Research Article

Sustainable transportation in selected tourism destinations within the scope of urban mobility: A multidimensional scaling analysis

Mustafa Yılmaz[1],*, Burcu Yılmaz[2]
[1]Department of Tourism Management, Tourism Faculty, Erciyes University, Kayseri, Türkiye
[2]Department of International Trade and Logistics, Faculty of Political Sciences, Trabzon University, Trabzon, Türkiye
*Correspondence: *mustafa.yilmaz@erciyes.edu.tr*
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Abstract: The accelerating processes of global population growth and urbanization have led to increased use of transportation systems. This intensifies urban mobility and poses various environmental sustainability challenges. In this context, sustainable urban mobility has become increasingly significant. It enhances the quality of urban life, reduces carbon emissions, improves the efficiency of transportation systems, transforms cities into smart destinations, and strengthens the sustainability and competitiveness of tourism destinations. This study aims to analyze sustainable transportation data from 26 cities included in the Sustainable Mobility Readiness Index. These cities are among the top 50 most visited countries worldwide and represent major tourism destinations. The study uses a multidimensional approach to identify similarities and differences among these cities from the perspective of sustainable mobility. Accordingly, six key dimensions are considered: transport supply, transport demand, innovation, policies, finance, and environment and energy. The study uses data from 2024 and 2025 for the selected 26 cities. It employs Multidimensional Scaling and hierarchical clustering methods in the analysis. The findings reveal that the sustainable mobility performance of the cities does not exhibit a homogeneous structure and can be grouped into two main clusters. Across all six dimensions, the Multidimensional Scaling and hierarchical clustering consistently distinguish cities according to their sustainable mobility characteristics, while the total score analysis confirms this overall classification. Although the degree of differentiation varies across dimensions, transport supply, finance, and environment and energy provide particularly clear groupings, whereas the policies dimension exhibits relatively greater heterogeneity. Furthermore, cities such as Amsterdam, London, Helsinki, Singapore, and Munich consistently cluster together, reflecting similar sustainable mobility profiles across multiple dimensions. London, Helsinki, Amsterdam, and Singapore demonstrate similar profiles in transportation infrastructure and innovation capacity. In contrast, developing cities such as Lagos, Cape Town, and Bogotá form a separate cluster characterized by more differentiated sustainable mobility profiles. The evaluations suggest that strengthening transportation infrastructure, promoting the adoption of electric vehicle technologies, advancing intelligent transportation systems, and implementing environmentally friendly transport policies are crucial for enhancing sustainable urban mobility and supporting sustainable urban mobility planning in cities that serve as major tourism destinations.

Keywords: Sustainable urban mobility, sustainable tourism, transport performance, sustainable transportation, multidimensional scaling

Kentsel hareketlilik kapsamında seçilmiş turizm destinasyonlarında sürdürülebilir ulaşım: Çok boyutlu ölçekleme analizi

Özet: Küresel nüfus artışı ve kentleşme süreçlerinin hızlanması, ulaşım sistemlerinin kullanımını artırmıştır. Bu durum, kentsel hareketliliği yoğunlaştırmakta ve çeşitli çevresel sürdürülebilirlik sorunlarını beraberinde getirmektedir. Bu bağlamda, sürdürülebilir kentsel hareketlilik giderek daha fazla önem kazanmaktadır. Sürdürülebilir kentsel hareketlilik, kentsel yaşam kalitesini artırmakta,

* Corresponding author.
ORCID: 0000-0003-3255-3788; 0000-0002-6004-0640
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karbon emisyonlarını azaltmakta, ulaşım sistemlerinin verimliliğini iyileştirmekte, şehirleri akıllı destinasyonlara dönüştürmekte ve turizm destinasyonlarının sürdürülebilirliğini ile rekabetçiliğini güçlendirmektedir. Bu çalışma, Sürdürülebilir Hareketlilik Hazırlık Endeksi kapsamında yer alan 26 şehre ait sürdürülebilir ulaşım verilerini analiz etmeyi amaçlamaktadır. Söz konusu şehirler, dünya genelinde en çok ziyaret edilen ilk 50 ülkesinde yer alan önemli turizm destinasyonlarını temsil etmektedir. Çalışmada, bu şehirler sürdürülebilir hareketlilik açısından benzerlik ve farklılıkların belirlenmesi amacıyla çok boyutlu bir yaklaşımla değerlendirilmiştir. Bu doğrultuda, ulaşım arzı, ulaşım talebi, inovasyon, politikalar, finansman ile çevre ve enerji olmak üzere altı temel boyut dikkate alınmıştır. Çalışmada seçilen 26 şehre ait 2024 ve 2025 yılı verileri kullanılmıştır. Analiz sürecinde Çok Boyutlu Ölçekleme (ÇBÖ) ve hiyerarşik kümeleme yöntemlerinden yararlanılmıştır. Elde edilen bulgular, şehirlerin sürdürülebilir hareketlilik performansının homojen bir yapı sergilemediğini ve iki temel küme altında toplanabildiğini göstermektedir. Altı boyutun tamamında Çok Boyutlu Ölçekleme ve hiyerarşik kümeleme analizleri, şehirleri sürdürülebilir hareketlilik özelliklerine göre tutarlı biçimde sınıflandırırken, toplam puan analizi de bu genel sınıflandırmayı doğrulamaktadır. Boyutlar arasındaki farklılaşma düzeyi değişmekle birlikte, ulaşım arzı, finans ile çevre ve enerji boyutlarının şehirler arasında daha belirgin kümelenmeler oluşturduğu; buna karşılık politikalar boyutunun görece daha heterojen bir yapı sergilediği belirlenmiştir. Ayrıca Amsterdam, Londra, Helsinki, Singapur ve Münih gibi şehirlerin birçok boyutta benzer sürdürülebilir hareketlilik profilleri sergileyerek aynı kümelerde yer aldığı görülmüştür. Londra, Helsinki, Amsterdam ve Singapur gibi şehirler ulaşım altyapısı ve inovasyon kapasitesi açısından benzer özellikler göstermektedir. Buna karşılık, Lagos, Cape Town ve Bogotá gibi gelişmekte olan şehirler, daha farklılaşmış sürdürülebilir hareketlilik profilleriyle ayrı bir kümede konumlanmaktadır. Yapılan değerlendirmeler; ulaşım altyapısının güçlendirilmesi, elektrikli araç teknolojilerinin yaygınlaştırılması, akıllı ulaşım sistemlerinin geliştirilmesi ve çevre dostu ulaşım politikalarının uygulanmasının sürdürülebilir kentsel hareketliliğin geliştirilmesi ve önde gelen turizm destinasyonlarında sürdürülebilir kentsel hareketlilik planlamasının desteklenmesi açısından kritik öneme sahip olduğunu göstermektedir.

Anahtar Kelimeler: Sürdürülebilir kentsel hareketlilik, sürdürülebilir turizm, ulaşım performansı, sürdürülebilir ulaşım, çok boyutlu ölçekleme

* Corresponding author.
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1. Introduction

The technologies that have emerged since the First Industrial Revolution, along with the rapidly increasing urbanization across the globe, have been transforming the economic, social, and environmental structures of cities. According to United Nations data, approximately 45% of the world's population now resides in urban areas (United Nations, 2025). Moreover, this proportion is expected to rise even further in the coming years. At the same time, the continued growth of international tourism is increasing the concentration of visitors in major cities, creating additional pressure on urban transportation systems. Cities such as London, Amsterdam, and Singapore, exhibit high levels of mobility as they both host large resident populations and experience substantial tourist inflows. As a result, this dynamic increases demand for transportation and places significant strain on existing transport infrastructure (Yılmaz & Yılmaz, 2025). Furthermore, the combined effects of population growth and increasing visitor flows pose critical challenges, including traffic congestion, air pollution, energy consumption, and carbon emissions, all of which directly affect the environmental sustainability of cities. In this context, the concept of sustainable urban mobility has gained increasing prominence in recent years, both in academic literature and in policy discussions (Web of Science, 2025).

Sustainable urban mobility refers to the ability of people and goods to move within cities in an environmentally responsible, economically efficient, and socially inclusive manner. It encompasses a variety of policy instruments, including the development of public transportation systems, the promotion of shared mobility models, the encouragement of non-motorized transport modes, the widespread adoption of electric vehicle technologies, and the implementation of intelligent transportation systems. These measures are expected to improve transportation efficiency, reduce transport-related environmental impacts, and support the long-term sustainability of cities. For tourism destinations, they also provide more favorable conditions for visitor mobility and destination accessibility.

In recent years, various indices have been developed to evaluate the sustainable transportation performance of cities. One such index, the Sustainable Mobility Readiness Index (SMRI), has been introduced as a tool to assess the extent to which cities are prepared for the transition toward sustainable mobility. The SMRI comprises six key dimensions: transport supply, transport demand, innovation, policies, finance, and environment and energy. Therefore, the index enables the analysis and interpretation of cities' sustainable mobility performance through quantitative data. In the present study, SMRI data for 26 cities located within the top 50 most visited countries worldwide (The World Tourism Organization [UN Tourism], 2026) are analyzed using Multidimensional Scaling (MDS) and hierarchical clustering methods. These cities were selected because they represent major tourism destinations. Accordingly, the primary objective of this study is to identify similarities and differences in sustainable mobility profiles among major tourism destinations based on the six SMRI dimensions.

A substantial portion of the existing literature evaluating sustainable transportation and tourism activities is limited to a specific city, region, or user group (Alkheder, 2016; Dickinson & Dickinson, 2006). In contrast, the present study adopts a comparative perspective, examining major cities from diverse geographical regions. Secondly, unlike the commonly employed methods in the literature, such as surveys, interviews, and conceptual analyses (Hącia et al., 2023), this study uses MDS and clustering analyses together, enabling the visualization and comparison of cities' sustainable mobility profiles. Thirdly, the study contributes to the literature by offering a novel analytical approach that examines the relationship between sustainable mobility and tourism performance not directly, but rather through multidimensional indicators. Thus, it provides a more nuanced and comprehensive understanding of this relationship while expanding the existing body of knowledge.

Despite the growing body of research on sustainable transportation and tourism, comparative studies examining sustainable mobility characteristics across internationally recognized tourism destinations using multidimensional analytical techniques remain limited. This study addresses this gap by comparing the sustainable mobility profiles of major tourism destinations based on SMRI indicators. It provides a comparative assessment of cities' sustainable mobility characteristics and discusses the implications of these differences for tourism destinations. Accordingly, this study seeks to answer the following research question: *How do major tourism destinations differ in terms of sustainable mobility*

characteristics across the six dimensions of the SMRI, and what patterns emerge from these similarities and differences?

In the first section of the study, the concept of sustainable mobility is introduced. Subsequently, information is provided on how this concept influences urban mobility in major tourism destinations, followed by explanations regarding the SMRI and evaluations of the scores for the 2024–2025 period. In the second section, studies in the literature that jointly address the relationship between transportation and tourism are reviewed, thereby highlighting the specific contributions of this research. In the third section, an overview of MDS analysis is presented, whereas in the fourth section, the findings obtained from the analysis are evaluated. The findings are interpreted within the context of the sustainable mobility literature, with particular emphasis on their implications for tourism destinations. Finally, in the fifth section, the study's overall findings are assessed. Based on these findings, policy recommendations and suggestions for future research are presented for cities seeking to strengthen sustainable mobility in tourism destinations.

2. Conceptual Framework

In this study, a comparative analysis and evaluation approach has been adopted using secondary data to assess sustainable transportation levels in selected cities within the scope of urban mobility. The data utilized in the research were obtained from the SMRI reports published in 2024 and 2025, which include information on certain highly populated cities around the world that also experience intense tourism mobility. Figure 1 presents the SMRI dimensions. The index evaluates the level of sustainable mobility in cities based on six core dimensions: transport supply, transport demand, innovation, policies, finance, and environment and energy (The Sustainable Mobility Readiness Index [SMRI], 2025). In this regard, the index provides the quantitative data needed to identify and compare the readiness of cities across five continents for sustainable mobility. Furthermore, these data are particularly significant for analyzing the sustainability of passenger transportation, logistics activities, and tourism-driven mobility in the metropolitan areas examined in this study.

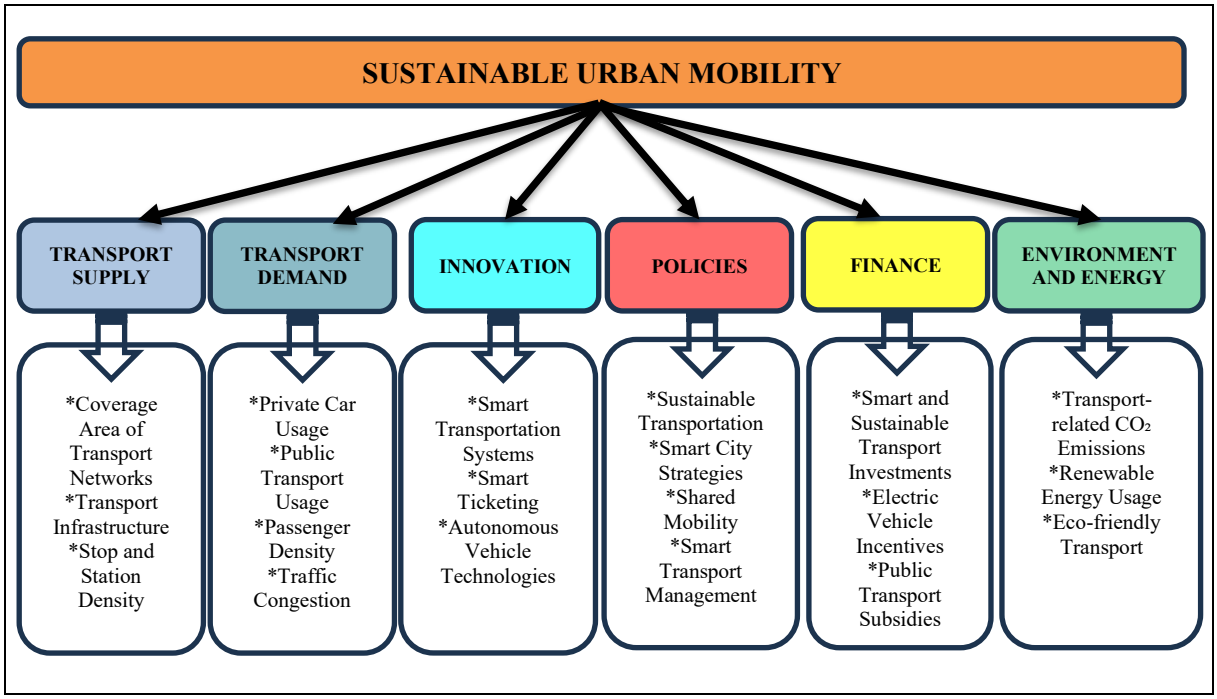


Figure 1. Prepared by the Authors Based on the SMRI Dimensions.

Within the scope of the study, the scores of the selected cities included in the reports for these dimensions were scaled so that each dimension ranged from 0 to 10. In this context, transport supply refers to the level of transportation infrastructure and service capacity available in a city. In contrast, transport demand indicates the extent to which different modes of transportation are utilized within the urban environment. Furthermore, innovation refers to the use of smart transportation technologies in transport systems, while the policies dimension encompasses public policies and regulatory frameworks that

support sustainable transportation. Finance denotes the economic resources allocated to the development of intelligent and sustainable transportation systems; environment and energy refers to energy consumption from transportation activities and the environmental impacts of transport (SMRI, 2025).

In the study, data obtained from the SMRI were tabulated and imported into Microsoft Excel to enable comparative evaluation. The data were organized in Excel, and the dimension-based values for the cities were analyzed using graphical visualization techniques. Accordingly, similarities and differences among cities in sustainable transport dimensions were compared using tables, figures, and graphs, and the findings were interpreted. Thus, variations in sustainable transportation structures across cities at different levels of development were identified, enabling comprehensive evaluations of sustainable urban mobility policies. Table 1 presents the 2024 scores for 26 cities on sustainable mobility dimensions, while Figure 2 illustrates their overall scores in a radar chart. Accordingly, it is observed that the cities with the highest overall sustainable transport scores are London, Helsinki, Amsterdam, Singapore, and Munich. When the dimensions are examined individually, it becomes evident that these cities demonstrate relatively high values in transport supply, innovation, and policies dimensions compared to others. This finding suggests that well-developed public transportation infrastructure, effective use of smart mobility systems, and regulatory frameworks that support sustainable transport have a positive impact on sustainable mobility performance in these cities. Moreover, the fact that these cities are prominent global tourism destinations indicates that sustainable transportation systems can effectively manage the intensive tourist mobility they attract. London stands out with its strong transport infrastructure and sustainable mobility policies (Transport for London, 2025), thereby achieving high scores across multiple dimensions. Similarly, Helsinki (European Union, 2026) and Amsterdam (Government of the Netherlands, 2025) are also among the cities exhibiting high performance, largely due to their advanced public transportation systems and sustainable mobility policies.

Table 1. Sustainable Mobility Scores for 2024

Development Category	Cities	Transport Supply	Transport Demand	Innovation	Policies	Finance	Environment and Energy	Total Scores
Mature	London	9.8	8.3	9.3	9.7	8.0	9.3	8.3
	Amsterdam	9.5	9.5	8.5	6.9	8.8	7.9	7.8
	Singapore	9.2	9.5	9.5	6.5	6.4	7.8	7.6
	Munich	9.0	8.5	9.2	5.7	8.8	7.4	7.5
	Madrid	9.0	9.2	8.2	7.1	7.1	7.3	7.4
	San Francisco	7.6	5.8	9.6	8.9	9.0	7.5	7.4
	Melbourne	6.7	7.2	8.6	8.7	5.6	8.7	7.0
	Milan	6.8	9.7	6.5	9.3	6.2	5.1	6.8
	New York	5.7	7.4	7.7	9.0	7.4	6.6	6.7
	Tokyo	6.4	6.7	7.3	7.1	7.6	4.6	6.1
	Boston	4.9	5.5	7.5	7.2	7.5	6.8	6.0
Emerging	Helsinki	8.9	10.0	9.4	8.8	7.0	9.0	8.2
	Hong Kong	9.6	9.7	9.3	6.7	5.2	5.9	7.3
	Seoul	7.6	8.1	8.6	6.7	6.2	5.9	6.7
	Shanghai	7.1	7.9	7.3	9.3	6.1	5.9	6.7
	Dubai	6.6	6.4	8.9	9.6	6.0	4.8	6.5
	Toronto	5.5	5.2	6.8	9.2	5.0	8.1	6.0
	Los Angeles	5.6	2.9	7.5	8.6	7.4	6.1	5.8
Developing	Buenos Aires	4.0	7.8	6.6	5.8	3.9	6.0	5.3
	Istanbul	5.9	6.1	5.3	8.2	4.8	3.3	5.2
	New Delhi	5.1	6.7	5.4	6.3	6.3	3.1	5.0
	São Paulo	4.8	5.5	4.7	3.8	7.1	6.3	4.9
	Riyadh	4.2	5.5	4.9	7.1	3.8	3.5	4.5
	Bogotá	4.2	6.2	3.7	3.6	6.4	5.5	4.5
	Cape Town	5.2	3.9	4.9	5.7	2.4	5.5	4.3
	Lagos	1.9	5.1	2.4	6.0	2.2	2.8	3.1

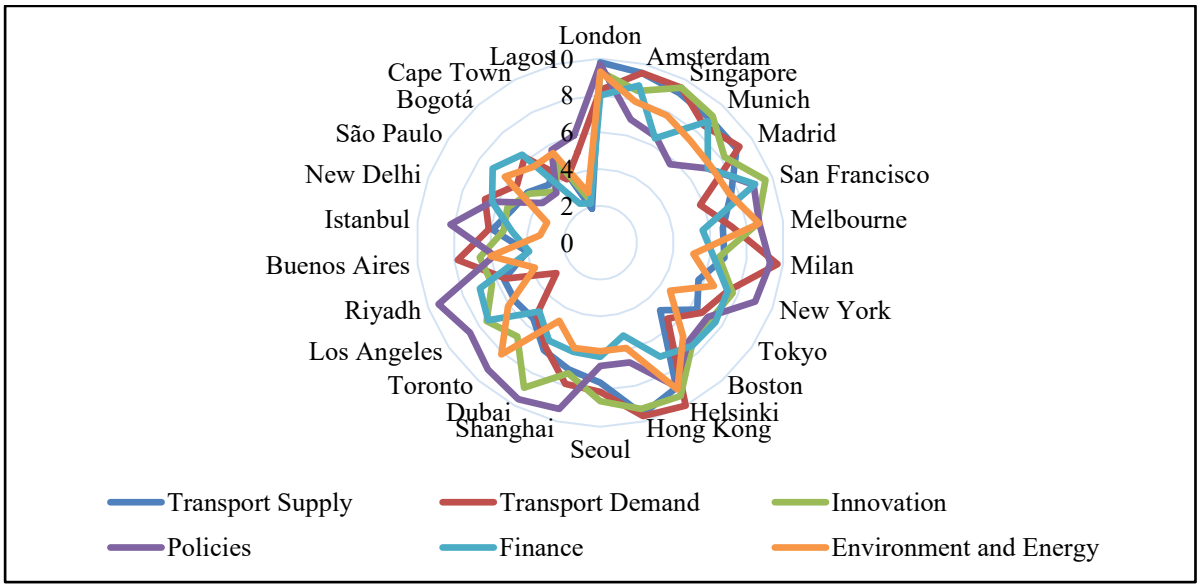


Figure 2. Sustainable Mobility Performance of Metropolitan Cities in 2024.

Among the cities demonstrating moderate performance in Table 1 are Munich, Madrid, San Francisco, Melbourne, Milan, New York, and Tokyo. Overall, it is observed that the sustainable transport scores of these cities range from 6.0 to 7.5. Although some dimensions exhibit relatively high scores in these cities, lower values are also evident in certain dimensions. San Francisco, for instance, performs well in innovation and finance; however, it records a comparatively lower score in transport demand. Similarly, large metropolitan areas such as New York and Tokyo attain high scores in the adoption of smart and sustainable transportation systems; nevertheless, due to their large populations and intense tourist inflows, they experience higher levels of transport-related carbon emissions, which, in turn, lead to lower scores in the environment and energy dimension.

Cities such as Buenos Aires, Istanbul, New Delhi, São Paulo, Riyadh, Bogotá, Cape Town, and Lagos are identified as the lowest-performing cities in the sample, based on total scores. These findings suggest that the transportation infrastructure in these cities needs further development compared to that of other metropolitan areas. At the same time, limitations in financial resources for smart and sustainable mobility, lower innovation capacity, and challenges related to transport-induced emissions and renewable energy use also play significant roles. Furthermore, the fact that these cities are emerging tourism destinations suggests that deficiencies in sustainable transportation infrastructure may also constrain tourism accessibility and destination competitiveness. Notably, Lagos records the lowest overall score at 3.1. In particular, the notably low levels of transport supply and innovation in Lagos highlight significant structural challenges to developing sustainable transportation systems in the city.

Table 2 presents the scores obtained by 27 cities (Paris was incorporated into the 2025 edition of the index) from sustainable mobility dimensions in 2025, while Figure 3 illustrates their overall scores through a grouped bar chart. When Table 2 and Figure 3 are combined with Table 1, it is observed that the overall trends in the sustainable urban mobility dimensions of the cities show a high degree of similarity. When the overall rankings are examined, it becomes evident that developed cities such as Paris, London, Helsinki, Amsterdam, and Singapore consistently rank at the top for sustainable mobility. This indicates that these cities possess strong transportation infrastructure, adequate resources to support smart and sustainable mobility, advanced technological innovation capacity, and well-established sustainable transport policies. Moreover, the overall scores for London, Amsterdam, Singapore, Munich, and Madrid remain similar across both years. This suggests that sustainable transportation systems in developed cities have reached a certain level of maturity, so significant short-term changes are not expected. Given that infrastructure in these cities is already well-established, the absence of major short-term improvements can be considered an expected outcome. Similarly, no substantial changes are observed between the two tables for cities positioned at the lower end of the ranking. Buenos Aires,

Istanbul, New Delhi, São Paulo, Riyadh, Bogotá, Cape Town, and Lagos remain among the cities with relatively lower sustainable mobility scores in both years.

Table 2. Sustainable Mobility Scores for 2025

Development Category	Cities	Transport Supply	Transport Demand	Innovation	Policies	Finance	Environment and Energy	Total Scores
Mature	Paris	9.9	9.6	9.8	9.9	9.2	8.8	8.8
	London	9.8	8.3	9.3	9.7	8.0	9.3	8.3
	Amsterdam	9.5	9.5	8.5	6.9	8.8	7.9	7.8
	Singapore	9.2	9.5	9.5	6.5	6.4	7.8	7.6
	Munich	9.0	8.5	9.2	5.7	8.8	7.4	7.5
	Madrid	9.0	9.2	8.2	7.1	7.1	7.3	7.4
	San Francisco	7.6	5.8	9.6	8.9	9.0	7.5	7.4
	Melbourne	6.7	7.2	8.6	8.7	5.6	8.7	7.0
	Milan	6.8	9.7	6.5	9.3	6.2	5.1	6.8
	New York	5.7	7.4	7.7	9.0	7.4	6.6	6.7
	Tokyo	6.4	6.7	7.3	7.1	7.6	4.6	6.1
	Boston	4.9	5.5	7.5	7.2	7.5	6.8	6.0
Emerging	Helsinki	8.9	10.0	9.4	8.8	7.0	9.0	8.2
	Hong Kong	9.6	9.7	9.3	6.7	5.2	5.9	7.3
	Seoul	7.6	8.1	8.6	6.7	6.2	5.9	6.7
	Shanghai	7.1	7.9	7.3	9.3	6.1	5.9	6.7
	Dubai	6.6	6.4	8.9	9.6	6.0	4.8	6.5
	Toronto	5.5	5.2	6.8	9.2	5.0	8.1	6.0
	Los Angeles	5.6	2.9	7.5	8.6	7.4	6.1	5.8
Developing	Riyadh	5.6	5.5	6.3	9.4	7.0	3.8	5.8
	Buenos Aires	4.0	7.8	6.6	5.8	3.9	6.0	5.3
	Istanbul	5.9	6.1	5.3	8.2	4.8	3.3	5.2
	New Delhi	5.1	6.7	5.4	6.3	6.3	3.1	5.0
	São Paulo	4.8	5.5	4.7	3.8	7.1	6.3	4.9
	Bogotá	4.2	6.2	3.7	3.6	6.4	5.5	4.5
	Cape Town	5.2	3.9	4.9	5.7	2.4	5.5	4.3
	Lagos	1.9	5.1	2.4	6.0	2.2	2.8	3.1

The consistent presence of London, Helsinki, Amsterdam, and Singapore at the top of the rankings in both years indicates that these cities have successfully integrated sustainable transportation into urban life. In these cities, it is evident that advanced public transportation networks, high accessibility, robust digital infrastructure, innovative mobility applications, and environmentally oriented transport policies are both effectively planned and implemented (Yılmaz, 2025b, p. 435). This situation can also be associated with countries such as Singapore, Finland, and the Netherlands, which rank highly on the Logistics Performance Index, as well as with their well-developed logistics infrastructure and high-quality service standards (European Commission, 2020, 2025; World Bank, 2023; Yılmaz, 2025a). Therefore, the results obtained can be linked to long-term infrastructure investments and stable public policies in these cities. Moreover, these cities possess the institutional and financial capacity to adopt innovations such as electric vehicles, smart ticketing systems, data-driven traffic management, and shared mobility solutions more rapidly. Notably, in Singapore, the Land Transport Master Plan 2040 aims to transform the transport system into one that is “convenient, well-connected, and fast”; in addition, it demonstrates that accessibility, innovative mobility approaches, and long-term sustainable transport planning are pursued simultaneously, supported by strong infrastructure and safety-oriented transport goals (Singapore Ministry of Transport, 2026). Consequently, this framework enables these cities to manage tourist flows effectively, thereby enhancing destination accessibility and contributing to the overall quality of the tourism experience.

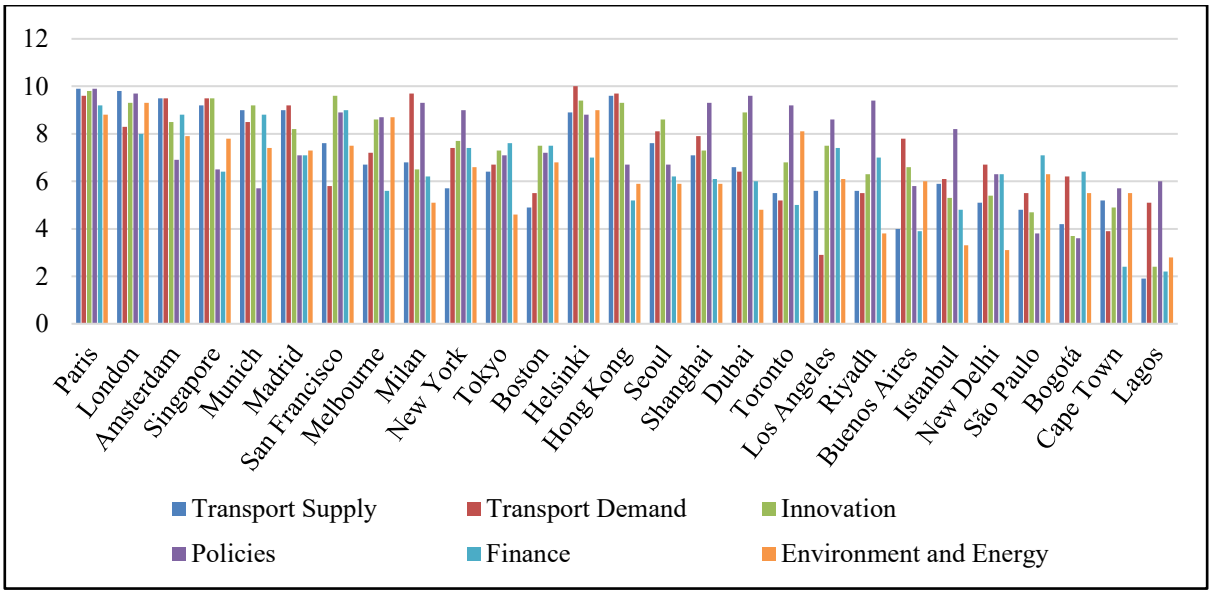


Figure 3. Sustainable Mobility Performance of Metropolitan Cities in 2025.

The fact that cities such as Buenos Aires, Istanbul, New Delhi, São Paulo, Bogotá, Cape Town, and Lagos consistently exhibit low scores in both years indicates structural challenges in sustainable transportation in these cities. Factors such as inadequate transportation infrastructure, limited financial resources, rapid and unplanned urbanization, high population pressure, dependence on private vehicles, limited access to environmentally friendly transport technologies, and inconsistent policy implementation may have contributed to their lower sustainable mobility performance. Furthermore, achieving sustainable transportation in low-performing cities is closely associated with economic capacity and institutional collaboration. For instance, insufficient investments in public transportation, limited availability of electric vehicles and charging infrastructure, and the lack of widespread adoption of smart transportation systems, all of which lead to higher carbon emissions, may further reduce the level of sustainable mobility in these cities. When these factors are combined with rapid population growth and increasing urbanization pressure, it becomes evident that transportation systems in these cities are under significant strain; therefore, it can be argued that such conditions prevent notable changes in ranking outcomes in the short term (Figure 4).

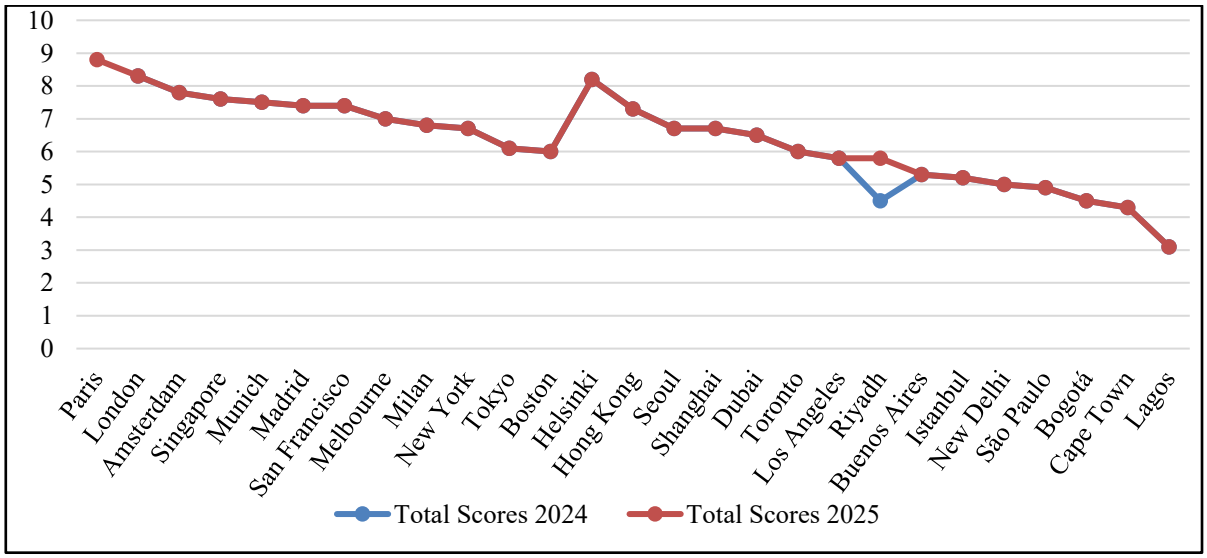


Figure 4. Comparison of Sustainable Mobility Total Scores for 2024–2025.

The fact that a significant proportion of these cities are emerging tourism destinations indicates that deficiencies in sustainable transportation infrastructure may also negatively affect the development of the tourism sector. Inadequate transport infrastructure and low levels of accessibility can hinder tourist

mobility, thereby reducing the international competitiveness of these destinations. Moreover, increasing population, unplanned urbanization, and additional demand generated by tourism mobility in these cities place an extra burden on urban carrying capacity, which, in turn, reduces the efficiency of transportation systems.

The results indicate that sustainable transportation performance improves over the long term through adequate investment, effective planning, and strong governance capacity. In this regard, top-ranking cities maintain their positions owing to their accumulated institutional experience and well-established infrastructure, whereas lower-ranked cities are unable to converge with the upper group in the short term due to structural and managerial constraints. This suggests that the sustainable mobility levels of the cities examined in this study can be raised through a cumulative process of development and transformation over time.

3. Literature Review

When the literature is evaluated broadly, it becomes evident that studies on the relationship between transportation and tourism predominantly focus on sustainability, accessibility, public transport integration, and smart mobility. A substantial body of research highlights the pressure tourism activities exert on transportation systems, while also emphasizing the decisive role of transport infrastructure in shaping tourism development. It is widely acknowledged that transport infrastructure enhances destination attractiveness; however, increased tourist mobility tends to create challenges related to capacity, safety, environmental impacts, and governance within transportation systems (Hopkins, 2020; Kuklina et al., 2022; Lund-Durlacher & Dimanche, 2013). Although these studies consistently emphasize the importance of sustainable transportation for tourism development, they differ substantially in terms of geographical scope, analytical perspective, and methodological approach. While conceptual studies mainly discuss theoretical relationships, empirical studies generally focus on specific destinations or transportation issues. Consequently, the cumulative evidence provides valuable insights into the transportation–tourism nexus but offers only limited understanding of how sustainable mobility characteristics differ across major tourism destinations at a comparative level.

It is observed that some studies in the literature examine the relationship between tourism and transportation through the lens of a specific city, region, or user group. Puchongkawarin and Ransikarbum (2021) focus on the integration of tourism and public transportation in the Ubon Ratchathani region of Thailand; meanwhile, Nadimi et al. (2025) investigate transportation preferences among elderly individuals in relation to their participation in tourism activities; furthermore, Alkheder (2016) evaluates the impact of transportation systems on tourism sustainability in Jordanian tourism cities based on residents' perceptions. Similarly, Dickinson and Dickinson (2006) explore social perceptions of transport and responses to car restrictions in rural tourism areas. Collectively, these studies demonstrate that transportation-related tourism issues are predominantly investigated within local or regional contexts. Although such studies provide detailed contextual evidence, their findings are often difficult to generalize across different tourism destinations. Therefore, comparative analyses based on standardized indicators remain relatively scarce in the literature.

From a methodological perspective, this study diverges from existing research. Previous studies have largely relied on methods such as surveys (Alkheder, 2016; Kuklina et al., 2022; Nadimi et al., 2025; Puchongkawarin & Ransikarbum, 2021; Samková & Navrátil, 2023), interviews (Dickinson & Dickinson, 2006; Kuklina et al., 2022), content analysis (Vithayaporn et al., 2023), bibliometric analysis (Hącia et al., 2023), panel data analysis (Marchesani & Masciarelli, 2025), or conceptual evaluations (Hopkins, 2020; Lund-Durlacher & Dimanche, 2013; Yigitcanlar et al., 2008). Despite the diversity of these methodological approaches, relatively few studies have employed multidimensional comparative techniques to evaluate sustainable mobility across multiple tourism destinations using standardized datasets. Furthermore, previous studies have generally examined either transportation systems or tourism-related issues separately, whereas comprehensive evaluations integrating multiple sustainable mobility dimensions remain limited. Accordingly, the present study addresses this methodological and empirical gap by applying MDS and hierarchical clustering analyses to the six dimensions of the SMRI. This approach enables the identification of similarities and differences in sustainable mobility profiles among major tourism destinations through a standardized comparative framework.

Table 3. Studies Addressing Transportation and Tourism Together

Author(s) & Year	Purpose & Methodology	Key Findings
Puchongkawarin and Ransikarbum (2021)	The study aimed to develop a decision support system that integrates tourism with public transportation in the Ubon Ratchathani region of Thailand. A survey was conducted to examine minibus users' satisfaction levels and travel behaviors, and qualitative analysis was conducted through open-ended questions. In addition, a Traveling Salesman Problem (TSP) model was constructed, and the shortest tourism routes were identified.	The study's findings indicate that vehicle options, route and service integration, and tourist attractiveness received the highest scores. In contrast, clean energy usage and promotional activities were rated comparatively lower. Furthermore, responses to open-ended questions revealed that improvements are needed in punctuality, safety, and vehicle conditions.
Vithayaporn et al. (2023)	The factors influencing the performance of green logistics implementation within the context of urban tourism in Thailand were analyzed through content analysis of interviews with 25 logistics firms and relevant stakeholders.	The main factors influencing green logistics in tourism were identified as green transportation systems, reverse logistics, environmental management, government policies, and firms' perceptions of green logistics. However, the lack of information, high costs, and policy inadequacies were identified as significant barriers.
Yigitcanlar et al. (2008)	The challenges associated with sustainable and smart transportation in Gold Coast, a tourism-oriented and developed city, were examined through a literature review and GIS-based spatial analysis.	The analyses revealed that more than 90% of commuting trips are made in private vehicles, while the city's low-density, dispersed urban structure reduces the effectiveness of public transportation. Moreover, it was found that young people and low-income individuals are disadvantaged in terms of accessibility. Therefore, technologies such as Automated People Movers (APM) and Personal Rapid Transit (PRT) were proposed, and the integration of smart transportation systems was emphasized as a necessary step forward.
Nadimi et al. (2025)	The study aimed to identify which transportation factors are significant in increasing elderly participation in tourism activities within the context of sustainable mobility. Accordingly, a survey was conducted with 360 participants in Kerman, Iran, and the data were analyzed using a structural equation modeling approach.	The results indicate that high-income, frequently traveling elderly individuals prefer air transport, whereas lower-income groups predominantly choose buses. Trains, on the other hand, emerged as the least preferred mode due to issues related to infrastructure, comfort, and speed. Safety, service quality, information services, and pricing were identified as the most decisive factors. Consequently, it was concluded that elderly tourism cannot develop without the establishment of sustainable and inclusive transportation systems.
Dickinson and Dickinson (2006)	Moscovici's Social Representations Theory was employed to examine	The analysis revealed strong social resistance to car restrictions, while improvements in public transportation positively influenced

	transportation-related problems arising from tourism in rural tourism areas. In line with this approach, tourism and transportation policies in the United Kingdom were analyzed, and in-depth interviews were conducted with 13 participants.	individuals' preferences. Moreover, pricing was identified as a significant factor in shaping transportation behavior.
Lund-Durlacher and Dimanche (2013)	A literature review and synthesis approach was employed to examine the relationship between mobility and sustainable tourism.	The findings indicate that motorized transportation poses a major sustainability challenge, while tourism mobility should be addressed alongside human movement, capital flows, information exchange, and social and economic mobility. Furthermore, it was emphasized that sustainable transportation in tourism remains an area that requires further research.
Samková, and Navrátil (2023)	A survey was conducted with 121 experts to evaluate the importance of public transportation in the development of tourism destinations, and cluster analysis was performed.	Public transportation was identified as the most important development factor across all countries, whereas services such as Uber and car rental were considered the least significant. However, regional differences were evident, as the importance of public transportation was relatively lower in Mexico, while it emerged as the most critical mode in Czechia and the Netherlands. In Italy, on the other hand, all modes of transportation were evaluated at similar levels. Overall, the findings indicate that shared mobility is more widely accepted in Europe.
Hopkins (2020)	The relationship between tourism and sustainable transportation was evaluated through a literature review and conceptual analysis.	The study highlights that tourism and transportation are interdependent. It further explains that transportation systems are not sustainable due to high carbon emissions and significant environmental impacts associated with tourism activities. Therefore, it is emphasized that addressing this issue requires technological advancements and broader social, economic, and political transformations.
Hacia et al. (2023)	The relationship between urban logistics and urban tourism was examined using a bibliometric analysis approach. In this regard, 166 publications from the Scopus database were analyzed to identify key trends and research patterns.	The findings indicate that the intersection of urban logistics and tourism remains underexplored. In particular, logistics and transportation, together with urban development, have emerged as key subfields. Moreover, most studies in this area are conducted in single cities or case studies, thereby underscoring the limited number of comparative analyses.
Marchesani and Masciarelli (2025)	A panel data analysis was conducted over 13 years across 30 cities in Italy to examine the impact of MICE tourism (Meetings, Incentives, Conventions, Exhibitions) on urban mobility in the context of	The results demonstrate that MICE tourism contributes to the development of transportation infrastructure and to the strengthening of smart mobility. However, an increase in tourist numbers leads to higher crime rates and weakens overall safety. Consequently, this situation reduces the

	smart cities. In this framework, urban mobility was treated as the dependent variable, MICE tourism as the independent variable, and urban crime as the moderating variable.	effectiveness of mobility investments and shifts resources toward security measures. Overall, the findings highlight the need to maintain a well-balanced relationship between mobility and safety.
Allis and Fraga (2018)	The relationship between tourism, public transportation, and sustainable mobility was examined through the development of a conceptual framework.	The study demonstrates that tourism activities generate high levels of carbon emissions, underscoring the importance of public transportation in this context. However, it is also noted that public transport systems are generally not designed specifically for tourists, which in turn creates a mismatch between user needs and system provision. Additionally, it is emphasized that overtourism may result in residents being excluded from certain transportation systems. Accordingly, the study underscores the significant role of smart technologies and the sharing economy in shaping sustainable transportation solutions.
Kuklina et al. (2022)	The relationship between tourism development and transportation infrastructure in Siberia was evaluated using a combination of methods, including surveys, expert interviews, non-participant observation, and in-depth interviews.	The findings indicate that as transportation infrastructure improves, tourism activity increases; similarly, tourism development also positively influences transportation infrastructure. However, it was determined that when tourism and transportation projects fail to account for local communities' needs and expectations, they may lead to environmental degradation and social conflict.
Alkheder (2016)	A survey was conducted among 600 residents to examine the impact of transportation systems on tourism sustainability in Jordan's tourism cities.	The results indicate that the existing transportation infrastructure is inadequate for ensuring tourism sustainability, as many tourist and archaeological sites are either inaccessible or connected by low-quality roads. Moreover, harsh winter conditions and the mountainous terrain further complicate accessibility. Consequently, these findings suggest that transportation has not been effectively integrated into tourism planning.

4. Methodology

The study included all cities that were available in both the 2024 and 2025 editions of the SMRI, thereby avoiding any additional sampling or selection among the cities covered by the index. These cities are located predominantly in countries that rank among the world's top 50 international tourism destinations according to UN Tourism (2026), providing a common tourism context for comparative analysis. Consequently, the rationale for including these cities was twofold: first, to ensure complete coverage of the comparable SMRI dataset across both years, and second, to examine sustainable mobility characteristics in internationally significant tourism destinations. It should be emphasized, however, that tourism was used to define the contextual scope of the study, whereas all statistical analyses conducted exclusively using the six dimensions of the SMRI.

In this study, MDS and hierarchical clustering analyses were employed together to examine the multidimensional structure of cities within the scope of the SMRI. The study's dataset consists of SMRI dimensions for 2024 and 2025, covering 26 cities that represent leading tourism destinations and are among the top 50 most visited countries worldwide (UN Tourism, 2026). Paris was excluded from the

comparative analyses because it was not included in the 2024 SMRI and corresponding data were therefore unavailable. Although Paris was incorporated into the 2025 edition of the index, its absence in the 2024 dataset prevented consistent year-to-year comparisons. To ensure methodological consistency and maintain an identical set of cities across both years, the MDS analyses were conducted using the 26 cities that were common to both the 2024 and 2025 datasets.

Accordingly, the selected cities represent internationally important tourism destinations while also providing comparable SMRI data for both years of analysis. This approach ensures methodological consistency and enables the comparison of sustainable mobility characteristics under a common tourism context. The city-country pairs included in the analysis, along with the global ranking of countries by tourism mobility, are presented in Table 4. Although the United Arab Emirates (UAE) and China are not listed in the World Tourism Organization's tourism statistics, cities such as Dubai and Shanghai were included in the analysis due to their significant tourism potential. Furthermore, although Finland and Nigeria are not ranked among the top 50 countries, Helsinki and Lagos were also included in the study because they are major metropolitan areas and part of the SMRI dataset.

Table 4. Cities Included in the Analysis

Nr	City	Country	Number of Visitors by Country in 2024 (million people)	World Tourism Ranking by Country
1	Madrid	Spain	93.8	2
2	Boston	the United States	72.4	3
3	Los Angeles	the United States	72.4	3
4	New York	the United States	72.4	3
5	San Francisco	the United States	72.4	3
6	İstanbul	Türkiye	60.6	4
7	Milan	Italy	57.7	5
8	London	the United Kingdom	41.8	7
9	Munich	Germany	37.5	8
10	Tokyo	Japan	36.9	9
11	Riyadh	Saudi Arabia	29.7	13
12	Hong Kong	Hong Kong (China)	21.9	16
13	Amsterdam	the Netherlands	21.3	17
14	New Delhi	India	20.6	18
15	Toronto	Canada	19.9	19
16	Seoul	South Korea	16.4	23
17	Singapore	Singapore	13.0	28
18	Cape Town	South Africa	8.9	33
19	Melbourne	Australia	8.3	37
20	Bogota	Colombia	6.8	40
21	Sao Paolo	Brazil	6.8	41
22	Buenos Aires	Argentina	6.6	44
23	Helsinki	Finland	2.9	62
24	Lagos	Nigeria	0.54	106
25	Shanghai	China	-	-
26	Dubai	UAE	-	-

Source: UN Tourism (2026)

In the analysis, six main dimensions were considered: transport supply, transport demand, innovation, policies, finance, and environment and energy. In addition, the total score was included in the analysis to provide a comprehensive evaluation of cities' sustainable mobility performance. Each dimension was analyzed separately based on its respective indicators. Taken together, this multidimensional structure enables an in-depth examination of how the pressure on transportation systems in major tourism destinations aligns with their overall sustainability performance.

MDS is a method for numerically measuring the similarity levels among a set of items. It simplifies the complex structure of a dataset, thereby revealing the relationships between items and facilitating their visual interpretation (Hout et al., 2013, p. 2). According to Wilkinson (2002, p. 186), MDS is a technique that positions a set of points in a spatial configuration so that the distances between them correspond to the dissimilarities among the objects. The data used in MDS analyses may consist of direct ratings or, alternatively, can be derived from indirect measurement techniques. In the MDS approach adopted in this study, the sustainable transportation profiles of cities were determined based on directly accessible quantitative data. In this respect, the analysis enables identification of the dimensions along which cities differ in sustainable mobility, while also allowing determination of unique performance patterns for each city. Furthermore, the results provide a basis for future studies integrating sustainable mobility indicators with tourism mobility, sustainable urban logistics, and environmental policies.

One of the key strengths of MDS analysis lies in its ability to reveal the underlying variable structures within items and to demonstrate how these items differ from one another (Ding, 2006, p. 229). In line with this, the MDS approach employed in this study identifies similarities and differences in sustainable mobility profiles among the selected cities based exclusively on SMRI indicators. Since all sampled cities represent internationally important tourism destinations, the findings provide a comparative assessment of sustainable mobility characteristics within a common tourism context. Moreover, this approach enables the easy identification of cities that deviate from general trends. In other words, it becomes possible to demonstrate that the high-performance sustainable transportation model typically associated with developed tourism destinations does not uniformly apply to all cities. Accordingly, factors such as infrastructure deficiencies, financial constraints, or insufficient commitment to smart and sustainable transport policies contribute to certain cities diverging from the expected sustainable mobility profile, thereby manifesting in lower fit values.

Through MDS analysis, a map is generated that illustrates the relationships among items. On this map, similar items are positioned close to one another, whereas dissimilar items are located farther apart. As a result, the analysis produces a visual representation that allows for a subjective evaluation of the dimensions within the dataset, while also enabling previously established assumptions to be tested using this spatial configuration.

In the initial stage of the analysis, the variables were standardized, and a distance matrix of cities was constructed using the Euclidean distance metric. The resulting distance matrix was then used as input for the MDS analysis. The MDS analysis was conducted using the PROXSCAL method, and a two-dimensional solution was preferred. The coordinates obtained from the analysis represent the positions of cities within a two-dimensional space. Model fit was evaluated using Stress and Tucker's coefficient of congruence. The Stress value is defined as a goodness-of-fit statistic that MDS seeks to minimize. It is calculated as the square root of the normalized squared differences between the distances among points on the resulting map and the distances derived from dissimilarities. The Stress value ranges between 0 and 1; accordingly, values closer to 0 indicate a better fit (Wilkinson, 2002, p. 188). Similarly, Tucker's coefficient assesses the model's representational adequacy, with values approaching 1 indicating a higher level of fit (Khiari et al., 2024, p. 15).

In the second stage, hierarchical clustering analysis was applied using the dimension coordinates obtained from the MDS results. In the clustering process, Ward's method and squared Euclidean distance were preferred. The optimal number of clusters was determined by examining the dendrogram, and cities were grouped based on their similarities. As a result, the clusters obtained reveal cities with similar sustainable mobility profiles based on the six dimensions of the SMRI. The combined use of these two methods enables both visual and statistical comparisons of cities according to their sustainable mobility characteristics. The integration of these methods provides a robust framework for identifying similarities, differences, and grouping patterns among cities based on standardized SMRI indicators.

5. Findings

5.1. Positioning and Clustering for the Transport Supply Dimension

The map obtained from the MDS analysis reveals similarities and differences among cities in the transport supply dimension within the scope of sustainable mobility. The Stress-I value of 0.028 indicates that the two-dimensional solution represents the data quite well; moreover, it demonstrates that the spatial configuration accurately reflects the underlying structure of the dataset. In addition, Tucker's coefficient of congruence, calculated as 0.999, further supports that the model fits well and exhibits a high level of goodness-of-fit.

The interpretation of dimensions generated by MDS focuses on the relative positions of cities and the similarities or differences reflected by their spatial configuration. Cities located close to one another exhibit similar transport supply characteristics across the SMRI indicators, whereas greater distances indicate more distinct transport supply profiles.

When the MDS map in Figure 5 is examined, it is evident that the cities are clustered into two main groups based on their transport supply performance. Amsterdam, London, Hong Kong, Singapore, Munich, Helsinki, Madrid, Shanghai, Seoul, Milan, Dubai, Mellbourne, San Francisco, and Tokyo are positioned in close proximity, suggesting that they exhibit similar characteristics in terms of transport supply. In contrast, Bogota, Buenos Aires, Cape Town, São Paulo, Boston, New Delhi, Toronto, New York, Los Angeles, Istanbul, Riyadh, and Lagos constitute a second cluster.

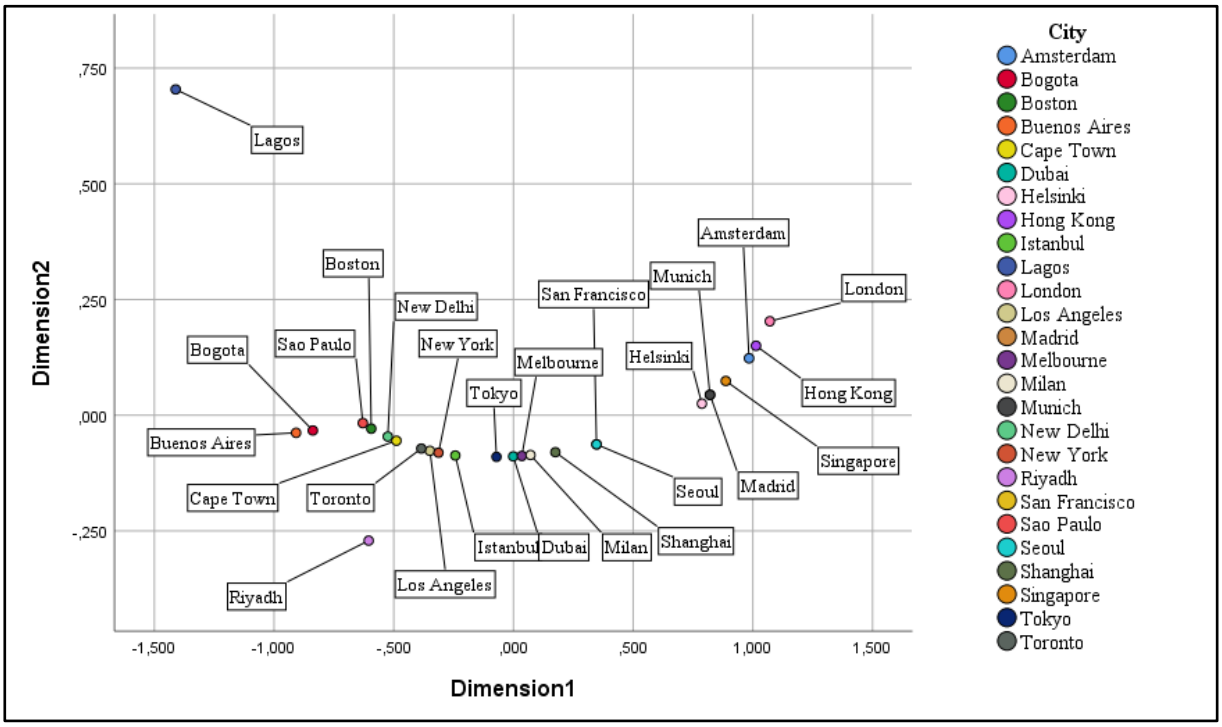


Figure 5. Positions Based on Transport Supply Coordinates.

The close positioning of cities such as Amsterdam, London, Singapore, Hong Kong, and Munich suggests that they share similar transport supply characteristics, despite differences in their geographical location and urban structure. According to the SMRI framework, these cities generally demonstrate strong public transport availability, well-developed multimodal networks, and high levels of integration between different transport modes. Their proximity on the MDS map therefore reflects structural similarity. This finding indicates that different cities may achieve comparable transport supply profiles through different institutional and infrastructural pathways. Furthermore, the clear divergence of Lagos and to a lesser extent Riyadh, suggest that their transportation infrastructure differ in terms of service balance; in other words, they appear to exhibit a distinct structural pattern compared to the other cities. According to the SMRI, this differentiation may be associated with lower levels of public transport provision, weaker multimodal integration, and comparatively limited readiness for

sustainable mobility transition. Another noteworthy finding concerns Boston and New York. Although both cities are located in one of the world's most developed economies, they are positioned within the second cluster rather than alongside London, Amsterdam, or Singapore. This result suggests that economic development alone does not necessarily correspond to a transport supply profile similar to that of cities recognized for highly integrated and multimodal urban transportation systems.

To support the findings from the MDS analysis, a hierarchical cluster analysis was conducted. The analysis, carried out using the Ward method and squared Euclidean distance, produced a dendrogram indicating that the cities are grouped into two main clusters. The first cluster includes San Francisco, Seoul, Shanghai, Melbourne, Milan, Dubai, Tokyo, Madrid, Munich, Helsinki, Singapore, Amsterdam, Hong Kong, and London. These cities exhibit similar transport supply characteristics. In contrast, the second cluster comprises Bogota, Buenos Aires, Los Angeles, Toronto, New York, Istanbul, Cape Town, New Delhi, Boston, São Paulo, Riyadh, and Lagos. Consistent with the MDS configuration, Lagos, and to a lesser extent Riyadh, display a more distinctive position within this cluster, suggesting a transport supply profile that differs from the remaining cities. Overall, the clustering results largely overlap with the spatial distribution obtained from the MDS analysis; thus, the findings from both analytical approaches support and reinforce one another.

From a tourism perspective, these structural differences suggest that internationally important tourism destinations do not exhibit a uniform transport supply profile. Cities grouped together in the first cluster appear to share similar levels of readiness in providing integrated transport services capable of supporting high urban mobility demand. In contrast, the cities in the second cluster exhibit transport supply structures that differ more substantially from this dominant profile. These findings indicate that sustainable transport supply constitutes an important contextual characteristic for cities that simultaneously accommodate large resident populations and substantial tourist flows.

5.2. Positioning and Clustering for the Transport Demand Dimension

In the MDS analysis of transport demand, the Stress-I value (0.024) and the high Tucker coefficient (0.999) indicate that the model demonstrates a high level of fit. The low Stress-I value indicates that the two-dimensional configuration accurately preserves the similarities and dissimilarities among cities in the transport demand dimension. Accordingly, the spatial distribution shown in Figure 6 provides a reliable basis for interpreting structural similarities.

The MDS map in Figure 6 indicates that the cities are clustered into two main groups based on their transport demand performance. Amsterdam, Helsinki, Hong Kong, Singapore, Milan, Madrid, London, Munich, Melbourne, New York, Shanghai, and Seoul are concentrated in the same region, exhibiting similar transport demand characteristics. In contrast, Tokyo, New Delhi, Bogotá, Istanbul, Dubai, Lagos, Toronto, Riyadh, São Paulo, Boston, San Francisco, Cape Town, and Los Angeles constitute the second cluster. The spatial proximity of Amsterdam, Singapore, Hong Kong, London, Munich, and Seoul suggests that these cities exhibit comparable transport demand structures despite substantial differences in population size, urban form, and geographical location. According to the SMRI framework, transport demand reflects the intensity of mobility and the ability of urban transport systems to accommodate travel demand efficiently. Therefore, the clustering of these cities indicates similarities in the overall balance between mobility demand and transport system capacity.

An interesting finding is the positioning of New York within the first cluster, whereas Boston, Toronto, and Los Angeles are located in the second cluster. This suggests that cities belonging to the same country do not necessarily display similar transport demand profiles. Instead, local urban structure, travel behaviour, modal distribution, and transport system characteristics appear to influence the overall similarity patterns identified by the MDS analysis. This finding highlights that transport demand is shaped primarily by city-specific mobility characteristics.

Notably, Los Angeles is clearly separated from all other cities along the second dimension, indicating the most distinctive transport demand profile among the cities examined. The isolated position of Los Angeles represents one of the most noteworthy outcomes of the analysis. According to the SMRI framework, this separation suggests that Los Angeles possesses a transport demand structure that differs considerably from the remaining cities. This distinctive position indicates that the overall combination of transport demand indicators is substantially different from the dominant patterns observed in the

sample. Similarly, Helsinki occupies a distinctive position within the first cluster. Although it remains structurally similar to Amsterdam, London, and Singapore, its relative separation along the second dimension suggests that it shares the general characteristics of this cluster while maintaining certain unique demand-related features. This finding illustrates one of the main strengths of MDS analysis, namely its ability to reveal subtle structural differences even among cities that belong to the same cluster.

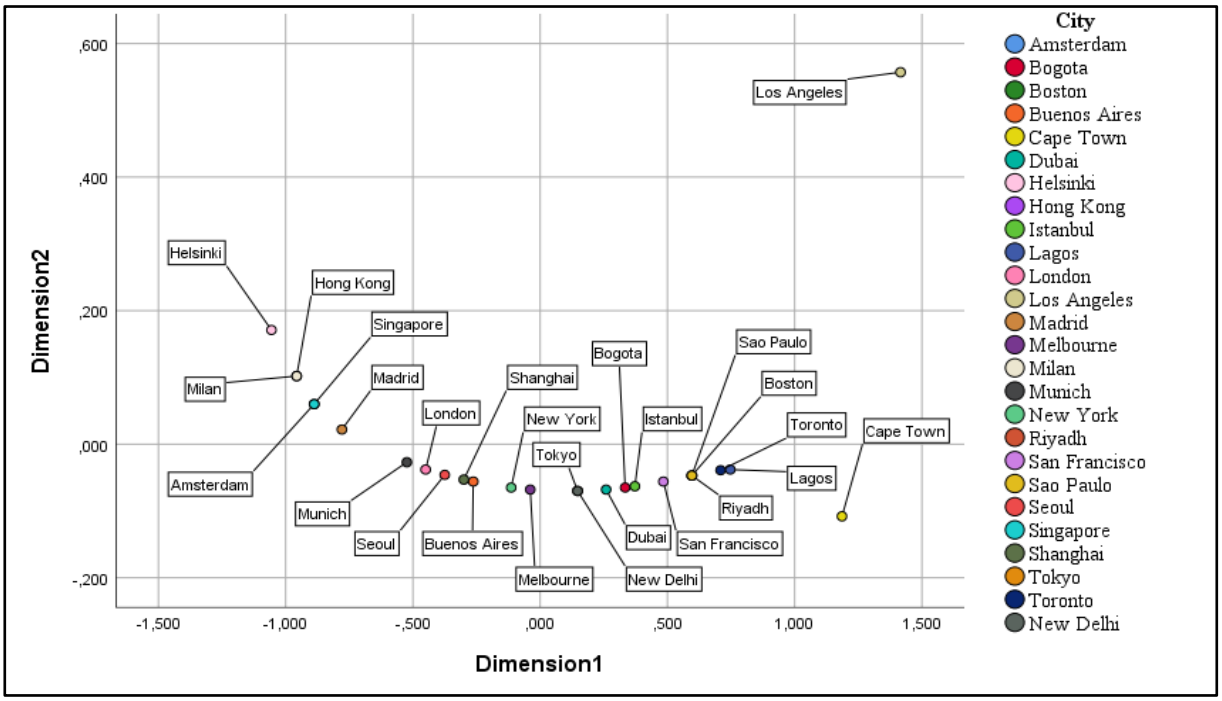


Figure 6. Positions Based on Transport Demand Coordinates.

The hierarchical cluster analysis, carried out using Ward method, indicates that the cities are grouped into two main clusters. Amsterdam, Singapore, Hong Kong, Milan, Madrid, Helsinki, Melbourne, New York, London, Munich, Buenos Aires, Shanghai, and Seoul form one cluster, reflecting similar transport demand characteristics, whereas Tokyo, New Delhi, Bogotá, Istanbul, Dubai, Lagos, Toronto, Riyadh, São Paulo, Boston, San Francisco, Cape Town, and Los Angeles constitute the second cluster. Notably, Los Angeles merges with the rest of its cluster at a considerably higher linkage distance than the other cities, indicating that it possesses a more distinctive transport demand profile. These findings are consistent with the MDS configuration, in which Los Angeles is also clearly separated from the remaining cities along the second dimension. Moreover, these clusters are found to be consistent with the distribution obtained from the MDS analysis; thus, the results of both methods align and reinforce one another.

The consistency between the MDS configuration and the dendrogram provides additional evidence that the observed grouping pattern is robust. The repeated separation of Los Angeles across both analytical techniques indicates that its distinctive position is systematic rather than an artefact of the visualization process. Likewise, the stable clustering of Amsterdam, Singapore, Hong Kong, London, Munich, and Seoul suggests that these cities represent a relatively homogeneous transport demand profile within the SMRI framework.

From a tourism perspective, these findings suggest that major tourism destinations differ in the scale of urban mobility and in the structural characteristics of transport demand. In cities with high transport demand, tourist mobility adds additional pressure on urban systems. Cities grouped within the same cluster appear to exhibit comparable levels of readiness in accommodating high mobility demand through similar transport demand profiles. In highly attractive destinations such as Los Angeles, Istanbul, and Tokyo, this situation may exacerbate the mismatch between infrastructure and demand, thereby leading to congestion, delays, and accessibility issues. The distinctive positioning of cities such as Los Angeles indicates that internationally important tourism destinations may experience substantially different demand structures despite sharing similar levels of global tourism importance.

Although tourism variables were not directly analyzed, the results demonstrate that transport demand constitutes an important contextual dimension for understanding sustainable urban mobility across internationally significant tourism destinations.

5.3. Positioning and Clustering for the Innovation Dimension

The Stress-I value (0.026) and the high Tucker coefficient (0.999) obtained from the MDS analysis of innovation dimension indicate that the model demonstrates a high level of fit. The low Stress-I value indicates that the spatial configuration reliably represents the similarities and differences among cities in terms of innovation-related sustainable mobility characteristics. The MDS map in Figure 7 indicates that the cities are clustered into two main groups based on their innovation performance. San Francisco, Singapore, Hong Kong, Helsinki, London, Munich, Amsterdam, Melbourne, Seoul, Dubai, and Madrid are positioned in close proximity, reflecting similar innovation profiles. In contrast, Istanbul, New Delhi, Cape Town, São Paulo, Riyadh, Bogotá, and Lagos constitute the second cluster. Notably, Lagos and Bogotá are clearly separated from the other cities, exhibiting distinctive innovation profiles within the dataset.

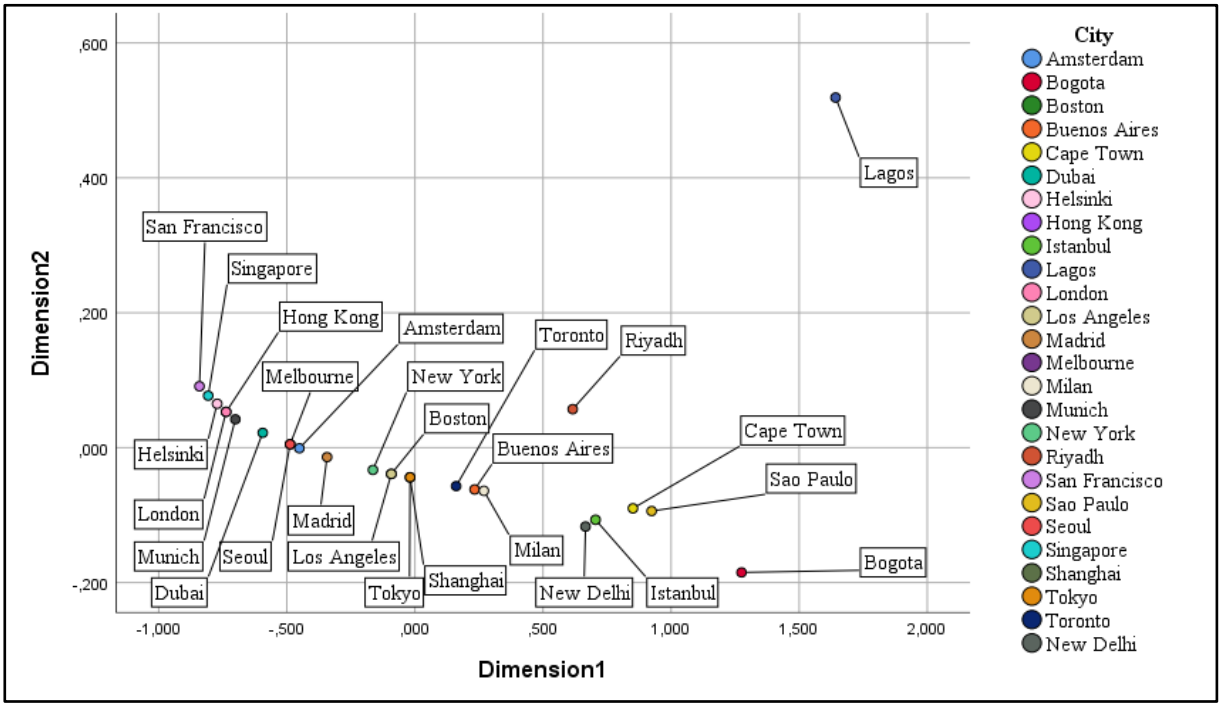


Figure 7. Positions Based on Innovation Coordinates.

The close positioning of cities such as San Francisco, Singapore, Helsinki, London, Amsterdam, and Seoul suggests that they share structurally similar innovation profiles within the SMRI framework. Although these cities differ in terms of economic structure and geographical context, they exhibit comparable levels of readiness in innovation-related mobility components, including digitalization and smart mobility capabilities. Conversely, the clear separation of Lagos and Bogotá indicates that their innovation structures differ substantially from the dominant pattern observed in the sample.

An additional noteworthy finding is that innovation profiles do not necessarily follow geographical proximity or national development levels. For example, Dubai is positioned close to cities such as Singapore, London, and Amsterdam, whereas Tokyo is grouped with a different set of cities. Similarly, North American cities do not form a homogeneous cluster, as San Francisco occupies a different position from Boston, New York, and Los Angeles. These findings suggest that sustainable mobility innovation is shaped primarily by city-level policy priorities, technological adoption, and urban mobility rather than by geographical location or national economic development alone.

The dendrogram generated using the Ward linkage method further supports the findings of the MDS analysis. The dendrogram shows that the cities are largely grouped into two main clusters. Shanghai, Tokyo, Boston, Los Angeles, New York, Buenos Aires, Milan, Toronto, San Francisco, Singapore,

Hong Kong, London, Helsinki, Munich, Melbourne, Seoul, Amsterdam, Dubai, and Madrid form a large cluster characterized by similar innovation profiles, whereas Istanbul, New Delhi, Cape Town, São Paulo, Riyadh, Bogotá, and Lagos constitute the second cluster. Notably, Lagos and Bogotá merge with the rest of their cluster at relatively higher linkage distances than the other cities, indicating that they exhibit more distinctive innovation performance profiles.

From a tourism perspective, the findings indicate that internationally important tourism destinations exhibit different innovation profiles in the field of sustainable mobility. Cities clustered together in the first group appear to share similar levels of readiness in adopting smart mobility technologies, digital transport services, and innovation-oriented transportation policies. According to the SMRI framework, these capabilities include the integration of intelligent transport systems, digital mobility services, data-driven traffic management, and support for emerging mobility technologies. Such characteristics may provide a more adaptive urban mobility environment for destinations experiencing high visitor demand. Conversely, the distinctive positioning of Lagos and Bogotá suggests that innovation-related components of sustainable mobility remain less aligned with the dominant structural profile observed among the other tourism destinations.

5.4. Positioning and Clustering for the Policies Dimension

The Stress-I value (0.024), which is at an acceptable level, and the high Tucker coefficient (0.999) obtained from the MDS analysis of the policies dimension indicate that the model provides an adequate level of fit. The low Stress-I value indicates that the spatial configuration reliably represents the similarities and differences among cities in terms of sustainable mobility policy characteristics. The MDS map in Figure 8 indicates that the cities are clustered into two main groups based on their transportation policies' performance. Dubai, London, Milan, Shanghai, Toronto, Los Angeles, Melbourne, New York, San Francisco, Helsinki, and Istanbul are concentrated in the same region, exhibiting similar policy profiles. In contrast, Madrid, Tokyo, Boston, Singapore, New Delhi, Hong Kong, Seoul, Amsterdam, Cape Town, Munich, Buenos Aires, Lagos, Bogotá, and São Paulo constitute the second cluster. Notably, Bogotá, São Paulo, and Riyadh are clearly separated from the other cities, exhibiting distinctive policy profiles within the dataset.

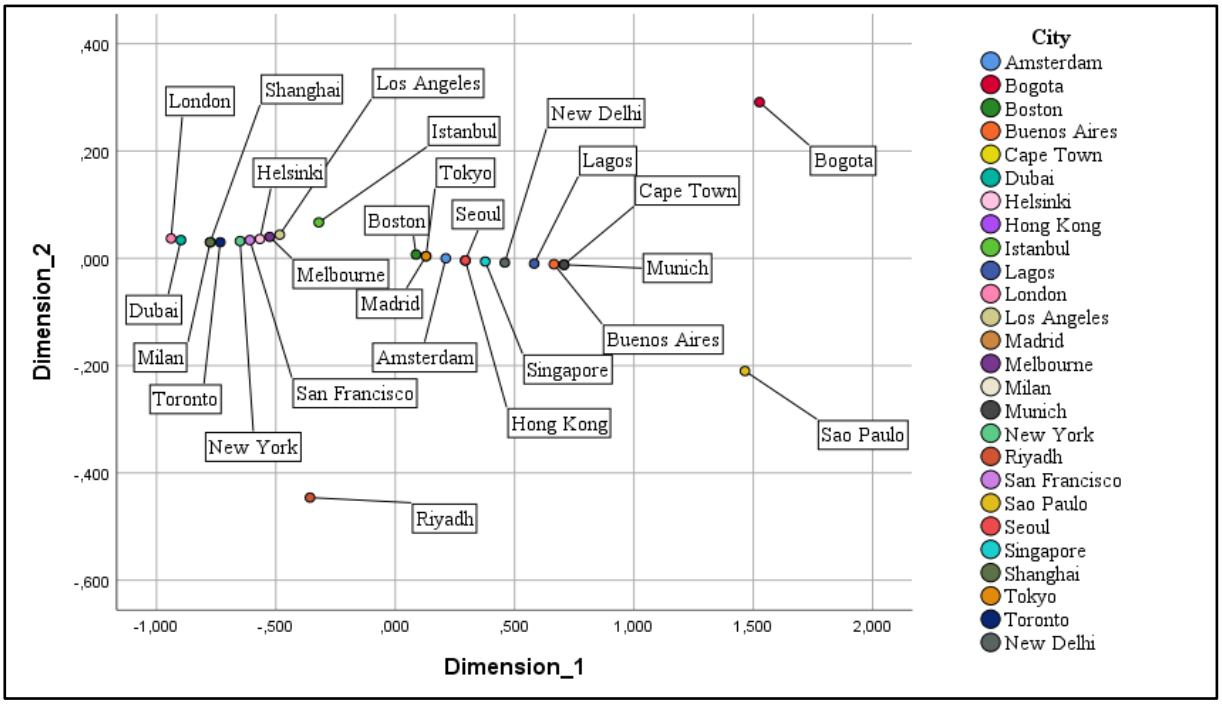


Figure 8. Positions Based on Policies Coordinates.

The close positioning of cities such as London, Dubai, Shanghai, San Francisco, Helsinki, and Melbourne suggests that they share structurally similar sustainable mobility policy profiles within the SMRI framework. Although these cities differ considerably in terms of geographical location, economic

structure, and transportation systems, they exhibit comparable levels of policy readiness regarding sustainable urban mobility. Conversely, the clear separation of Bogotá, São Paulo, and particularly Riyadh indicates that their policy structures differ substantially from the dominant pattern observed across the sample.

An additional noteworthy finding is that sustainable mobility policy profiles do not necessarily correspond to geographical proximity or overall economic development. For example, Amsterdam and Singapore are grouped separately from London despite all three cities being internationally recognised for their advanced sustainable mobility strategies. Similarly, Istanbul is positioned closer to cities such as London and San Francisco than to several European cities. These findings suggest that similarities in sustainable mobility policies are shaped primarily by city-specific governance models, policy priorities, and implementation strategies.

The dendrogram generated using the Ward linkage method further supports the findings of the MDS analysis. The dendrogram shows that the cities are largely grouped into two main clusters. The first cluster comprises Madrid, Tokyo, Boston, Singapore, New Delhi, Hong Kong, Seoul, Amsterdam, Cape Town, Munich, Buenos Aires, Lagos, Bogotá, and São Paulo, whereas the second cluster includes Dubai, London, Milan, Shanghai, Toronto, Los Angeles, Melbourne, New York, San Francisco, Helsinki, Istanbul, and Riyadh. The fact that Bogotá, São Paulo, and Riyadh remain relatively distinct from the dominant policy configurations identified by the MDS analysis further supports the robustness of the observed policy patterns.

From a tourism perspective, the findings suggest that sustainable mobility policies influence the efficiency of urban transportation systems and the management of visitor movements within destinations. Cities clustered in the first group appear to share similar levels of policy readiness in areas such as integrated transport planning, multimodal mobility, and long-term sustainable mobility strategies. According to the SMRI framework, these policy capabilities support better coordination between different transport modes and encourage more balanced urban accessibility. For tourism destinations experiencing high visitor demand, such policy frameworks may facilitate access to attractions beyond traditional tourism hotspots, helping to distribute visitor flows more evenly across urban areas. Conversely, the distinctive policy profiles observed for Bogotá, São Paulo, and Riyadh suggest that differences in policy structures may create greater challenges in coordinating tourism-related mobility with everyday urban transportation, particularly during periods of high visitor concentration.

5.5. Positioning and Clustering for the Finance Dimension

The Stress-I value of 0.022 obtained from the MDS analysis of the finance dimension indicates that the two-dimensional solution represents the data at a near-perfect level. Moreover, the Tucker coefficient of congruence, which is 0.999, indicates that the model exhibits a very high level of fit; thus, the overall configuration can be considered highly reliable.

The MDS map in Figure 9 indicates that the cities are clustered into two main groups based on their finance performance. Amsterdam, Munich, San Francisco, Madrid, São Paulo, Helsinki, Los Angeles, New York, Boston, Tokyo, and London are concentrated in the same region, exhibiting similar financial profiles. They appear to have stronger, more stable financial support systems; therefore, they tend to be more resilient in sustaining transportation investments. In contrast, Bogotá, Singapore, Milan, Seoul, New Delhi, Dubai, Shanghai, Istanbul, Toronto, Hong Kong, Melbourne, Buenos Aires, Riyadh, Cape Town, and Lagos constitute the second cluster. Notably, Riyadh, Cape Town, and Lagos are clearly separated from the other cities, exhibiting distinctive financial profiles within the dataset.

The close positioning of cities such as Amsterdam, London, Munich, San Francisco, Tokyo, and Helsinki suggests that they share structurally similar financial profiles within the SMRI framework. Although these cities differ in terms of economic size and geographical location, they exhibit comparable levels of financial readiness for supporting sustainable mobility investments. Conversely, the clear separation of Riyadh, Cape Town, and Lagos indicates that their financial structures differ substantially from the dominant pattern observed across the sample.

An additional noteworthy finding is that financial profiles do not necessarily correspond to overall sustainable mobility performance or geographical proximity. For example, Singapore is grouped separately from several cities that perform strongly in other SMRI dimensions, whereas São Paulo is positioned close to Amsterdam and London despite notable differences in overall sustainable mobility readiness. These findings suggest that the financial dimension reflects differences in investment structures and funding capacity rather than overall mobility performance alone.

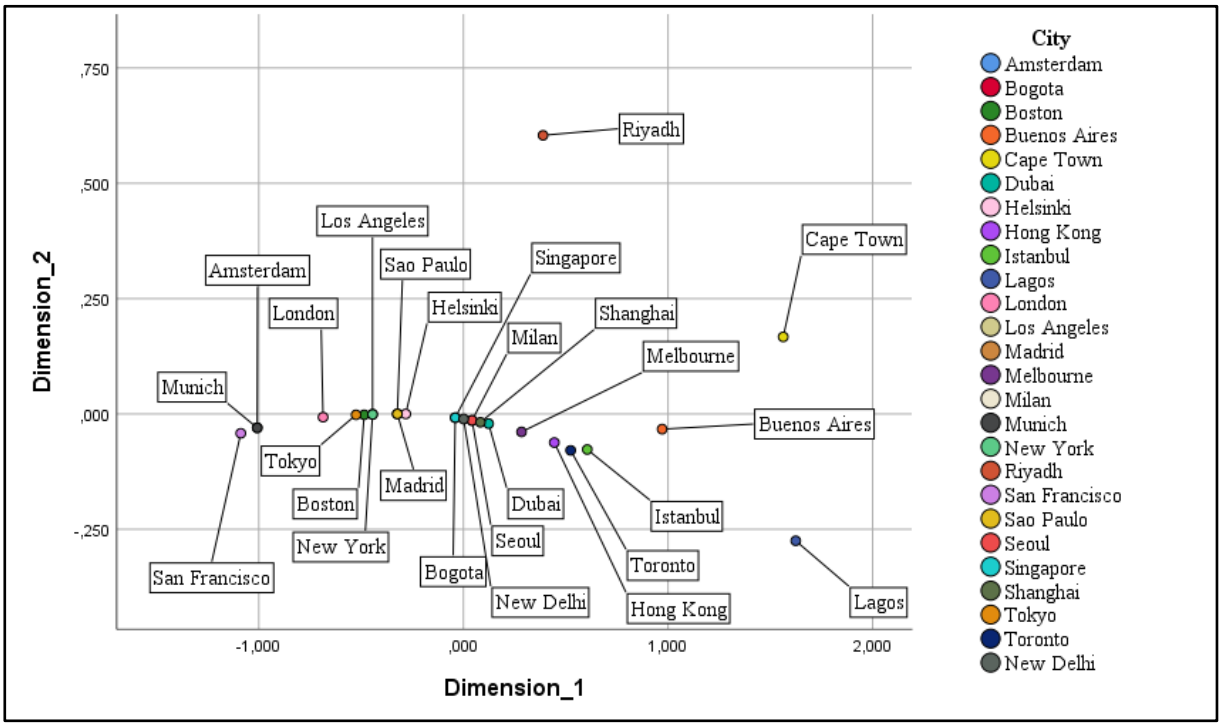


Figure 9. Positions Based on Finance Coordinates.

The dendrogram generated using the Ward linkage method further supports the findings of the MDS analysis. The dendrogram shows that the cities are largely grouped into two main clusters. The first cluster comprises Bogotá, Singapore, Milan, Seoul, New Delhi, Dubai, Shanghai, Istanbul, Toronto, Hong Kong, Melbourne, Buenos Aires, Riyadh, Cape Town, and Lagos, whereas the second cluster includes Amsterdam, Munich, San Francisco, Madrid, São Paulo, Helsinki, Los Angeles, New York, Boston, Tokyo, and London. The distinctive positioning of Riyadh, Cape Town, and Lagos observed in the MDS analysis is also reflected in the clustering results, confirming the robustness of the identified financial patterns.

From a tourism perspective, the findings indicate that internationally important tourism destinations differ considerably in their financial capacity to support sustainable mobility investments. Cities clustered in the higher-performing financial group appear to share similar levels of readiness in financing public transport improvements, smart mobility infrastructure, and long-term sustainable transport projects. According to the SMRI framework, sustained investment capacity is essential for maintaining and upgrading transport systems that accommodate increasing urban and visitor mobility demand. Destinations with stronger financial readiness may be better positioned to expand transport capacity, modernise mobility infrastructure, and sustain service quality during periods of intensive tourist activity. Conversely, the distinctive positioning of Riyadh, Cape Town, and Lagos suggests that differences in financial capacity may constrain the long-term implementation of sustainable mobility initiatives, potentially limiting the ability of these destinations to respond to increasing tourism-related transport demand.

5.6. Positioning and Clustering for the Environment and Energy Dimension

The Stress-I value of 0.019 obtained from the MDS analysis of the environment and energy dimension indicates that the two-dimensional solution represents the data at a near-perfect level. Moreover, the

Tucker coefficient of congruence, which is 0.999, indicates that the model exhibits a very high level of fit; thus, the overall configuration can be considered highly robust and reliable.

The MDS map in Figure 10 indicates that the cities are clustered into two main groups based on their environment and energy performance. Helsinki, Melbourne, London, Munich, San Francisco, Madrid, Amsterdam, Singapore, and Toronto are concentrated in the same region, exhibiting a stronger and more similar profile in terms of environmentally friendly transportation and energy use. In contrast, Seoul, Shanghai, Hong Kong, Buenos Aires, Los Angeles, São Paulo, Bogotá, Cape Town, Boston, New York, Dubai, Tokyo, Milan, Istanbul, New Delhi, Riyadh, and Lagos constitute the second cluster. They are considered to generate greater environmental pressure; thus, they tend to stand out as facing greater sustainability challenges. Notably, Lagos, London, and Riyadh are clearly separated from the other cities, exhibiting distinctive performance profiles in the Environment and Energy dimension.

The close positioning of cities such as Helsinki, Amsterdam, London, Munich, Singapore, and Toronto suggests that they share structurally similar environmental and energy profiles within the SMRI framework. Although these cities differ in terms of geographical location and urban characteristics, they exhibit comparable levels of readiness regarding environmentally sustainable mobility and energy use. Conversely, the clear separation of Lagos and Riyadh indicates that their environmental and energy structures differ substantially from the dominant pattern observed across the sample.

An additional noteworthy finding is that environmental and energy performance does not necessarily correspond to overall sustainable mobility performance or geographical proximity. For example, London and Singapore are positioned within the leading environmental cluster, whereas Tokyo and Seoul appear in a different configuration despite their strong overall sustainable mobility performance. These findings suggest that progress in environmentally sustainable mobility depends primarily on city-specific environmental policies, energy transition strategies, and the adoption of low-carbon transport systems.

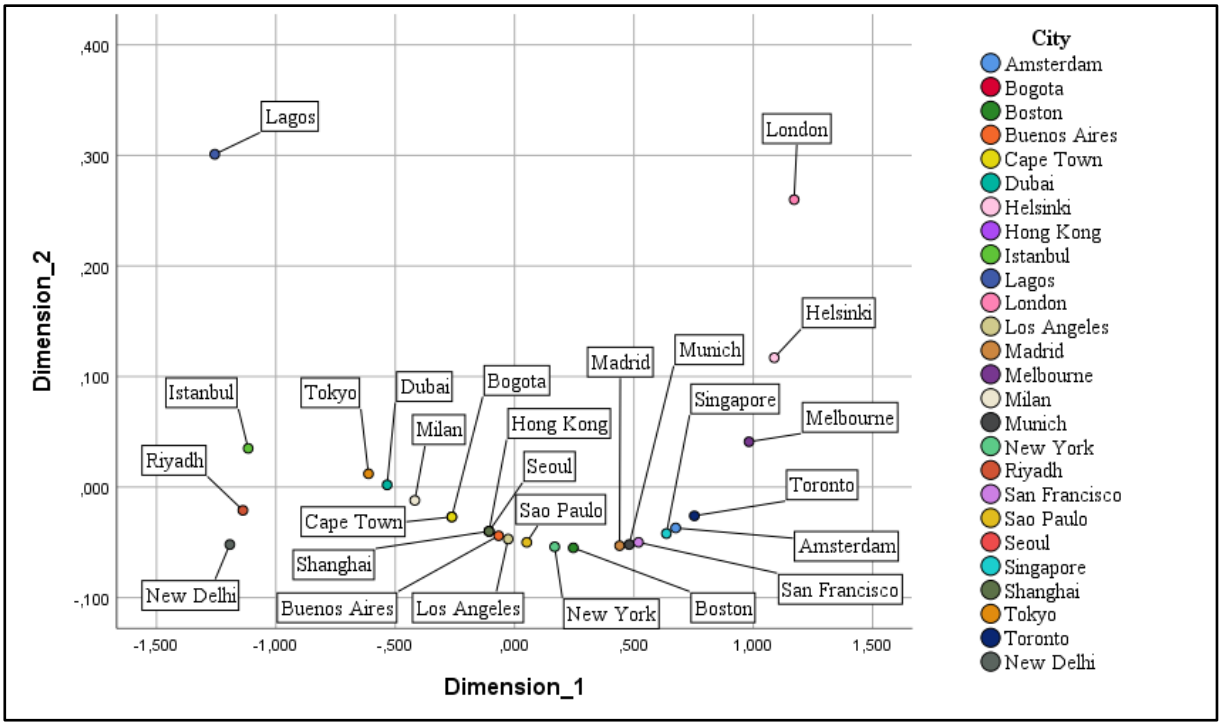


Figure 10. Positions Based on Environment and Energy Coordinates.

The dendrogram generated using the Ward linkage method further supports the findings of the MDS analysis. The dendrogram shows that the cities are largely grouped into two main clusters. The first cluster comprises Seoul, Shanghai, Hong Kong, Buenos Aires, Los Angeles, São Paulo, Bogotá, Cape Town, Boston, New York, Dubai, Tokyo, Milan, Istanbul, New Delhi, Riyadh, and Lagos, whereas the second cluster includes Helsinki, Melbourne, London, Munich, San Francisco, Madrid, Amsterdam, Singapore, and Toronto. The distinctive positioning of Lagos and Riyadh identified in the MDS analysis

is also reflected in the hierarchical clustering results, confirming the robustness of the observed environmental and energy patterns.

From a tourism perspective, the findings indicate that internationally important tourism destinations exhibit different levels of readiness in integrating environmentally sustainable mobility into their urban transport systems. Cities clustered in the leading group appear to share similar capabilities in promoting low-emission transport, energy-efficient mobility systems, and environmentally oriented transport policies. According to the SMRI framework, these characteristics contribute to reducing the environmental impacts of urban mobility while supporting the transition toward more sustainable transport systems. For destinations receiving large numbers of visitors, such capabilities may help mitigate tourism-related transport emissions and improve the environmental sustainability of visitor mobility. Conversely, the distinctive positioning of Lagos and Riyadh suggests that environmental and energy-related components of sustainable mobility differ more substantially from the dominant structural profile observed among the other tourism destinations, potentially creating greater challenges in balancing increasing visitor mobility with environmental sustainability objectives.

5.7. Positioning and Clustering for the Total Scores

As shown in Table 5, the Stress-I value of 0.028 from the MDS analysis of the total scores dimension indicates that the two-dimensional solution fits the data well. Moreover, the Tucker coefficient of congruence of 0.999 indicates a high degree of fit; thus, the overall configuration can be considered reliable and well-structured.

Table 5. Stress and Fit Measures for Total Scores

Normalized Raw Stress	.00078
Stress-I	.02786[a]
Stress-II	.04895[a]
S-Stress	.00272[b]
Dispersion Accounted For (D.A.F.)	.99922
Tucker's Coefficient of Congruence	.99961

PROXSCAL minimizes Normalized Raw Stress.
a. Optimal scaling factor = 1.001.
b. Optimal scaling factor = 1.009.

The MDS map in Figure 11 indicates that the cities are clustered into two main groups based on their overall sustainable mobility readiness performance. Amsterdam, Hong Kong, Helsinki, London, Munich, Singapore, Madrid, San Francisco, Melbourne, Tokyo, Los Angeles, Seoul, Shanghai, New York, Milan, Dubai, Boston, and Toronto are concentrated in the same region, exhibiting similar overall performance profiles. They demonstrate a more advanced performance across multiple dimensions, including transport supply and demand, smart transportation systems, as well as sustainable transportation policies and investments. In contrast, Bogotá, Cape Town, São Paulo, New Delhi, Buenos Aires, Istanbul, Riyadh, and Lagos constitute the second cluster reflecting relatively lower and more heterogenous levels of sustainable mobility readiness. Notably, Lagos, Riyadh, and, to a lesser extent, Cape Town are clearly separated from the other cities, exhibiting distinctive overall sustainable mobility readiness profiles.

The close positioning of cities such as Amsterdam, London, Singapore, Helsinki, Munich, and Hong Kong suggests that they share structurally similar sustainable mobility profiles across the six SMRI dimensions. Although these cities differ geographically and institutionally, they exhibit comparable levels of readiness in developing integrated sustainable mobility systems. Conversely, the clear separation of Lagos, Riyadh, and Cape Town indicates that their overall sustainable mobility structures differ substantially from the dominant pattern observed across the sample.

An additional noteworthy finding is that overall sustainable mobility readiness does not strictly follow geographical proximity or economic development levels. For example, cities from Europe, Asia, and North America are positioned within the same cluster, whereas cities from similar geographical regions are sometimes distributed across different groups. These findings suggest that overall sustainable

mobility readiness reflects the combined outcomes of city-specific governance, investment capacity, innovation, environmental strategies, and transport system performance.

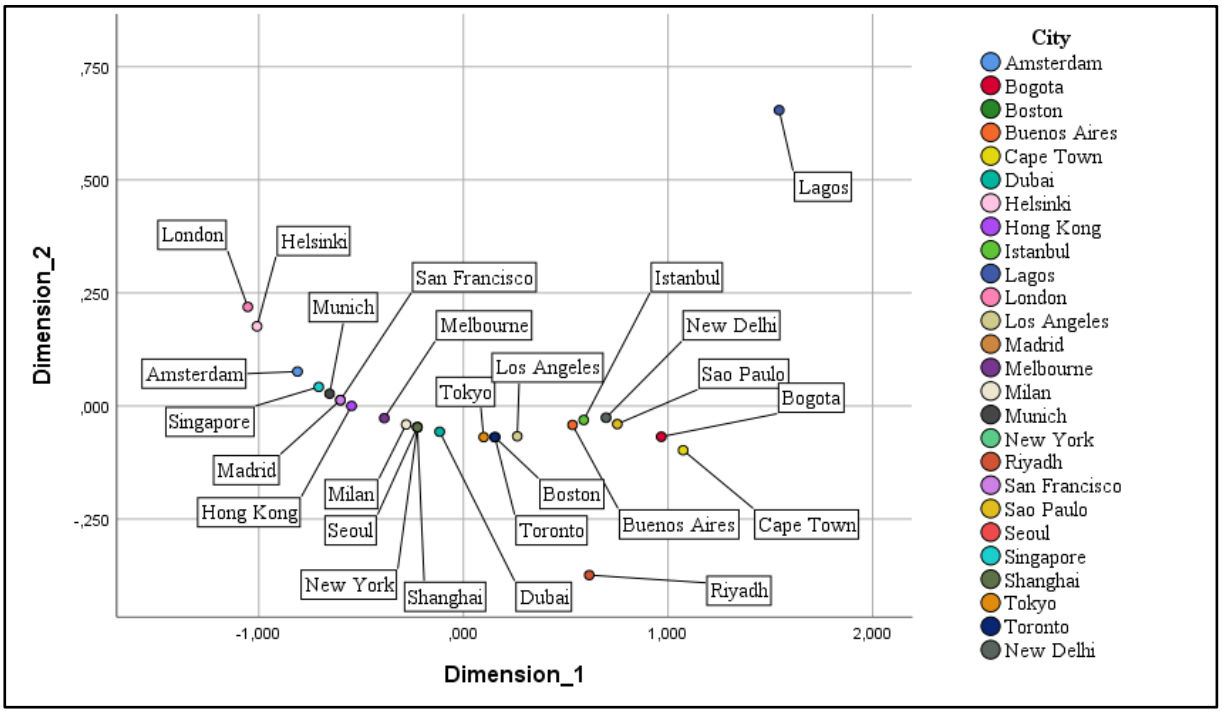


Figure 11. Positions Based on Total Scores Coordinates.

The dendrogram generated using the Ward linkage method (Figure 12) further supports the findings of the MDS analysis. The dendrogram shows that the cities are largely grouped into two main clusters. The first group consists of cities exhibiting relatively high and balanced sustainable mobility readiness, whereas the second group includes cities with more limited and unbalanced performance. The first cluster comprises Boston, Toronto, Tokyo, Los Angeles, Seoul, Shanghai, New York, Milan, Dubai, Melbourne, Helsinki, London, Munich, Singapore, Madrid, San Francisco, Hong Kong, and Amsterdam, whereas the second cluster includes Bogotá, Cape Town, São Paulo, New Delhi, Buenos Aires, Istanbul, Riyadh, and Lagos. The distinctive positioning of Lagos, Riyadh, and Cape Town identified in the MDS analysis is also reflected in the hierarchical clustering results, confirming the robustness of the overall sustainable mobility patterns.

From a tourism perspective, the findings indicate that internationally important tourism destinations exhibit substantial differences in their overall sustainable mobility readiness. Cities clustered in the higher-performing group appear to share stronger capabilities across multiple dimensions, including transport infrastructure, demand management, innovation, policy implementation, financial capacity, and environmental sustainability. According to the SMRI framework, these complementary capabilities contribute to the development of integrated urban mobility systems capable of supporting both everyday travel and increasing visitor mobility demand. For destinations experiencing high tourist flows, such integrated mobility systems may improve accessibility between airports, accommodation businesses, attractions, and public transport networks while supporting a more balanced spatial distribution of visitors. Conversely, the distinctive positioning of Lagos, Riyadh, and Cape Town suggests that lower overall sustainable mobility readiness may create greater challenges in accommodating tourism-related mobility demand, particularly where weaknesses occur simultaneously across multiple dimensions.

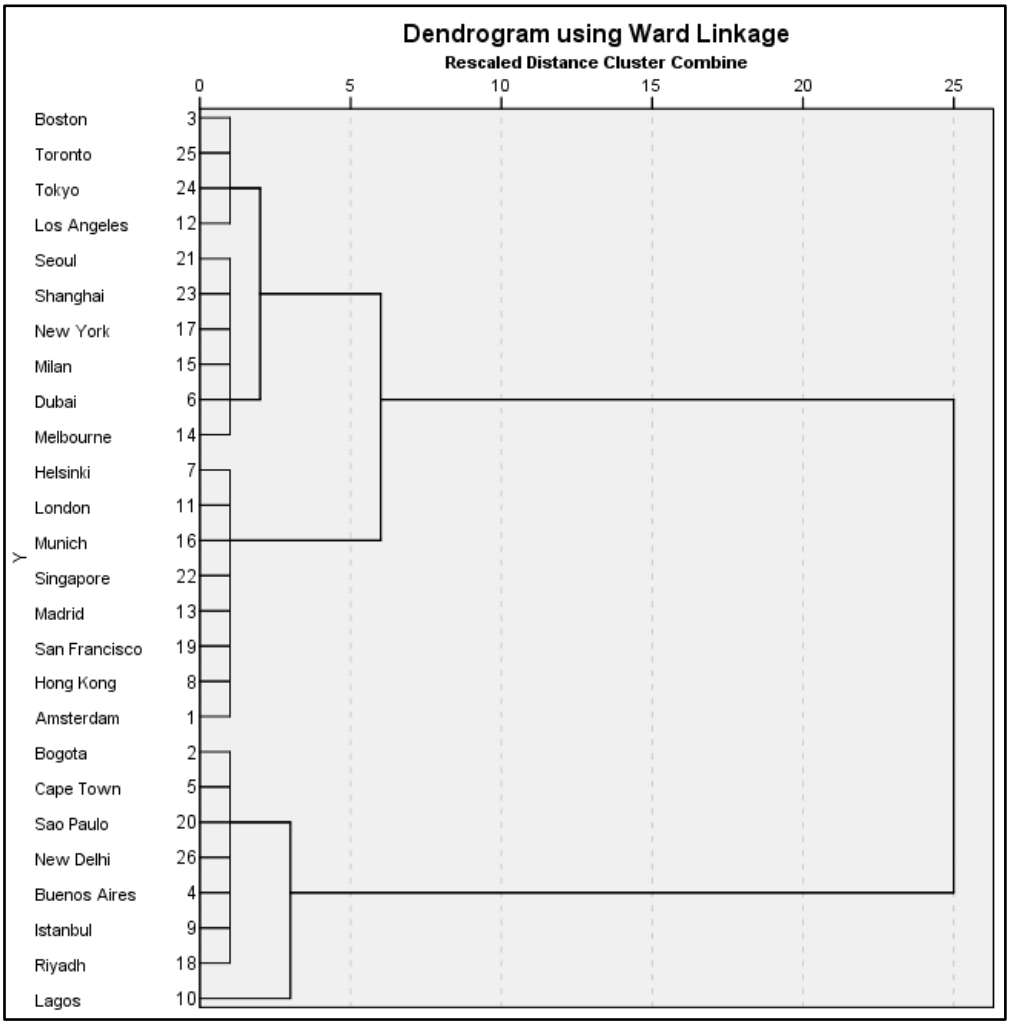


Figure 12. Hierarchical Cluster Analysis Based on Total Score Coordinates.

The findings of this study reveal that sustainable mobility plays a comprehensive and decisive role in the performance of tourism destinations. When transport supply and demand, innovation, policies, finance, and environment and energy dimensions are evaluated together, these elements form an interconnected system that complements its individual components; thus, the effectiveness of this system directly influences the accessibility of destinations, the quality of the tourist experience, and overall competitiveness. Through robust transportation infrastructure, effective demand management, advanced technological applications, and smart, sustainable transportation policies, cities such as London, Singapore, Amsterdam, and Hong Kong appear to be better positioned to manage high tourist flows in a more balanced and sustainable manner. Conversely, in cities where these dimensions perform more poorly, tourist demand is likely to put pressure on transportation systems, thereby exacerbating accessibility problems and leading tourism activities to concentrate in specific areas; as a result, this may negatively affect the overall sustainability of tourism.

Overall, the findings demonstrate that sustainable mobility readiness is a multidimensional construct shaped by the combined performance of transport supply, transport demand, innovation, policies, finance, and environment and energy. The integration of these dimensions distinguishes cities with more balanced and comprehensive mobility systems from those exhibiting more fragmented mobility structures. Within the context of internationally important tourism destinations, these differences provide valuable insights into the varying levels of preparedness of urban mobility systems to accommodate increasing visitor mobility demand while supporting broader sustainability objectives.

6. Discussion

The findings of this study indicate that major tourism destinations exhibit different sustainable mobility profiles across the six dimensions of the SMRI. The results reveal substantial differences in the level and structure of sustainable mobility readiness among internationally important tourism destinations. This differentiation is likely to reflect long-term differences in transport governance, infrastructure investment, technological adoption, and environmental priorities. While many of the cities included in the analysis are globally important tourism destinations, the MDS and clustering results demonstrate that comparable tourism significance does not necessarily correspond to similar sustainable mobility structures. This finding extends previous studies, which have predominantly examined transportation–tourism relationships within individual cities or regions, by providing a multidimensional comparative perspective across internationally important destinations.

The literature emphasizes that transportation infrastructure enhances destination attractiveness and that tourism development interacts closely with transportation systems (Kuklina et al., 2022; Lund-Durlacher & Dimanche, 2013). Similarly, this study shows that cities with stronger transport supply characteristics tend to be positioned closer to one another within the multidimensional configuration, indicating comparable levels of sustainable mobility readiness. These findings imply that well-developed transport systems constitute one of the key structural components supporting sustainable urban mobility in major tourism destinations.

The findings related to the transport demand dimension indicate that cities exhibit distinct transport demand profiles, with MDS and cluster analyses identifying two major groups and highlighting Los Angeles as a particularly differentiated city. These differences may reflect varying capacities to accommodate mobility demand generated by both residents and visitors. This interpretation is consistent with the capacity and management challenges frequently emphasized in the literature (Hopkins, 2020; Kuklina et al., 2022). Likewise, the observations of Allis and Fraga (2018) suggest that tourism activities can generate congestion within transportation systems when demand exceeds available capacity. The observed differentiation therefore suggests that the ability of cities to accommodate increasing mobility demand depends on the physical capacity of transport systems and on the interaction between infrastructure provision and demand management. Consequently, cities experiencing similar tourism intensity may nevertheless display substantially different sustainable mobility profiles. This finding complements previous case-based studies by demonstrating that these differences become more apparent when cities are evaluated simultaneously using standardized mobility indicators.

The findings on the innovation, policies, and finance dimensions indicate that sustainable mobility readiness is shaped by the interaction of technological capacity, governance quality, and financial resources. Previous studies have highlighted the importance of smart transportation systems, digitalization, financing mechanisms, and policy support for achieving sustainable mobility (Hopkins, 2020; Vithayaporn et al., 2023; Yigitcanlar et al., 2008). The present study supports these observations while also demonstrating that cities recognised internationally for advanced mobility systems do not necessarily exhibit similar profiles across all three dimensions. Instead, several cities are grouped differently according to their innovation, governance, or financial characteristics. This finding suggests that comparable levels of sustainable mobility readiness may be achieved through different combinations of policy priorities, technological development, and investment strategies. Accordingly, the results extend the existing literature by indicating that there is no single pathway toward sustainable mobility readiness; rather, cities follow different development trajectories depending on their institutional and financial contexts.

The findings on the environment and energy dimension further demonstrate that cities differ considerably in their environmental readiness for sustainable mobility. Previous studies emphasize that transportation is one of the major contributors to tourism-related carbon emissions and environmental degradation (Allis & Fraga, 2018; Hopkins, 2020; Lund-Durlacher & Dimanche, 2013). Consistent with these studies, the present research identifies two distinct environmental and energy profiles among internationally important tourism destinations. However, the differentiation observed in this dimension is likely to reflect differences in the pace of low-carbon transport transition, environmental policy implementation, renewable energy integration, and city-specific sustainability strategies. These findings

therefore support previous conceptual studies while extending the literature by demonstrating that environmental and energy readiness varies considerably even among cities with similar international tourism importance.

Overall, the findings demonstrate that sustainable mobility readiness is a multidimensional phenomenon shaped by the combined interaction of transport supply, transport demand, innovation, policies, finance, and environment and energy. These dimensions collectively determine the overall sustainable mobility profiles of cities. This multidimensional perspective helps explain why cities with similar tourism importance may nevertheless exhibit substantially different sustainable mobility characteristics.

Compared with previous studies, which have predominantly focused on individual destinations, transportation modes, or specific aspects of sustainable mobility, the present study provides a broader comparative assessment based on standardized SMRI indicators. By combining MDS and hierarchical clustering analyses, the study identifies common patterns and distinctive city profiles that are not readily observable through conventional analytical approaches. Consequently, the study extends the existing transportation–tourism literature by offering a comparative framework for evaluating sustainable mobility characteristics across internationally important tourism destinations. Finally, these findings contribute to the growing literature by demonstrating that sustainable mobility readiness should be understood as a multidimensional urban characteristic whose implications extend beyond transportation systems alone and provide valuable insights for understanding the varying levels of preparedness of major tourism destinations to accommodate increasing visitor mobility while supporting broader sustainability objectives.

7. Conclusion and Recommendations

This study examines how the dimensions of the SMRI differ across leading tourism cities in the top 50 most visited countries worldwide and evaluates the multidimensional relationship between transportation systems and tourism performance using MDS and hierarchical cluster analyses. Accordingly, the findings reveal that sustainable mobility constitutes a fundamental component of urban transportation and provides a useful framework for comparing tourism destinations according to their mobility readiness.

The analysis results indicate that cities display distinct sustainable mobility profiles across the transport supply, transport demand, innovation, policies, finance, and environment and energy dimensions. Cities with similar performance levels are consistently grouped together in both the MDS maps and hierarchical clustering results, indicating comparable sustainable mobility characteristics. From a tourism perspective, these differences suggest varying levels of preparedness to support sustainable tourist mobility. Therefore, the findings indicate that sustainable mobility should be considered an important component of tourism planning and destination management.

When the analysis results are evaluated overall, it is observed that the cities are consistently grouped into two main clusters across the MDS maps and Ward's hierarchical clustering analyses. One cluster generally comprises cities with relatively similar and higher sustainable mobility readiness profiles, whereas the other includes cities that exhibit comparatively lower or more differentiated performance across the evaluated dimensions. Notably, Lagos clearly diverges from the other cities across almost all dimensions; thus, it tends to stand out as the most distinct case in the overall analysis.

When evaluated by sub-dimensions, it is determined that all six SMRI dimensions successfully distinguish cities according to their sustainable mobility characteristics, although the degree of differentiation varies across dimensions. Transport supply, finance, and environment and energy produce particularly clear groupings, while the policies dimension exhibits relatively greater heterogeneity. Overall, the findings confirm that sustainable mobility is a multidimensional construct encompassing transport infrastructure, mobility demand, innovation, governance, financing, and environmental performance.

Based on the findings, several policy recommendations can be proposed to enhance sustainable mobility in leading tourism destinations. First and foremost, cities exhibiting relatively lower sustainable mobility readiness should prioritize improvements in the dimensions where they demonstrate weaker performance. In this regard, increasing investments in renewable energy, promoting environmentally

friendly public transportation systems, and implementing policies aimed at reducing carbon emissions are of critical importance. Furthermore, strengthening transportation supply requires integrating different modes of transport. Connectivity between airports, public transportation systems, and micromobility solutions should be ensured to facilitate tourists' intra-destination mobility. In addition, balancing transportation demand both spatially and temporally is essential; thus, smart guidance systems, dynamic pricing, and congestion-monitoring technologies should be used to redirect tourist demand to alternative areas. Moreover, in the innovation dimension, the widespread adoption of real-time information systems, smart ticketing, and data-driven transportation management applications is necessary. Such applications have the potential to improve tourists' access to transportation services and support more efficient mobility management within destinations. Concerning the finance dimension, the pronounced differences among cities highlight the need for strong financial mechanisms to support sustainable transportation projects. Therefore, it is recommended to develop public–private partnerships, leverage green financing instruments, and tap into international funding sources. At the same time, the heterogeneous nature of the policies dimension underscores the importance of governance and planning processes. Policies promoting low-carbon transportation systems, incentives for electric vehicles, and the expansion of public transportation may contribute to improving environmental sustainability while supporting the long-term attractiveness and competitiveness of tourism destinations. Given that cities exhibit different sustainable mobility profiles across the six dimensions, policy interventions should be tailored to each city's specific strengths and weaknesses rather than adopting a one-size-fits-all approach. Finally, best practices from high-performing cities such as Amsterdam, London, and Helsinki can serve as valuable benchmarks for others. The integrated transportation policies, environmentally friendly technologies, and innovative financing models implemented in these cities can be adapted by other destinations; therefore, they provide a practical roadmap for achieving sustainable urban mobility.

Recommendations for Future Research

Although this study addresses sustainable mobility patterns across leading tourism destinations through a comparative, multidimensional approach, it also identifies certain limitations and avenues for future research. First, future studies may benefit from analyzing sustainable mobility dimensions alongside tourism data, such as tourist arrivals, overnight stays, and tourism revenues, thereby enabling a more concrete and measurable understanding of the association between sustainable mobility and tourism outcomes. In addition, future studies may employ explanatory approaches, such as panel data models or structural equation modeling, to examine the direction and magnitude of these relationships. Second, this study evaluates cities within a static framework. Therefore, future research could adopt time-series or panel data analyses to examine the dynamic nature of changes in sustainable mobility performance and their implications for tourism destinations over time. Third, while this study focuses on cities' overall performance, it does not consider intra-urban spatial variation. In this regard, future research based on urban sub-regions or specific tourist attraction areas could provide a more detailed understanding of the interaction between transportation and tourism. Fourth, this study relies on quantitative methods. However, future research could employ mixed methods approaches, supported by qualitative techniques such as in-depth interviews or stakeholder evaluations, thereby contributing to a deeper understanding of policy and governance dimensions and providing practical insights into the implementation of sustainable mobility strategies in tourism destinations. Finally, comparative analyses across different types of cities, such as coastal destinations, heritage cities, and metropolitan areas, could further enrich the understanding of how sustainable mobility characteristics vary across different tourism destination types; therefore, such studies would offer more nuanced, destination-specific, and context-specific insights.

Declaration of Author(s) Contribution

The author(s) contributed equally to the study.

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Conflict of Interest Statement

There is no conflict of interest with any institution or person within the scope of the study.

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During the preparation of this manuscript, the author(s) used ChatGPT-5.3 for the purpose of improving the language of the text and for translation into English. Additionally, Grammarly was used for proofreading purposes. The author(s) have reviewed and edited the output and take full responsibility for the content of this publication.

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