–178. , b2017. https://doi.org/10.1016/j.techfore.2016.08.007

Harrison, G., Thiel, C., and Jones, L., Powertrain Technology Transition Market Agent Model (PTTMAM), In *JRC Technical Reports*. , 2016. https://ec.europa.eu/jrc%0Ahttps://publications.jrc.ec.europa.eu/repository/bitstream/JRC100418/pttmam technical report final_online.pdf

Helveston, J. P., Wang, Y., Karplus, V. J., and Fuchs, E. R. H., Institutional Complementarities: The Origins of Experimentation in China's Plug-In Electric Vehicle Industry, *Research Policy*, vol. *48*, no. 1 , pp.206–222. , 2019. https://doi.org/10.1016/j.respol.2018.08.006

Höltl, A., Macharis, C., and De Brucker, K., Pathways to Decarbonise the European Car Fleet: A Scenario Analysis Using the Backcasting Approach, *Energies*, vol. *11*, no. 1 . , 2018. https://doi.org/10.3390/en11010020

IEA, *World Energy Outlook 2015*, IEA. , 2015.

IEA, *Energy Technology Perspectives 2016 Towards a Sustainable Energy System*, IEA. , 2016.

Jenn, A., Emissions of Electric Vehicles in California's Transition to Carbon Neutrality, *Applied Energy*, vol. *339*, , pp.120974. , 2023. https://doi.org/https://doi.org/10.1016/j.apenergy.2023.120974

Jones, L. R., Cherry, C. R., Vu, T. A., and Nguyen, Q. N., The Effect of Incentives and Technology on the Adoption of Electric Motorcycles: A Stated Choice Experiment in Vietnam, *Transportation Research Part A: Policy and Practice*, vol. *57*, , pp.1–11. , 2013.

Kannan, R., and Hirschberg, S., Interplay Between Electricity and Transport Sectors – Integrating the Swiss Car Fleet and Electricity system, *Transportation Research Part A: Policy and Practice*, vol. *94*, , pp.514–531. , 2016. https://doi.org/https://doi.org/10.1016/j.tra.2016.10.007

Larson, P. D., Viáfara, J., Parsons, R. V, and Elias, A., Consumer Attitudes About Electric Cars: Pricing Analysis and Policy Implications, *Transportation Research Part A: Policy and Practice*, vol. *69*, , pp.299–314. , 2014.

Meckling, J., and Biber, E., A Policy Roadmap for Negative Emissions Using Direct Air Capture, *Nature Communications*, vol. *12*, no. 1 . , 2021. https://doi.org/10.1038/s41467-021-22347-1

Pasaoglu, G., Harrison, G., Jones, L., Hill, A., Beaudet, A., and Thiel, C., A System Dynamics Based Market Agent Model Simulating Future Powertrain Technology Transition: Scenarios in the EU Light Duty Vehicle Road Transport Sector, *Technological Forecasting and Social Change*, vol. *104*, , pp.133–146. , 2016.

Riaman, Sukono, Supian, S., and Ismail, N., Mapping in the Topic of Mathematical Model in Paddy Agricultural Insurance Based on Bibliometric Analysis: A Systematic Review Approach, *Computation*, vol. *10*, no. 4 , pp.50. , 2022.

Roy, M., Ghoddusi, H., and Trancik, J. E., Evaluating Low-Carbon Transportation Technologies When Demand Responds to Price, *Environmental Science and Technology*, vol. *56*, no. 4 , pp.2096–2106. , 2022. https://doi.org/10.1021/acs.est.1c02052

Schuitema, G., Anable, J., Skippon, S., and Kinnear, N., The Role of Instrumental, Hedonic and Symbolic Attributes in the Intention to Adopt Electric Vehicles, *Transportation Research Part A: Policy and Practice*, vol. *48*, , pp.39–49. , 2013.

Shah, K. U., Awojobi, M., and Soomauroo, Z., Electric Vehicle Adoption in Small Island Economies: Review from ATechnology Transition Perspective, *Wiley Interdisciplinary Reviews: Energy and Environment*, vol. *11*, no. 4 .
, 2022. https://doi.org/10.1002/wene.432

Song, C. H., and Aaldering, L. J., Strategic Intentions to the Diffusion of Electric Mobility Paradigm: The Case ofInternal Combustion Engine Vehicle, *Journal of Cleaner Production*, vol. *230*, , pp.898–909. , 2019. https://doi.org/10.1016/j.jclepro.2019.05.126

Song, Y., Li, G., Wang, Q., Meng, X., and Wang, H., Scenario Analysis on Subsidy Policies for the Uptake of Electric Vehicles Industry in China, *Resources, Conservation and Recycling*, vol. *161*, , pp.104927. , 2020.

Struben, J., and Sterman, J. D., Transition Challenges for Alternative Fuel Vehicle and Transportation Systems, *Environment and Planning B: Planning and Design*, vol. *35*, no. 6 , pp.1070–1097. , 2008.

Ucer, E., Koyuncu, I., Kisacikoglu, M. C., Yavuz, M., Meintz, A., and Rames, C., Modeling and Analysis of A Fast Charging Station and Evaluation of Service Quality for electric Vehicles, *IEEE Transactions on Transportation Electrification*, vol. *5*, no. 1 , pp.215–225. , 2019. https://doi.org/10.1109/TTE.2019.2897088

Ucer, E. Y., Kisacikoglu, M. C., Erden, F., Meintz, A., and Rames, C., Development of A DC Fast Charging Station Model for Use with EV Infrastructure Projection Tool, *2018 IEEE Transportation and Electrification Conference and Expo, ITEC 2018*, pp.934–938. , 2018. https://doi.org/10.1109/ITEC.2018.8450158

Xue, X., Sun, X., Ma, H., Li, J., Hong, F. T., and Du, S., Transportation Decarbonization Requires Life Cycle-Based

Regulations: Evidence from China's Passenger Vehicle Sector, *Transportation Research Part D: Transport and Environment*, vol. *118*, . , 2023. https://doi.org/10.1016/j.trd.2023.103725

Yamamura, C. L. K., Takiya, H., Machado, C. A. S., Santana, J. C. C., Quintanilha, J. A., and Berssaneti, F. T., Electric Cars in Brazil: An Analysis of Core Green Technologies and the Transition Process, *Sustainability (Switzerland)*, vol. *14*, no. 10 . , 2022. https://doi.org/10.3390/su14106064

Zhang, H., Xue, B., Chen, L., Wang, L., Huang, K., Chang, Z., and Yu, Y., The Electric Vehicles' Recycling Process to Carbon Neutrality Mission in China Tends to Be Negative: Depending on the Technology Transition, *Polish Journal of Environmental Studies*, vol. *32*, no. 2 , pp.1941–1948. , 2023. https://doi.org/10.15244/pjoes/157219

Zhao, Z., and Simic, M., Transition to Electric and Autonomous Vehicles in China, In Z. A., H. R.J., & J. L.C. (Eds.), *International KES Conference on Human Centred Intelligent Systems, KES HCIS 2022* (Vol. 310, pp. 111–123), Springer Science and Business Media Deutschland GmbH. , 2022. https://doi.org/10.1007/978-981-19-3455-1_8

Biographies

Roni Zakaria is currently a doctoral student in Industrial Engineering Department. Faculty of Engineering, Universitas Sebelas Maret. He is also a lecturer at Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret since 2000. He earned his Bachelor and Master Degree in Industrial Engineering from Institut Teknologi Bandung. His research interests are business management, strategic management and organizational behavior. He published some papers in journals and proceedings his research area. He is a member of PII (Indonesian Professional Engineer Association) and IEOM (Industrial Engineering and Operations Management).

Wahyudi Sutopo is a professor in industrial engineering and coordinator for the research group of industrial engineering and techno-economy (RG-RITE) of Faculty Engineering, Universitas Sebelas Maret (UNS), Indonesia. He earned his Ph.D. in Industrial Engineering & Management from Institut Teknologi Bandung in 2011. He is also a researcher for the university center of excellence for electrical energy storage technology (UCE-EEST). He has done projects with Indonesia endowment fund for education (LPDP), sustainable higher education research alliances (SHERA), MIT-Indonesia research alliance (MIRA), PT Pertamina (Persero), PT Toyota Motor Manufacturing Indonesia, and various other companies. His research interests include logistics & supply chain management, engineering economy, cost analysis & estimation, and technology commercialization. He is a member of the board of industrial engineering chapter - the institute of Indonesian engineers (BKTI-PII), Indonesian Supply Chain & Logistics Institute (ISLI), Society of Industrial Engineering, and Operations Management (IEOM), and Institute of Industrial & Systems Engineers (IISE).

Muhammad Hisjam is a lecturer at Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret since 1998. He earned Bachelor in Agroindustrial Technology from Universitas Gadjah Mada, Master in Industrial Engineering & Management from Institut Teknologi Bandung and Ph. D in Environmental Science from Universitas Gadjah Mada. His research interests are supply chain, logistics, business and sustainable development. He published some papers in journals and proceeding his research area. He holds Accredited Supply Chain Analyst from American Academy of Project Management. He is the Head of Logistics System and Business Laboratory, Faculty of Engineering, Universitas Sebelas Maret. He is a member of IISE, AAPM and IEOM.

Djoni Hartono is a Professor at the Department of Economics, Faculty of Economics and Business, Universitas Indonesia. He received his B.S. degree in mathematics from Bogor Agricultural University, while his Master and Ph.D. degrees in economics were obtained from Universitas Indonesia. He teaches several subjects such as mathematical economics, econometrics, energy economics, regional economics, and economic modelling. His research interests cover the economy-wide impact of energy policies as well as regional and economic development. His another specialty is on the computable general equilibrium modelling. He also has published academic articles in reputable journals such as Energy for Sustainable Development; Energy Policy; International Journal of Urban Sciences; Energy Sources Part B: Economics, Planning, and Policy; Renewable and Sustainable Energy Reviews; Environmental Economics and Policy Studies; Renewable Energy; Review of Urban and Regional Development Studies; International Journal of Development Issues; International Journal of Energy Sector Management; and Asian Economic Journal.