A scientometric analysis of cycling and the case study of the city of Ioannina

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Abstract. The use of bicycles as a means of transport offers a wide range of benefits, including improved health, less pollution and traffic, financial rewards for the individual, and reduced dependence on fossil fuels. Moreover, cycling promotes sustainability across various research fields. Despite the many benefits of bicycling, communities struggle to encourage its wide adoption, and the effectiveness of campaigns to promote cycling varies. Scientifically proven, communities need to encourage the use of bicycles for transport in city and regional planning, civil engineering, and urban and regional planning. This paper presents a comprehensive scan of the literature on bicycling and sustainability, with a focus on Ioannina, Greece. The paper aims to understand the main issues, trends, and results of research on bicycling and sustainability. The case study of the city of Ioannina is examined. The technical characteristics of the existing cycling paths in the city, the safety-oriented research fields in Ioannina, and the implementation and use of cycling in Ioannina are presented by analyzing the responses of 102 residents of Ioannina in a structured questionnaire. Moreover, in this study, the implementation and use of cycling in Ioannina are examined, laying on the technical characteristics of the existing cycling paths in the city of Ioannina.

1 Introduction

Bicycles offer an affordable and sustainable mode of transport, particularly in low- to middle-income settings. By using bicycles, individuals can significantly reduce their carbon footprint, air pollution, and greenhouse gas emissions. The spread adoption of cycling can contribute to combating climate change and enhancing social equity. In urban areas, cycling as a sustainable mode of transport contributes to creating a human-friendly atmosphere. This paper provides an environmental and sustainable scan of the literature on bicycles using established systematic literature review approaches. The connection between bicycles and sustainability is multi-dimensional. Bicycles play a crucial role in promoting sustainability across various research fields, from city and regional planning to civil engineering and urban and regional planning. This paper focuses on Ioannina, Greece, as a case study to examine the existing literature on bicycling and sustainability in this area.

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2 Literature review

An extensive literature review of existing studies was carried out concurrently with a bibliometric and visualization analysis to identify relevant publications and explore the sustainable concept of the bicycle mode of transport. This method is widely accepted in the literature and in bibliometrics and includes identification, description, analysis, interpretation and critical evaluation of the existing body of knowledge regarding a certain research area such as bicycle mode of transport.

Rapid computational methods and digital information have resulted in optimized and low-cost data collection procedures that can be used in various analyses. Therefore, bibliometricians and researchers can apply sophisticated clustering analyses without requiring technical expertise and time-consuming methods.

To appropriately select the examined literature, a comprehensive database of gathered data from Scopus was developed. Documents that contain the key terms “bicycle” and “sustainability” or “sustainability” were selected for the analysis. Following this procedure, a dataset of 1,991 scientific publications was developed.

The software VOS was applied to examine, analyze and visualize the distribution of the most important key terms co-occurring in the keywords of the examined publications. More specifically, a smart local moving algorithm introduced by Waltman et al. was employed to identify relations among scientific publications and therefore to evaluate patterns of the existing literature. A clustering technique was then applied to assign the identified key terms to groups of common characteristics.

Following the analysis, the presence of 10,970 keywords in the 1,991 publications was confirmed. The threshold of 10 occurrences was adopted and resulted in 369 key items for the analysis. The consistency of the database ensured the validation of the analysis in the context of this study. The final analysed keywords and their node size are illustrated in Figure 1. An interpretation of each cluster according to its characteristics is presented as well.

According to the analysis, the higher the keyword and the node, the larger number of articles containing the specific keyword. Thick lines indicate the occurrence of the keyword in the literature. Thicker lines indicate a stronger link.

Four clusters of key terms were developed according to the analysis, each of which constitutes a grouping of research activity and subsequent publication (set of related items). Table 1 presents an interpretation of each one cluster according to its characteristics, concurrently with identified key terms for each case based on the analysis.

Fig. 1. Network visualization of authors’ keyword occurrence.
Table 1. Interpretation of identified clusters.

<table>
<thead>
<tr>
<th>Cluster/ total key items</th>
<th>Characteristic</th>
<th>Key terms</th>
</tr>
</thead>
</table>
| Red (178)                | environment oriented | - greenhouse gas  
|                          |               | - carbon footprint  
|                          |               | - environmental impact  
|                          |               | - climate change  
|                          |               | - sharing systems |
| Green (96)               | infrastructure oriented | - transportation infrastructure  
|                          |               | - accessibility  
|                          |               | - commuting  
|                          |               | - policy making  
|                          |               | - public transport  
|                          |               | - Covid 19 |
| yellow (70)             | safety oriented | - accident prevention  
|                          |               | - road safety |
| blue (25)               | health oriented | - health care policy  
|                          |               | - human  
|                          |               | - exercise  
|                          |               | - active travel |

The main issues the existing literature is dealing with according to the identified clusters can be categorized into four main categories that rely on environment-oriented, infrastructure-oriented, safety-oriented and health-oriented research fields. More specifically, significant key terms for each cluster were identified, focusing on climate change, carbon footprint and the sharing systems for the first case, accessibility, COVID-19 and commuting for the second case, accident prevention for the third case and finally, health care policy and the bicycle as a mode of transport for the last one cluster.

According to Figure 2, a rising trend in the publication of environment-oriented and infrastructure-oriented research fields is observed during the last years. Proposed strategies and adopted policies appeared recently in order to reduce greenhouse gas emissions by promoting a shift to low-emission mobility, concurrently with the impacts of COVID-19, explaining the fact that cycling infrastructure, sharing transport systems and carbon footprint assessment are the main research fields the literature is dealing with during the last years. On the other hand, health-oriented and safety-oriented research fields regarding cycling were examined mostly during the previous decade.
3 Data and methodology

3.1. Survey

A structured questionnaire survey is conducted among respondents, which focuses on the profile and whether widespread use of cycling will motivate them to buy a bicycle, to what extent various factors would motivate them to buy a bicycle, to what extent various factors would motivate them to own a bicycle, and whether widespread use of cycling would help reduce traffic problems.

In the Fig. 3, a vision of an integrated network for cycling and the integration of cycling in public transport, which is due to the light traffic network is absent, is presented. According to the 2013 census, the municipality had 130,000 inhabitants, private car ownership is widespread, and the number of routes is very low. Consequently, a questionnaire of three pages was created to be filled in by the respondents.

3.2. Study area

The research of this study was conducted in the area of Ioannina, as a major urban center and the resident traffic network of the city. Ioannina has an extensive road network, as well as the traffic congestion problem in the city is presented. In addition, residents are less occupied on the walking, which focuses on the possession of some sections of the route have discouraged people from using bicycles.

Fig. 3. The existing cycling network infrastructure in the city of Ioannina and the traffic network of the city of Ioannina.
Table 2. Demographic characteristics of respondents (N=102).

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Characteristic</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>48</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;18</td>
<td>15.7</td>
</tr>
<tr>
<td></td>
<td>18-50</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>&gt;50</td>
<td>35.3</td>
</tr>
<tr>
<td>Residential</td>
<td>Urban</td>
<td>68.6</td>
</tr>
<tr>
<td></td>
<td>Peri-urban</td>
<td>31.4</td>
</tr>
</tbody>
</table>

4 Results

According to the survey, in Ioannina, the main means of transport is the private car at 43.1%, followed by walking (26.5%), public transport (15.7%), and finally cycling (14.7%). Based on the above statistics, cycling is the last in preference, which should be of concern to those responsible for the effort to integrate cycling into the everyday life of citizens. It can be observed that sustainable means of transport (cycling, walking, public transport) have an overall preference of 56.9% over the car, which shows the shift of citizens to sustainable mobility compared to the past when the private car was the only choice.

All the respondents (97.1%) declared that there are many traffic and congestion problems in the city. A large percentage of 83.3% responded positively in the owning of a bicycle, while only 16.7% did not. This result shows the potential for residents to the transition to sustainable mobility.

Residents of Ioannina, when asked how regularly they use the bicycle, 44.6% answered rarely, 26.1% often, 16.3% daily, while 13% never. These results are not particularly encouraging, as the majority use bicycles infrequently. This fact should certainly be of concern to those responsible for the creation of the SUMP. Bearing in mind, from a previous question, that 83.3% of citizens own a bicycle but only 42.4% use it frequently or daily, it reveals the lack and the poor quality of the infrastructure as well as the poor cycling awareness.

The majority of citizens responded for sport/recreation (60.9%). The next selected use was commuting to work (23%) and commuting to school (11.5%), while the other uses are below 5%.

Based on the characteristics of the existing cycle paths the existing network does not serve to meet basic needs of everyday life. According to the questionnaire, 23.8% use bicycles on cycle paths, 27.4% on roads, 8.3% on pedestrian streets and 40.5% on all of the above.

Citizens were asked about the safety offered by the road network of Ioannina to cyclists, with the results being discouraging. The majority with a cumulative,
4 Discussion-Conclusion

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Safety Measures: Ensuring the safety of cyclists on the road is crucial. Implementing traffic calming measures, educating both motorists and cyclists about road safety, and enforcing traffic laws can reduce the risks associated with cycling and boost its popularity.

Public Awareness and Education: Raising public awareness about the benefits of bicycling, including its positive impact on personal health, the environment, and traffic congestion, can influence more people to adopt cycling as a mode of transportation.

Bicycle Sharing Programs: Implementing bicycle-sharing schemes in urban areas can make cycling more accessible to people who don't own bikes or need them for occasional use.

Incentives and Policies: Governments and organizations can offer incentives, such as tax benefits for bike commuters or employer-sponsored bicycle programs, to encourage more people to choose cycling over other modes of transportation.

Health and Environmental Concerns: Growing concerns about public health and environmental issues can lead individuals to opt for bicycling as a sustainable and healthier alternative to driving.

Integration with Public Transport: Improving the integration of bicycles with public transport systems, such as allowing bicycles on buses and trains, can extend the reach of cycling and make it a more attractive option for longer trips.

Supportive Culture: Developing a positive and supportive cycling culture within communities can foster a sense of community and encourage more people to embrace cycling.

Economic Considerations: Bicycling can save individuals and society money in terms of reduced infrastructure costs, lower healthcare expenses (due to improved public health), and less environmental damage.

References
5. B. B. Badassa, B. Sun, L. Qiao, Sustainability, 12, 2033, (2020).
10. A. Tsompikos, Diploma Thesis, Civil Engineering Department AUTh, ICED2023 https://doi.org/10.1051/e3sconf/202343611011.