Transportation in the Path of Sustainability: A Systematic Quantitative Review of Case Studies

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ABSTRACT

After the COVID-19 pandemic and the spectrum of new climate change disruptionsin the supply chain, a holistic approach towards sustainable transportation is needed. Sustainable transportation could benefit sustainable development from different angles; reduced traffic deaths, increased share of renewable energy, higher quality of transport-related infrastructure, increasedsatisfaction with public transportation, increased responsible consumption and production, and reduced fossil fuel consumption. This study is an attempt to show whereon the scholars were focused previously and where the focus needs to be more on under the spotlight. This study has reviewed 358 case studies and categorized them into twenty groups based on the transportation mode, and nine groups, based on the authors' primary area of concern. Keyword analysis followed by topics modeling showed three non-overlapping trends in the cohort. The results, with a corroboratory investigationon on the benefits of the United States' infrastructure bill, were discussed in four categories: in-vehicle improvements, built-environment elements, human factors, and planning & regulations.

Keywords: Sustainable Transportation, Sustainability, Transportation, Mobility, Infrastructure, Sustainable Development

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1 INTRODUCTION

There is a 12 to 15 Gigaton (Gt) gap in 2030 emissions to limit the global warming to 2°C and almost 30 Gt gap to limit to 1.5℃ above pre-industrial levels (UNEP, 2020). The world, now more than ever, feels an urgent need to move towards the Paris Agreement commitments to avoid climate change

impacts. We have seen globally introduced so-called green infrastructure programs entailing transportation (Osmani, 2021). In the United States, the "H.R.3684 - Infrastructure Investment and Jobs Act" also known as "the Infrastructure Deal," will invest $110 billion of new funds "with a focus on climate change mitigation, resilience, equity, and safety for all users (The Whitehouse, 2021)." As of writing this article, the Dow Jones Transportation index (average) has experienced a more than 80% increase from its low point in the middle of March 2020 at the beginning of the pandemic.

Transportation after the severe impacts of the Covid-19 pandemic, both on travel behavior and transportation infrastructure (Shokouhyar et al., 2021), by adopting a holistic approach (Gudmundsson et al., 2016) couldplay into reaching sustainable development goals and make up for the lost time (Barbarossa, 2020). Sustainable transportation in this regard could benefit Sustainable development from different angles and various sustainable development goals (SDGs):

- Reduced traffic deaths (of SDG 3)
- Increased share of renewable energy (of SDG 7)
- Decent work and economic growth (SDG8)
- Higher quality of transport-related infrastructure (of SDG 9)
- Increased satisfaction with public transportation (of SDG 11)
- Increased responsible consumption and production (SDG 12)
- Reduced fossil fuel consumption (of SDG 13)

This study is an attempt to facilitate what Jiron & Carrasco described as a "radical shift" to "adapting to interdisciplinary ways of understanding mobility and designing mobility alternatives that are based on experience-based knowledge, mediated with other forms of knowledge (Jiron & Carrasco, 2020)". This study, unlike other reviews, provides readers with a review of case studies, many of which happened to beneglected. A case study virtually shows authors' penchant to argue the functionality of their findings in promoting sustainable transportation. In this work, all the reviewed authors either have indicated the direct benefits of their works to sustainable transportation or have imparted an incorporated perspective to the applicability of their findings in the realm of sustainable transportation.

The rest of the paper is dedicated to the methods and findings of a quantitative systematic review of more than 350 case studies, showing transport mode & main area of concern, geographical location, frequency of publications, keyword analysis, and a discussion over the findings at the end.

2 METHODOLOGY

The objective of this study is to not overlook any of the invaluable works that have been reviewed.

Therefore, a systematic quantitative review influenced by the work of (S. Mahmoudi et al., 2019) has been deployed.The systematic quantitative method by identifying the gaps in the literature, as of geographic, scalar, and methodological differences and deficiencies, this method leads us to the most substantial subjects and variables for future research (Pickering & Byrne, 2014). Systematic reviews using mixed methods will present components that are narrative and are presented in Tables (Grant & Booth, 2009). The systematic quantitative review methodology works well in areas such as the subject of this study where methodological approaches are so diverse that the possibility of other types of quantitative reviews exists like meta-analysisis limited (Pickering & Byrne, 2014). Figure 1 illustrates taken by using this method.

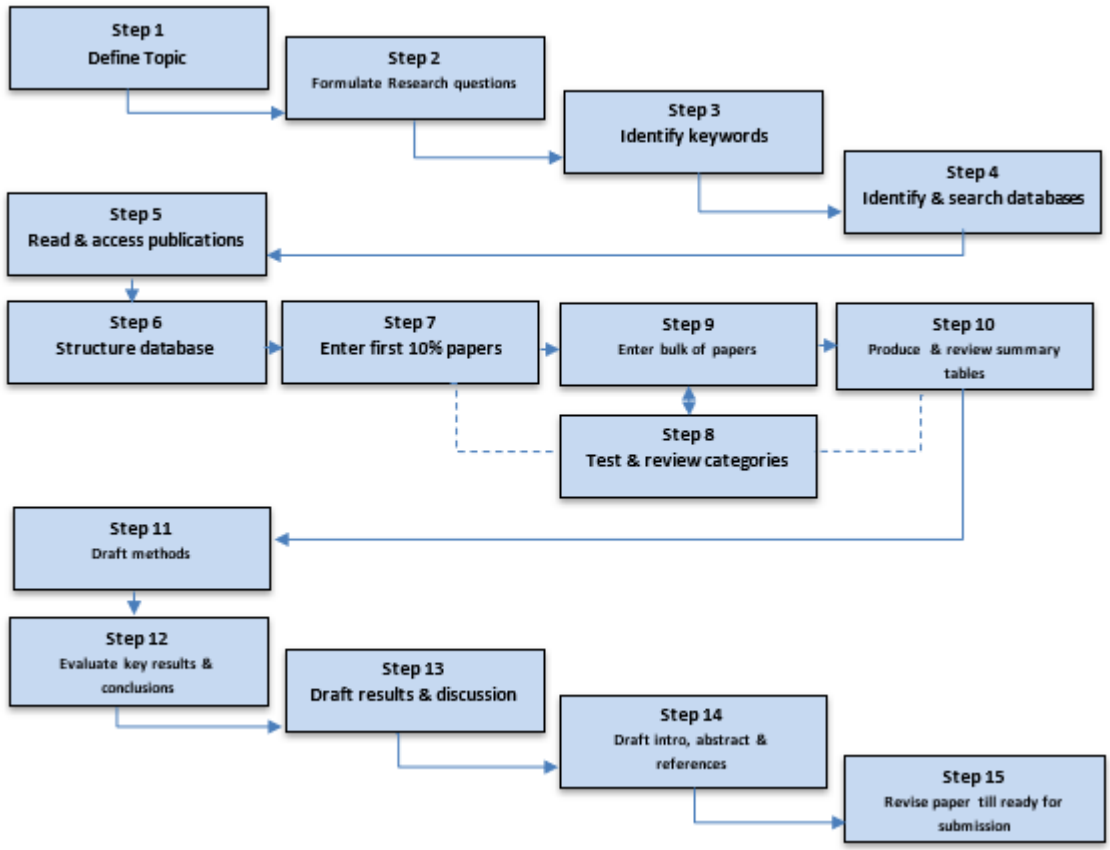

Figure 1 Fifteen Stages in Systematic Quantitative Review, Adopted from (Pickering & Byrne, 2014)

2.1 Selection process

The main objective of this review is to reveal the best practices of sustainable transportation in the literature,the areas of concern, and eventually, identify future research directions. Published research focused on case studies in sustainable transportation were extracted from the Scopus database. Figure 2 depicts the process of extraction. It is influenced by the flowchart of the PRISMA statement (Moher et al., 2009). Toanswer the questions drafted in the introduction of this study, a combination of

different words such as “sustainable transportation”, “sustainable mobility”, and “sustainable transport” was used to find records of the general topic. In the next stage, a combination of words such as “case study” was used to exclude irrelevantrecords. After screening founded records and assessing for eligibility, 358 papers were included in this review. In this step, for structuring our database, the following information was set as criteria: Year of publication, Journal of publication, Publisher, Author keywords, Geographical location, Transportmode, and researcher’s main area of concern.

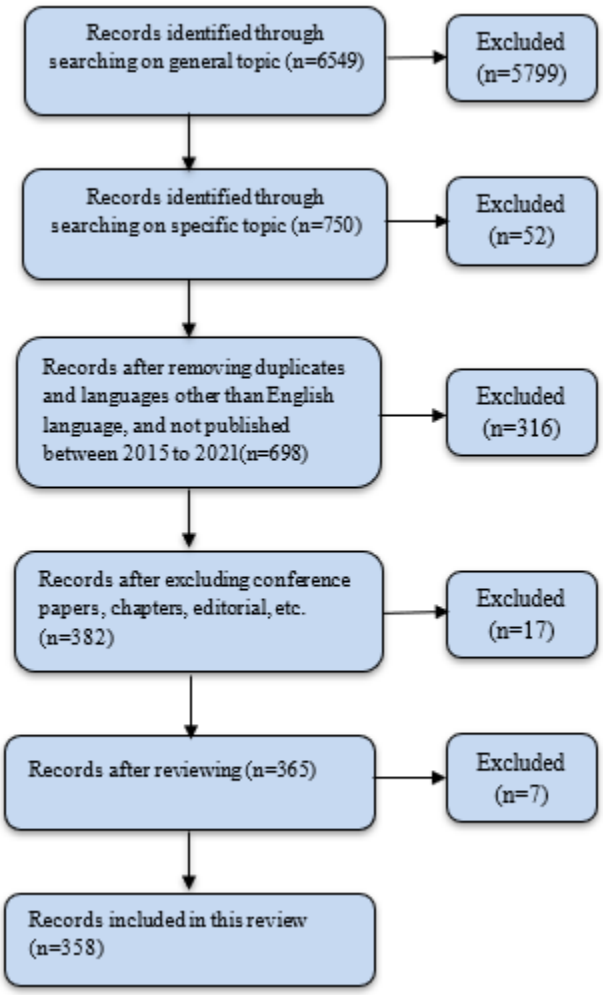

Figure 2 Extraction Process

2.2 Keyword Analysis

Regarding the large number of publications concerning sustainable transportation, a manual analysis will not lead to a comprehensive review. Therefore, an acute keyword analysis was also applied to supplement the manual analysis. For this analysis,the raw data set includes 8 features (Table 1) with 358 rows of data in total.

Title	Evaluating the impact …
Year	2021
Source Title	Sustainable Cities and Society
Cited By	
Link	https://www.scopus….
Abstract	Walking accessibility planning is seen a ... © 2021 The Authors
Author Keywords	Accessibility; …
Publisher	Elsevier Ltd

Table 1 An Example of Dataset for Keyword Analysis

2.2.1 Content Cleaning

The main objectives of this cleaning process are first, to remove all information irrelevant with the topics modeling, and secondly to convert all different formats of characters to a consistent and python readable format for the topics modeling. After cleaning, the remaining single nouns with the frequency of morethan 10 times were extracted as follows: ['sustain_mobil', 'rural_area', 'mobil', 'mobil', 'develop', 'transit', 'paper', 'region', 'object', 'question', 'mobil', 'govern', 'transit', 'sustain_mobil', 'rural_area', 'order', 'adopt', 'respons', 'organ', 'mobil', 'complex', 'mobil', 'govern', 'rural_area', 'analysi', 'field', 'sustain_mobil', 'case_studi', 'organ', 'public_transport', 'servic', 'area']

2.2.2 Topics Modeling

In the modeling stage, the Latent Dirichlet allocation (LDA) model was used to explore the topics behind the prepared text data. LDA is a generative probabilistic model of a corpus, and its basic idea is that documents are represented as random mixtures over latent topics, where each topic is characterized by a distribution over words (Blei et al., 2003). For this first step, the Python library Gensim was used to build the LDA model. Gensim is a free open-source Python library, designed to process raw, unstructured digitaltexts (”plain text”) using unsupervised machine learning algorithms (Gensim, 2021). Second, the library pyLDAvis is used to interpret the outcome of the LDA model. The pyLDAvis helps users interpret the topics in a model fitted to a corpus of text data. Third, the optimal number of topics is settled by comparing the coherence scores (C_V) from the Genism and the overlaps of different topics in the pyLDAvis.Fourth, the top 10 keywords in each topic are explored to enable us to name each topic. Finally, each paper inthe data set was classified into one topic to further analyze the associated trends.

Figure 3 shows the Coherence scores (C_V) by different numbers of topics. The score has 3 steep

increases on the number of 3, 9, and 13. Choosing 3 for the number of topics gives a score of 0.377, 9 gives a score of 0.406, and 13 gives a score of 0.429 (Figure 3). The highest scores will not always result in better findings as it makes it harder to distinguish them, so three topics were settled. Figure 4 also shows a global view of the topic distribution of 3, 9, and 13 topics. Each circle shows a topic and the size of a circle is the prevalence of the topic in the corpus. The bigger size of a circle, the more words, and phrases in the corpus are within the remit of that topic. The distance between circles means the differences of topics. The more distant the two topics are, the more difference they have. Furthermore, the overlap of circles means that some words and phrases are commonly used in topics; the bigger overlap they have, the more common words and phrases the two topics have. The three non-overlapping topics are relatively largeenough to be able to distinguish them for further analyses (Figure 4).

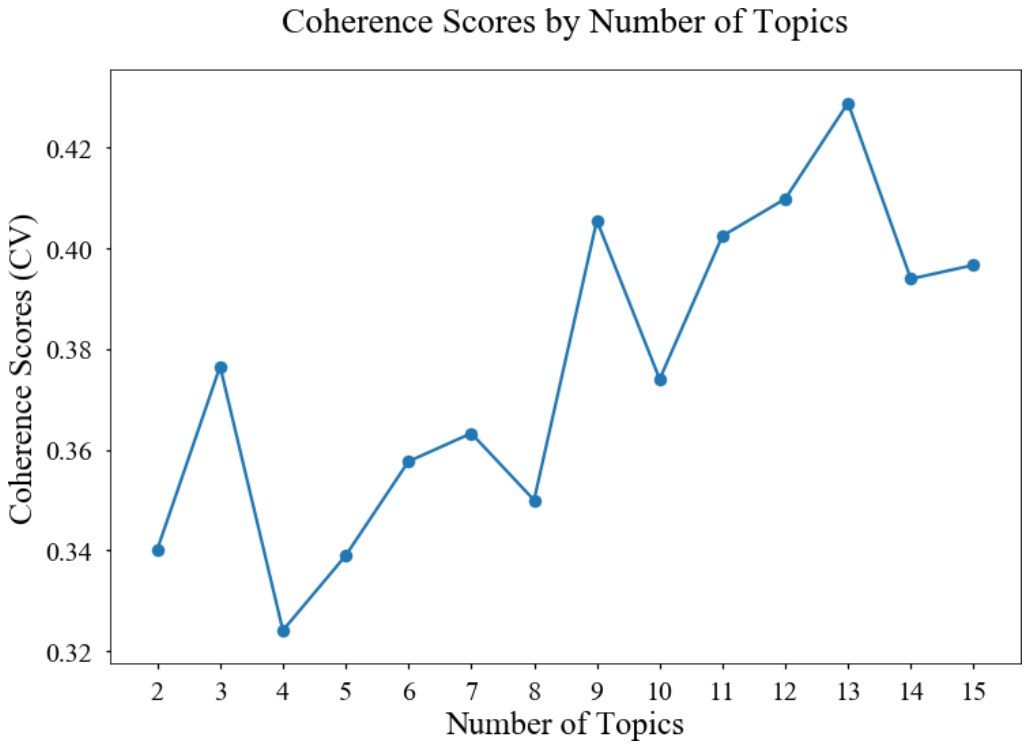

Figure 3 Coherence Score (CV) by Number of Topics

Figure 4 Topics Distribution by the 3, 9, and 13 of Topic

Figures A.1 to A.3 (Appendix) show the top 30 most relevant terms of one topic. For example, when λ = 0.6, the term “energi” is the most relevant term for topic 1, followed by the terms “car_share” and “vehicle”.The blue bar is the overall frequency of a term in the corpus. The red bar is the estimated term frequency within the selected topic. For convenience to name the topics, table 2 gives the top 10 most relevant termsin each topic. For topic 1, “energi” and “fuel” are semantic similar. “vehicl”, “batteri”, and “electr_vehicl”have the similar meaning of “electr_vehicl”. Given that “reduct” has a significant direction, topic 1 is named“energi reduct & electr_vehicl”. For topic 2, “health”, “bicycl”, “cycl”, and “walk” are semantic similar to“health,” therefore, topic 2 is named “health & mobil”. For topic 3, most terms are related to “sustain”, “transport,” therefore, topic 3 is named “sustain transport develop” (Table 2).

Top 10 most relevant terms	**Topic 1** "energi reduct & electr_vehicl"	**Topic 2** "health & mobil"	**Topic 3** "sustain transport develop"
1	energi	health	transport
2	car_share	mobil	sustain
3	vehicl	bicycl	paper
4	cost	cycl	develop
5	batteri	car	case_studi
6	servic	share	model
7	system	transit	sustain_transport
8	electr_vehicl	walk	traffic
9	reduct	studi	citi
10	fuel	transport	studi

Table 2 Top 10 Most Relevant Terms in pyLDAvis (λ =0.6)

3 FINDINGS AND RESULTS

Although the number of publications in the first years of this almost 7 years period was obtrusively low, we see a drastic change in the year 2020, pointing to an increase in 2021 (Figure 5). The larger number of publications in road transportation-related categories, compared to other groups, is a denotation of a depreciatory perspective towards reaching sustainability in other areas such as maritime transport and air transport.

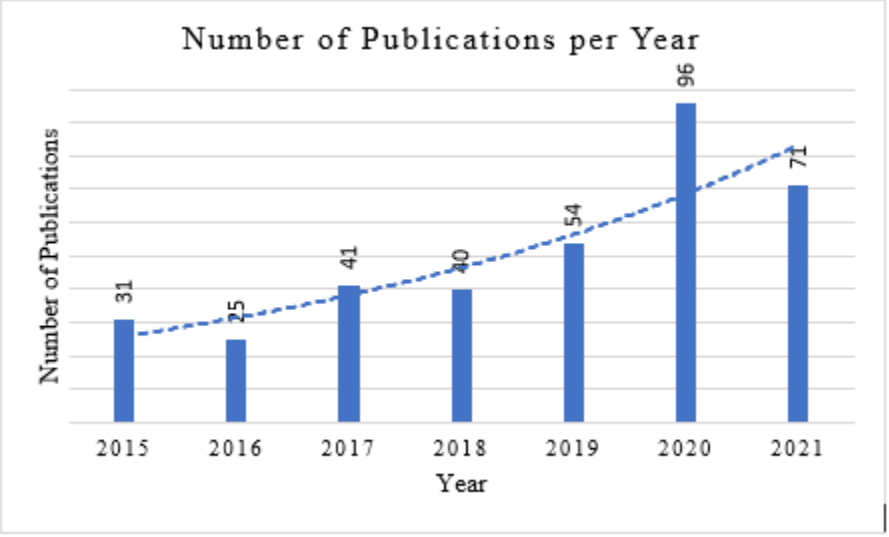

Figure 5 Number of Publications Per Year

Table 3 summarizes all 358 reviewed case studies based on their authors' intended transport mode and theirMain area of concern for conducting the study. While governance (103) is being by far the most attractive one for researchers, surprisingly, health impacts (7) and safety (5) are at the bottom of the list (Table 3).

	Accessibility	Energy Efficiency	Governance	Health Impacts	Optimization	Safety	Smartification	Sustainability Impacts	Travel Behavior	Grand Total
Air Transport			1							1
Alternative Fuel Vehicle	1	2	2		1			1	2	9
Autonomous Vehicle					1				2	3
Bike	2		6	1	3	1			7	20
Bike-Sharing	5		3		2				3	13
Cable Car								1		1
Cargo Tram			1							1
Carsharing			3		2		1	2	2	10
Electric Bike	2									2
Electric Vehicle		6	2		12		1	8		29
Logistics			3		9		2	4		18
Maas	1								1	2
Maritime Transport	1	1	3		1					6
Pedestrian	6				3				4	13
Personal Car									2	2
Public Transport	8		4		7			5	3	27
Rail Transport	5	3	6		2			1	3	20
Ride-Sharing	2		1					1		4
Road Transportation	16	3	67	6	12	4	3	29	36	176
Scooter			1							1
Grand Total	49	15	103	7	55	5	7	52	65	358

Table 3 The Number of Studies For each Main Area of concern Category and Intended Transport Mode

3.1 Transport mode

Figure 6 presents received citations per each transport mode category. For this study, the medianwas considered exclusively. Keeping aside the outliers in each category, we see that “electric vehicles,” “electric bikes,”and “autonomous vehicles” have attained the most citations on average (Figure 6). It also shows that manystudies on “autonomous vehicles” and “bike-sharing” have not yet reached their full potential in terms of citations since they were published in 2020, and 2021 and will become more popular in the future. Road transportation,as a general category, is also far behind other categories regarding its top-of-the-list position in table 3.Sustainable transportation in other transport modes such as “scooters,” “cable cars,” “air transport,” and “maritime transport” need to be studied more. For instance, not only are there ways to reduce the negativeimpacts of boats (Tercan et al., 2021) but including water transport into inland transportation, a case studyon the Danube region, facilitates the transition to sustainable transportation (Mako et al., 2021).

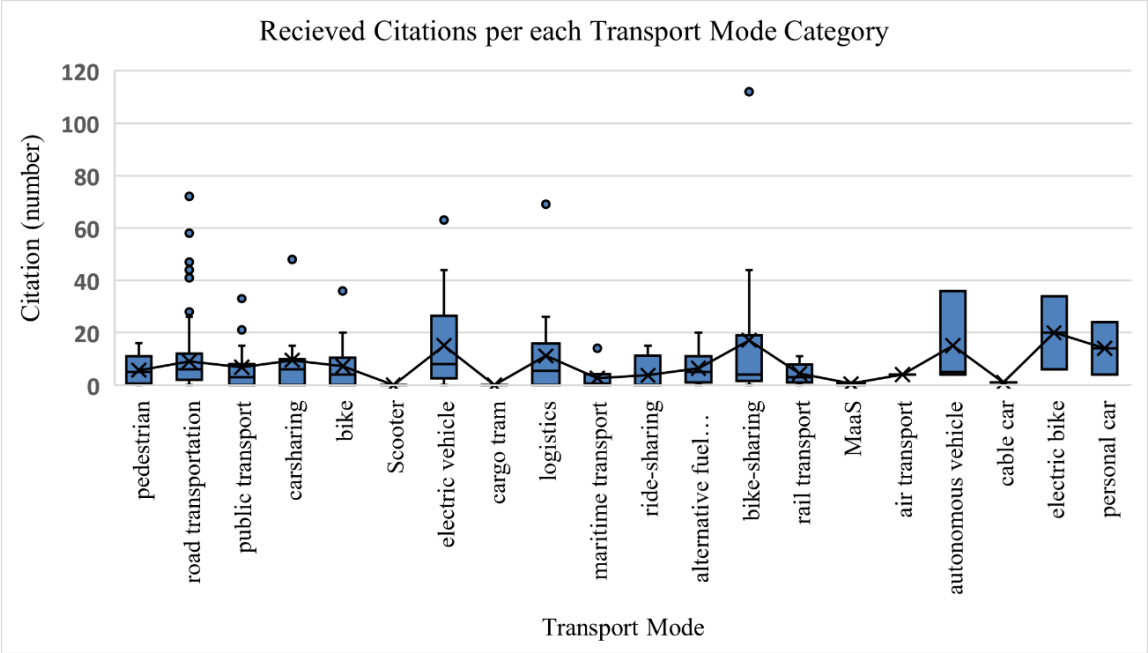

Figure 6 Received Citations per each Transport Mode Category

3.2 The main area of concern

To enable sustainable transportation, throughout the years, different criteria have been identified or used by scholars such as carbon dioxide (CO2) emissions, energy efficiency, safety, user’s satisfaction, etc. (Kumar et al., 2021; Singh et al., 2020; Xia et al., 2017). Considering these criteria, authors also categorizedpapers into different categories based on their main area of concern (Figure 7). Once again, the median was used exclusively. The medians of certain categories show the potential of each category

to attain more citations, therefore, these figures will change in coming years in favor of categories such as "sustainability impacts" and "optimization" regarding the steady growth of the number of publications in these groups. Figure 7 also shows us that the category of "health impacts" has received citations equal to categories of "accessibility," "travel behavior," and "governance" on average whereas it only contains seven studies of which three have been done in 2021 (Figure 7).

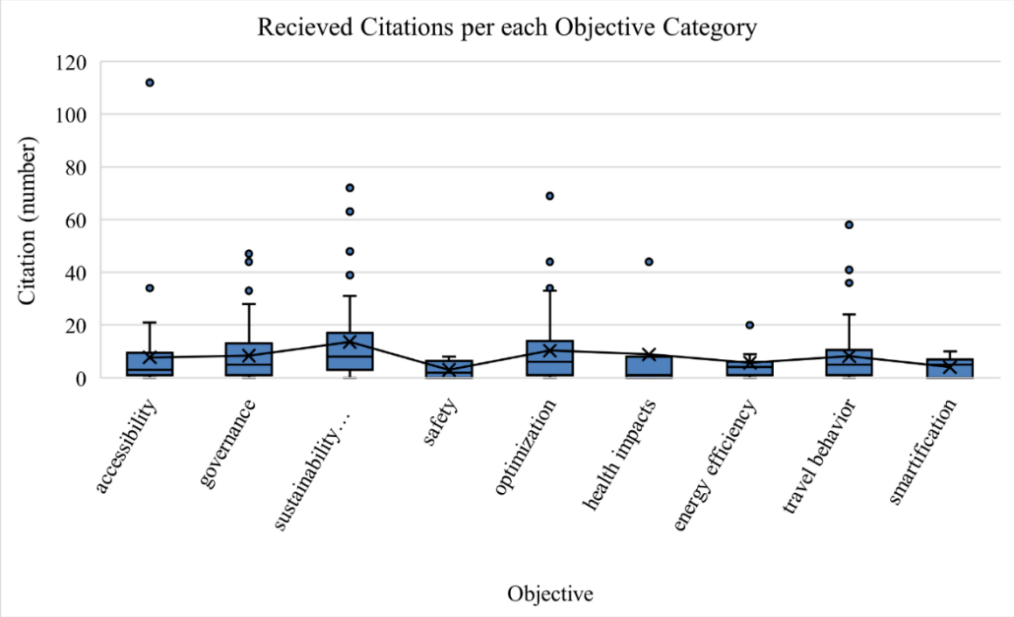

Figure 7 Received Citations per each Main Area of Concern Category

3.3 Global distribution of research

The distribution of research, based on the number of publications, weighs heavily on developed countries mostly in Europe such as Italy (42), Spain (21), Sweden (16), and the United States (28), except for China (28) and India (12) (Figure 8). Since China and India are an important role in global supply chains, their researchers may be interested in transportation.

Italy	42
Spain	21
Sweden	16
United Kingdom	11
Netherlands	10
Germany	9
Turkey	9
Denmark	8
Poland	8
Portugal	8
Austria	5
Belgium	5
Finland	5
France	5
Greece	5
Switzerland	5

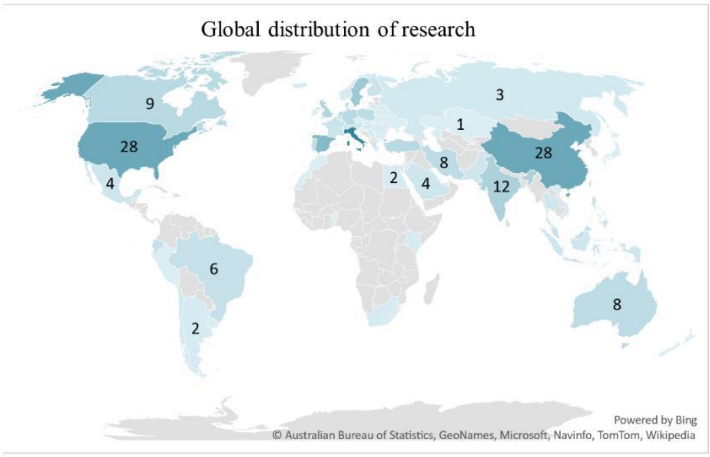

Figure 8 The Distribution of Research Weighs Heavily on Developed Countries

3.4 Frequency of publications and journals

Elsevier Ltd., with 32 percent of the sample, leads all publishers, followed by MDPI, with 24 percent (Figure 9). A considerable majority of publications in this cohort are from the Journal of Sustainability, which has 68 articles (Figure 10).

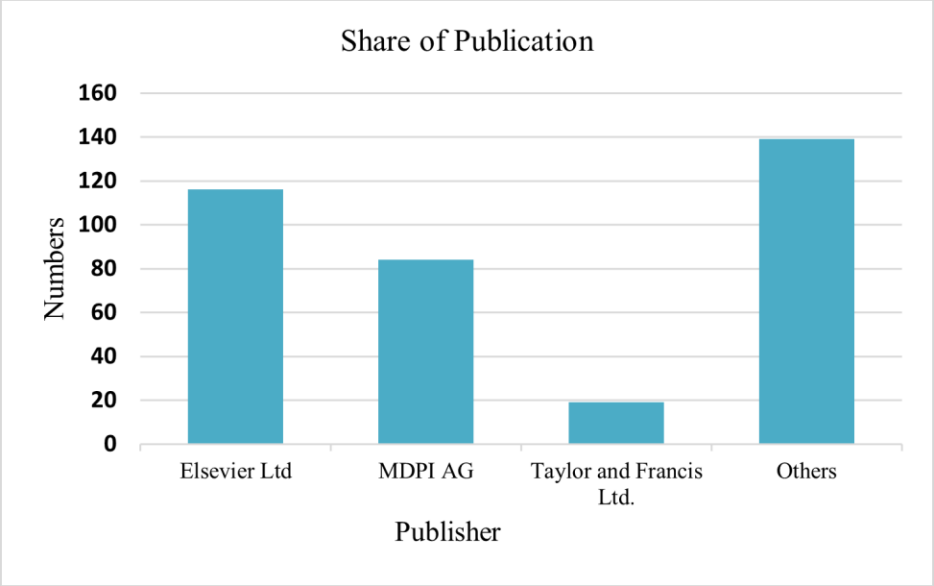

Figure 9 Share of Publication

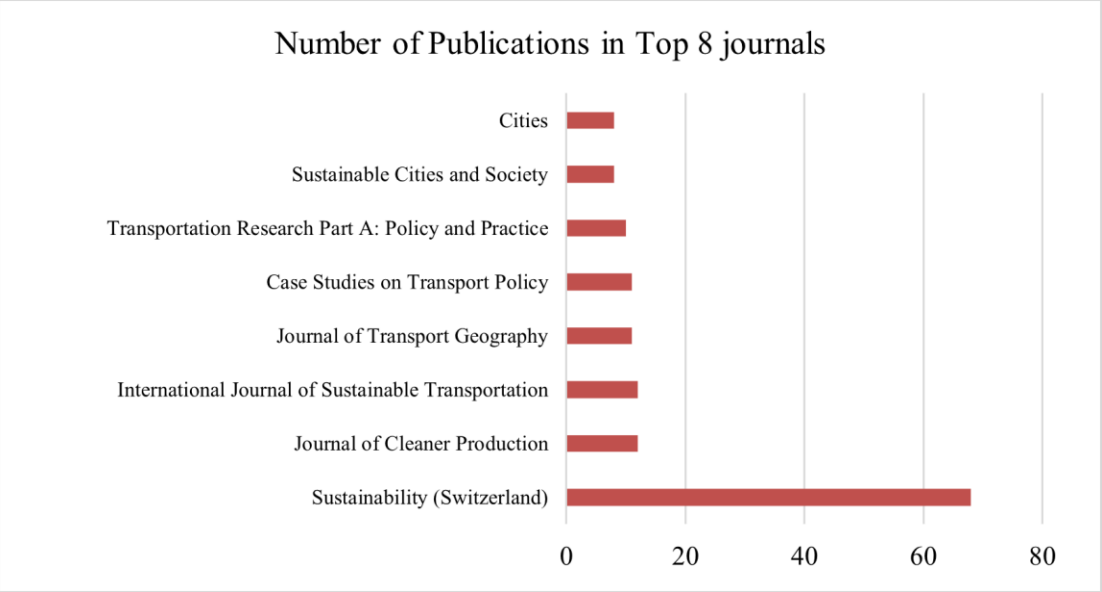

Figure 10 Number of Publications in Top 8 Journals

3.5 Topics' Trend Analysis

The named topics are used to analyze the trend of the topics. Figure 11 shows the percentage of topics in the publications. Around 58% of publications are associated with topic 3: "sustain transport develop" whereas 22.91% are within topic 2: "health & mobil" and 18.72% are associated with topic 1: "energi reduct& electr_vehicl" (Figure 11).

Figure 12 shows the percentage of topics in the publications by year. Topic 3: "sustain transport develop" has less percentage in the publication after 2018 than before 2018 while topic 2 and topic 1 have higher percentage after 2018 than before 2018 (Figure 12).

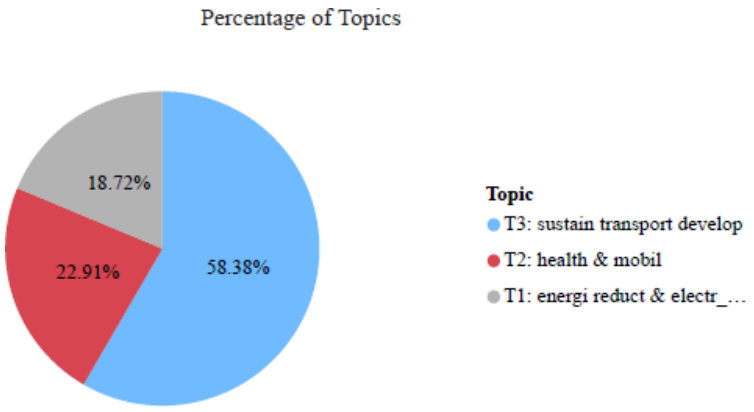

Figure 11 Percentage of Topics (2015-2021)

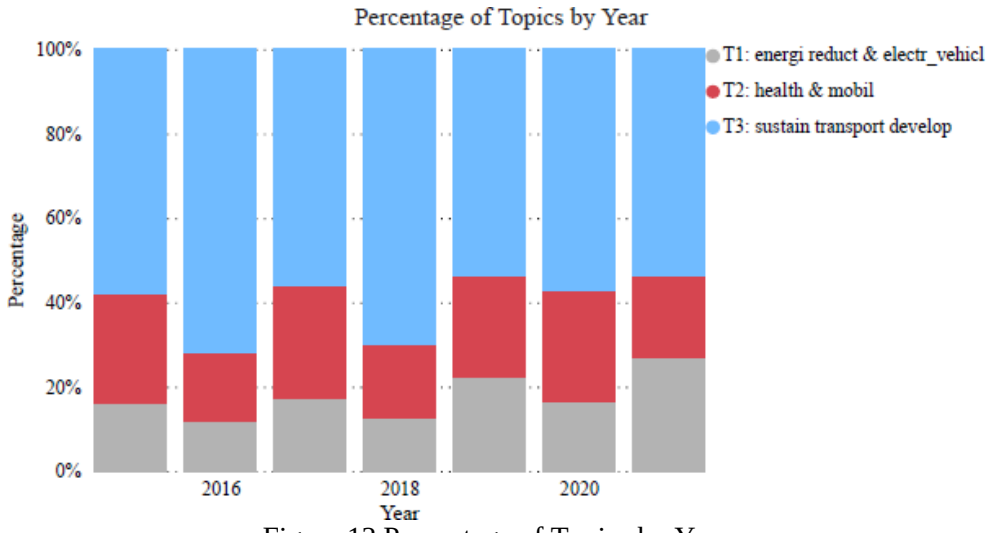

Figure 12 Percentage of Topics by Year

Figure 13 shows the average number of citations by topic and year. Topic 3: "sustain transport develop" has a consistent drop in the average number of citations. The average number of citations of topic 2: "health& mobil" and topic 1: "energi reduct & electr_vehicl" surpasses that of topic 3 "sustain transport develop" in 2017. Although topic 3 is the dominant topic it seems to become less popular after 2018 whereastopic 2 and topic

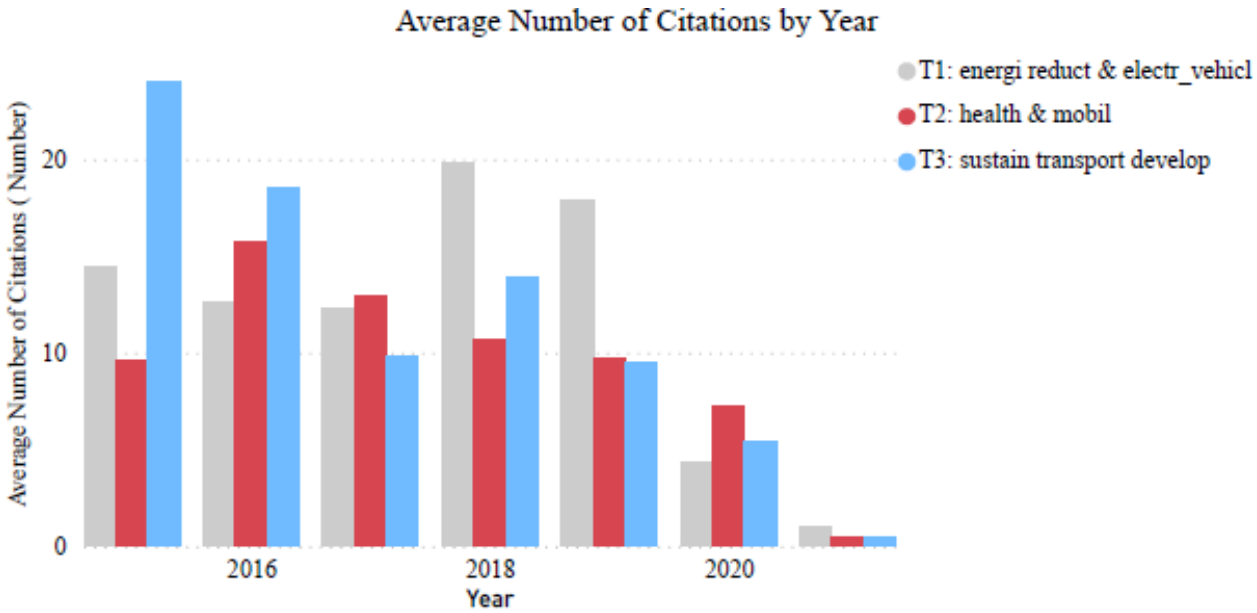

Figure 13 Average Number of Citation by Topics and Year

4 DISCUSSION

As seen in the sub-section of keyword analysis, dominant topic 3: “sustain transport develop” accounted for 58.38% of the total publication (Figure 11). “Sustainability impacts” as the main area of concern was also counted for over 14% of all papers (Table 3), with more than 14 citations on average (Figure 7). However,the transition to sustainable transportation requires collaboration between transportation and other sectors (Corwin & Pankratz, 2021). This collaboration demands a holistic and integrative approach (Gudmundssonet al., 2016), whereas “there is relatively little action to date to systematically address the complex multisectoral agenda of sustainable development (Sachs et al., 2021).” Organizations also need “a systems lens that grapples with the complex and multifaceted net-zero economy” to thrive (Corwin, 2021).

In this work, authors categorized papers based on transport mode and main area of concern. The number of publications and received citations for each category was presented. In the next step, keyword analysis revealed three separate topics. But the need for a systematic approach guided authors to categorize four groups and discuss the importance of each on sustainable development goals. Yet all groups interact and impact each other, the change in one group causes others to change.

4.1 In-vehicle improvements

“Optimization”, “energy efficiency”, and “smartification” categories constitute more than 20 percent of allpapers (Table 3). And categories of “electric vehicle”, “alternative fuel vehicle”, and “electric bike” accounted for 40 papers of which 22 fall within the above-mentioned area of concern. This alone explains the magnitude of the impacts they will have on transportation. The Infrastructure Deal in the United States “will replace thousands of transit vehicles, including buses, with clean, zero emission vehicles; investing “$2.5 billion in zero emission buses, $2.5 billion in low emission buses, $2.5 billion for ferries, and $66 billion in rail fleets (The Whitehouse, 2021).” These categories were associated with topic 1 “energi reduct& electr_vehicl”. About 18.7% of all publications are comprised of this topic (Figure 11). Starting in 2017,it bested topic 3, and soon outperformed both topics in 2018 (Figure 13), showing relatively bigger attentiontowards energy reduction in this sector. Sustainable transportation by increasing the share of renewable energy could play into reaching the SDG 7- Affordable and Clean Energy, however, only 14 out of 37 countries, in 2019, had best performed above the green threshold (=20) for their “Share of renewable energyin total primary energy supply, “ 11 countries were below the red threshold (=10) (Sachs et al., 2021). This,too, will directly impact SDG 13- Climate Action through reduced fossil fuel combustion. Environmental dimension with GHG emissions as its most important criteria predominates sustainable transportation (R. Mahmoudi et al., 2019). Other transport modes are

likely to become under the spotlight in the coming years;even in air travel, “the next airplane will have to meet some serious sustainability tests (Root, 2021).”

“In-vehicle improvements” also result in safer vehicles that impact the SDG3- Good Health and Well-beingby reducing traffic deaths. In 2019, out of 183 countries, there were only 51 countries below the green threshold (=8.4) for their performance in “Traffic deaths (per 100,000 population)”, while 78 countries wereabove the red threshold (=16.8) (Sachs et al., 2021). Safety is an important criterion and a big concern (R. Mahmoudi et al., 2019; Xia et al., 2017), therefore, the interactions between other sustainable development criteria and safety in transportation need to be investigated further. “The infrastructure deal invests $11 billion in transportation safety programs (The Whitehouse, 2021).” In addition to that, the infrastructure deal “implements new safety requirements across all transportation modes (117th Congress,2021).”

Although health was not the main area of concern for many of the authors it was frequently mentioned and becameour topic 2 (Figure A.2). “Health impacts” of sustainable transportation could be a potential future researchdirection to be focused on in case studies. Based on the result of keyword analysis, around 22.9% of publications were associated with topic 2 “health & mobil” (Figure 11) with a whopping year-to-year decline in received citations (Figure 13). On the contrary, the category of “health impacts” has received citations equal as each of “accessibility”, “travel behavior”, and “governance” categories on average (Figure7) whereas there are only seven studies under the “health impacts” category of which three had been donein 2021. More to the direct benefits of in-vehicle improvements, automakers and transportation companies should actively support the transition to a circular economy and sustainable transportation by strengthening systematic design, sharing models, circular supply models, and green logistics (Nguyen, 2020; UNSSC, 2021)

4.2 Built-environment elements

Built environment elements could be either a hindrance or a facilitator for sustainability in transportation. The category “accessibility” with 49 publications has a median of 3, and a mean of 7.75 (Figure 7). These case studies are where scholars were mostly focused on the surrounding environment in their analysis. In 2018, among 158 countries, only 46 countries were above the green threshold (=3) of theLogistics Performance Index: Quality of trade and transport-related infrastructure (of SDG 9), and 18 countries were below the red threshold (=2); this index for the United States for the years 2010, 2012, 2014,2016, 2018 were 4.152, 4.139, 4.185, 4.152, and 4.045 (Sachs et al., 2021). The infrastructure deal is goingto “repair and upgrade aging infrastructure, make stations accessible to all users, and bring transit service to new communities (The Whitehouse, 2021).”

Although ~~a~~fter the pandemic, according to The Economist, in the United States, Britain, France, and Japanactivity has remained substantially lower in cities than it does nationally (The Economist, 2021b), growth in sustainable mobility in urban areas is globally more likely than that in rural areas (Tao et al., 2019). The H.R.3684 - Infrastructure Investment and Jobs Act, "establishes a rebuild rural bridges program to improvethe safety and state of good repair of bridges in rural communities (117th Congress, 2021)."

Built-environment is also a canvas for picturing the impacts of sustainable transportation on cities. Its elements are highly influential on the safety and health of passengers, especially on the safety of cyclists and pedestrians (Ding et al., 2020). Infrastructure was among the most relevant terms for topic 2 (Figure A.2), demonstrating the impacts of infrastructure on health. Traffic, which was the seventh most relevant term for topic 3 (Figure A.3), and road-traffic noise also have negative health impacts (Schmitz et al., 2021;Vaverková et al., 2021). In large cities and denser areas, special attention should be given to the safety of the design of truck routes, "which are typically wider and higher-volume than other urban streets (Conway& Conway, 2021)."

The presence of robust non-auto infrastructures could support evolving travel preferences (Henao et al., 2015). Providing "ease-to-walk" walking routes, "accommodations and dedicated lines for bike and scooterusers," and "parking supply in urban areas" could play into the implementation of sustainable transportation(Agarwal et al., 2020; Ortega et al., 2021; Tira et al., 2016; Xie & Wang, 2018), even in consolidated areaswith little available space to build new infrastructures (Jiménez et al., 2020). Economic viability and environmental benignity should be contemplated in evaluation processes to ensure the sustainability of transportation infrastructures (Henke et al., 2020). The important point is that, in some scenarios, "proactivepractices, based on preservation and maintenance, result in more efficient policies in the long-term than reactive policies based on rehabilitation (Torres-Machi et al., 2018)." The use of electric vehicles on a large scale depends on the expansion of appropriate supporting infrastructures. The infrastructure deal also "invests $7.5 billion to build out a national network of EV chargers (The Whitehouse, 2021)."

Cases with a concern of the role of the built environment in sustainable maritime transport, and air travel isvery limited. Given the inclusion of airports, rail lines, and harbors in the Infrastructure Investment and Jobs Act (117th Congress, 2021), more studies in these areas could be helpful.

4.3 Human factors

"Travel behavior" category with 65 papers alone shows the importance of human factors in sustainable transportation (Table 3). In 2020, Among 66 countries Only 7 countries in the index of Satisfaction with

public transport (of SDG 11) were equal or above the green threshold (=72), and 7 countries were below the red threshold (=43) (Sachs et al., 2021).

For dealing with human factors, the inclusion of clearly-set social equity goals at the metropolitan level is substantial (Henke et al., 2020). “If sustainability privileges environmental protection over social and economic development, it risks being considered a luxury concern of educated, urban elites, especially in developing economies (Bergman & Bergman, 2019).” In the United States, the infrastructure bill promisedthat “it will benefit communities of color since these households are twice as likely to take public transportation and many of these communities lack sufficient public transit options,” adding elsewhere that“the deal creates a first-ever program to reconnect communities divided by transportation infrastructure (The Whitehouse, 2021).” The important point is to know “the opinion of the population in order to propose good practices (Spadaro & Pirlone, 2021).” Considering people's needs in the post-COVID era is so critical(Shokouhyar et al., 2021). The concern is that remote working and “thus, less of vibrant cities, makes it harder to make personal bonds and soak up knowledge from others (The Economist, 2021b).” This will counteract the participation of people in urban planning.

The transition from a car-ownership lifestyle to more sustainable choices requires major cultural and behavioral changes (Köhler et al., 2020). On 10th November 2021, Secretary Pete Buttigieg tweeted that “The build Back Better package includes tax incentives to help purchase an EV.” Isetti et al. warn policymakers that monetary incentives without intrinsic motivations, “pro-environmental behaviors,” could have potential unintended consequences (Isetti et al., 2020). Pro-environmental behaviors also known as environmental citizenship are “about the active participation of citizens in moving towards sustainability (Hadjichambis et al., 2020).” More research on the motivators for conscious pro-environmental behaviors will be helpful to reach the objectives of this bill. In addition, conducting thorough studies on counteractiveeffects of increasing quality of products, or decreasing the costs of use on pro-environmental behavior are highly crucial. “Sustainable transportation benefits awareness,” “traffic problems awareness factors,” and “Carbon-emitting awareness options” are some of the measures to increase pro-environmental behaviors and therefore the demand for sustainable transportation choices (Isetti et al., 2020; Köhler et al., 2020; Xiaet al., 2017). These behavioral changes, too, will result in more “pressure on suppliers to meet strict sustainability criteria, thus investors begin to factor sustainability into their business decisions (UNSSC, 2021).”

4.4 Planning & regulations

After the Covid-19 pandemic, there are serious crises in the supply chain, energy market, and labor market,affecting the sustainability of transportation too. The current supply chain chaos added more

verisimilitudeto the probability of similar perilous disruptions in the logistics of goods due to the possible weather eventsin the future (Sorkin, 2021), let alone the risks of geopolitically related supply shocks (UNSSC, 2021). After the pandemic, "industrial policies have taken the form of "mission-oriented" investment for the green recovery (The Economist, 2021a)" with a focus on infrastructures. The Infrastructure Investment and Jobs Act addresses climate change, including strategies to reduce the climate change impacts of the surface transportation system (117th Congress, 2021).

"Planning & regulations" in all sectors need to be addressed more. Although the "governance" category with 103 papers has the highest number of research in the cohort (Table 3), its citations average is not the highest (Figure 7). Regarding the growth in the number of publications in this category, researchers could broaden their perspectives to explore, analyze, and work on more multi-objective solutions. Researchers, actors, and governments should have a more holistic approach without losing in-detailed concentration ontheir intended cases.

"Political culture characteristics play a central role in the ability of cities to develop strong network ties across a variety of network levels, ties which are essential to effective transportation planning and development (Irish, 2017)." In the United States, the Infrastructure Deal, a Bipartisan bill with support from both sides of the aisle, could increase American cities' capacities to implement a more sustainable transportation system.

Localized plans and developments alongside involving stakeholders in decision-making could improve pathways and increase customer acceptance (Fraske & Bienzeisler, 2020; Icasiano & Taeihagh, 2021; Smith, 2021). A whole journey perspective (Woodcock & Tovey, 2020) by Integration of different transport modes and empowering customers to choose the optimum set of options will decrease costs and greenhousegas (GHG) emissions (Göçmen & Erol, 2018; Luo et al., 2021; Pattanaro, 2020). In some cases, people inlow-income urban areas, whose only way of commuting is walking, are considered to be far more sustainable in terms of transportation while empowering them is virtually bringing more fossil fuels using (Bergman & Bergman, 2019), therefore, sharing business models should be more endorsed as it, too, encourages circular economy(UNSSC, 2021), and directly impacts SDG12-Increased responsible consumption and production. In the infrastructure deal, under Sec. 11133. Bicycle Transportation and Pedestrian Walkways, we see interesting amendments to be made in section 217 of title 23, United States Code; adding "pedestrians" and "shared micromobility" relatively under the subsections "a," "e," and "f"of that section (117th Congress, 2021).

5 CONCLUSION

This study's goal was to show where the focus of the previous literature has been and to emphasize where the focus should be for future publications. From a cohort of 358 case studies, the authors categorized each case study into twenty categories based on transportation, and nine categories based on the authors' main area of concern. In accordance with the features of the United States' infrastructure bill, the results are categorized into the following categories: In-vehicle improvements, Built-environment elements, Human factors, and Planning & regulations. We analyzed literature in each section and were able to identify common topics and themes amongst them while also identifying possible next steps in research focuses (i.e. health).

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APPENDIX

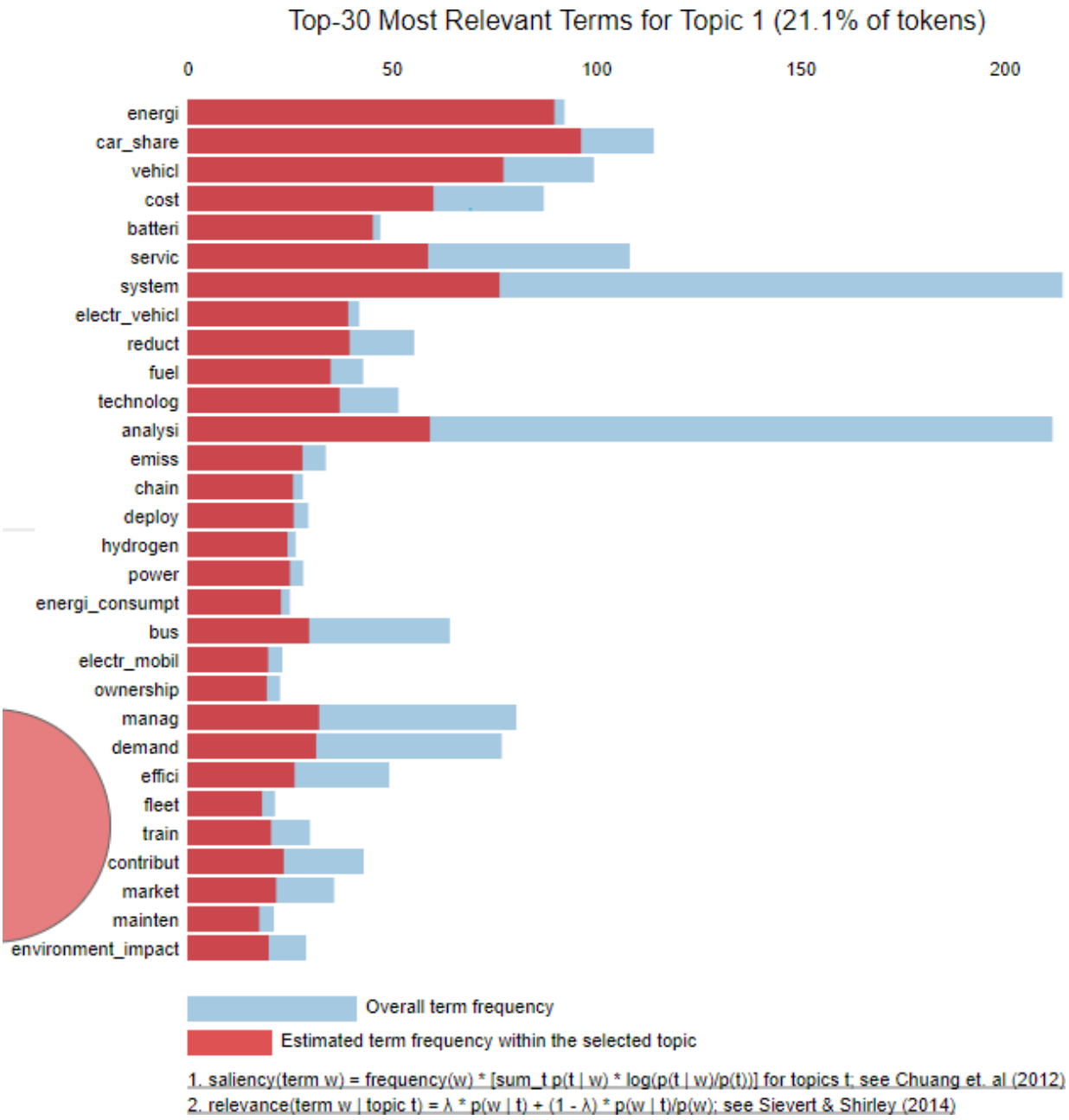

Figure A.1 Top 30 Most Relevant Terms in pyLDAvis (λ = 0.6) Top 30 Most Relevant Terms in pyLDAvis (λ = 0.6)

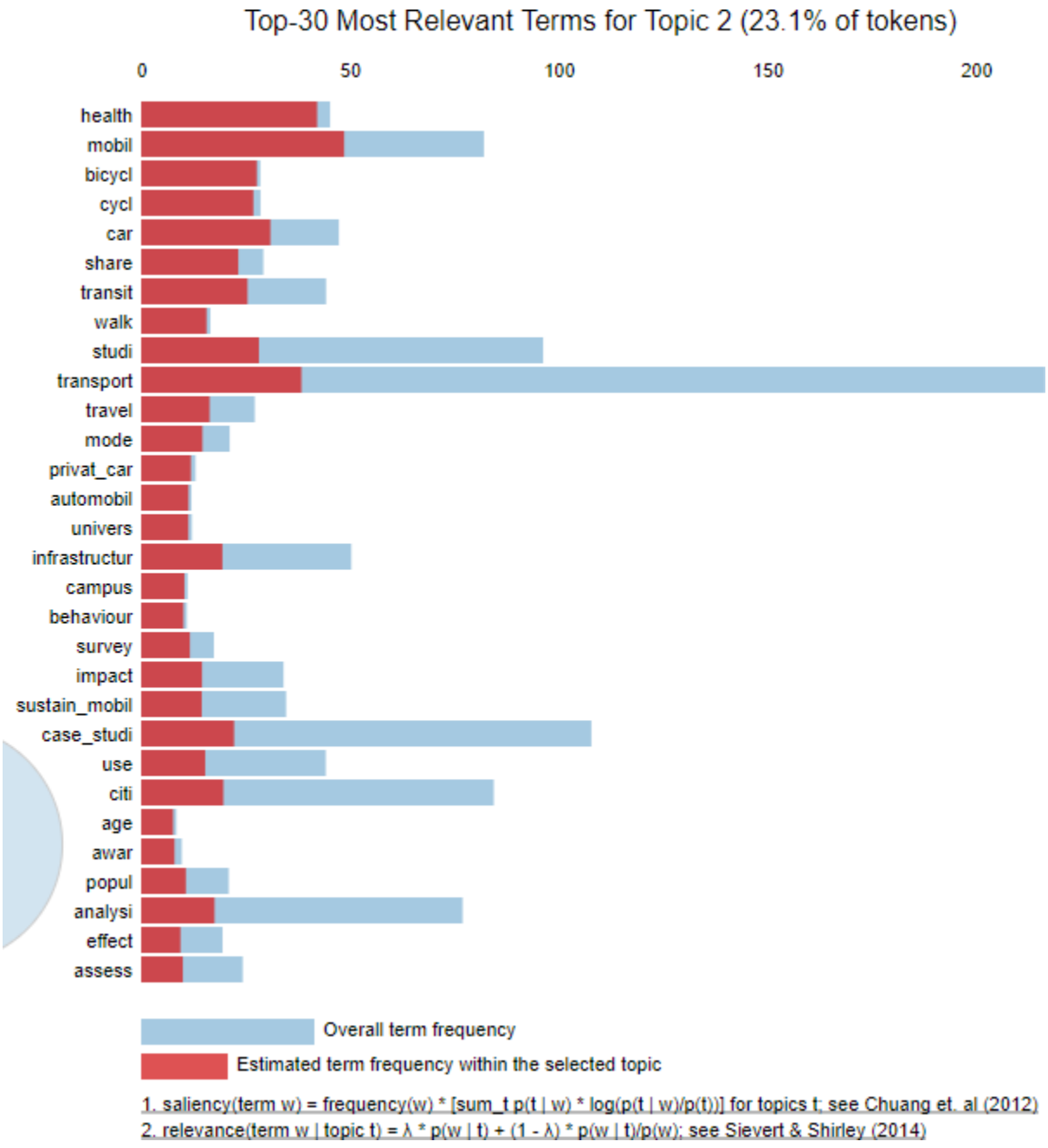

Figure A.2 Top 30 Most Relevant Terms in pyLDAvis (λ = 0.6)

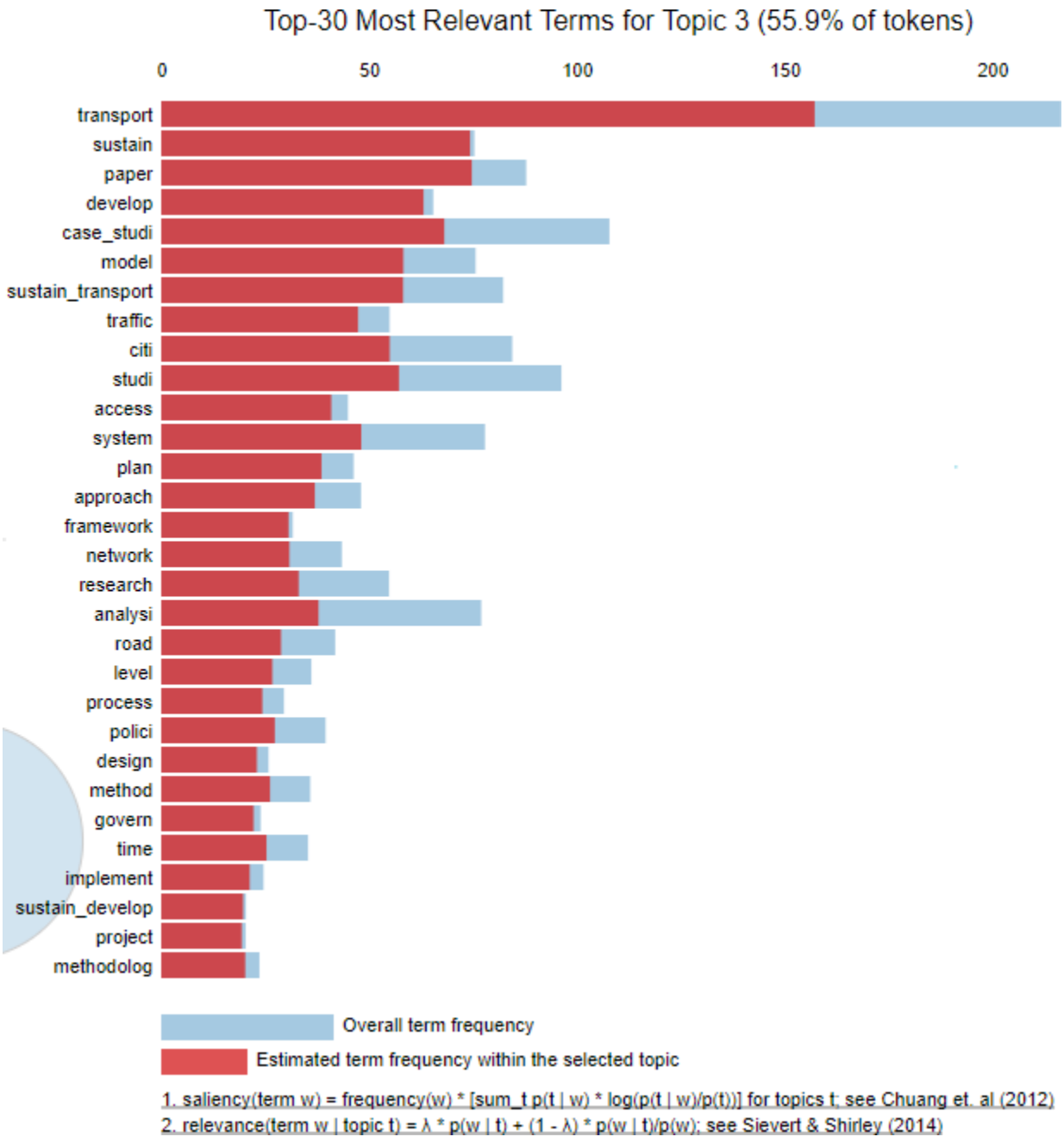

Figure A.3 Top 30 Most Relevant Terms in pyLDAvis (λ = 0.6)