



The Evolution of Transport Infrastructure in European Cities: A Comprehensive Study on Sustainable and Smart Mobility Projects

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Abstract

This study analyses the evolution of sustainable urban mobility priorities across European cities by examining CIVITAS initiative projects from 2002 to 2024. The research investigates how project themes and investment patterns have responded to changing urban mobility needs, analysing data from 69 projects across 10 thematic areas in 28 countries. Using descriptive statistics and trend analysis, the study confirms two hypotheses: foundational thematic areas (Collective Transport, Clean Vehicles, and Integrated Planning) remain consistently prioritised, while cities increasingly shift towards technology-driven solutions rather than traditional infrastructure-heavy approaches. The analysis reveals significant variations in project participation across European countries, with Italy and Spain showing the highest engagement. Investment patterns demonstrate vulnerability to external factors like economic crises and COVID-19. The findings suggest a need to balance technological innovation with traditional mobility solutions while ensuring resilient funding mechanisms for sustainable urban transport initiatives.

Keywords: smart cities, smart mobility, sustainable mobility, transport infrastructure, CIVITAS initiative, urbanisation.

1. Introduction

The increased need for efficient, accessible, and sustainable mobility solutions has shaped the evolution of transport infrastructure in cities of Europe. Under the influence of rapid urbanisation and increased environmental concerns, European cities tend to face serious challenges related to many adverse factors, such as congestion, air pollution and dependence on fossil fuels. In response, governments and urban planners have prioritised the construction of transport infrastructure responsive to the increasing population and the aspirations of the world's sustainability. This has led to the adoption a smart mobility approach in which modern technology is incorporated into the existing modes of transportation.

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In the last few decades, numerous European projects have emerged that focus on smart and sustainable mobility to update the transport infrastructures to be efficient and sustainable, capable of mitigating climate change and enhancing the quality of life for urban populations. Projects range from provisions for hybrid and electric vehicles in the public transport systems to more complex systems whereby dynamic data, shared transport, and green technology work harmoniously to create a complete transport solution.

This article explores how the transport infrastructure in European cities has changed over the years, with particular attention to sustainable and smart mobility projects. Examining case studies and critical initiatives provides insights into how cities transform their transport systems to become more adaptable, resilient, and environmentally friendly.

The evolution of projects under the CIVITAS initiative was tracked to identify shifts in key thematic areas using linear trend analysis to uncover patterns in project focus over time, such as increasing attention to emerging technologies, sustainability priorities, or policy-driven changes (*CIVITAS Initiative: official website*, 2024). This allows us to determine how urban mobility solutions have evolved and predict future trends. Furthermore, this article discusses the risks and prospects of such undertakings and how they can impact the future of European urban mobility.

2. Research context and methodology

2.1. Research Context and Objectives

The transport sector has long been a focal point of urban policy due to its significant impact on economic growth, environmental sustainability, and the overall quality of life. Urban mobility challenges, including traffic congestion, air pollution, and inefficient public transport systems, have prompted policymakers and researchers to explore innovative solutions to create more sustainable and inclusive urban environments.

Many researchers demonstrated that the concept of smart cities, driven by digital technologies, can optimise transport systems, reduce CO₂ emissions, improve energy efficiency, and ensure accessibility for all (Zawieska and Pieriegud, 2018). Another study proposed a framework that uses data from mobile devices to analyse traffic patterns and optimise routing, reducing congestion and travel times. Still, it raised concerns about privacy risks and varying effectiveness in different urban contexts (Behal, Vyas and Pal, 2019). Experts also highlighted the transformative role of smart mobility in addressing urban transport challenges through technology integration and data analytics while pointing out the ongoing concerns regarding social equity and the long-term efficacy of these solutions in diverse settings (Mitięka *et al.*, 2023).

Some researchers provide a comprehensive system of sustainability indicators for road infrastructure initiatives, emphasising the need for a balanced approach that integrates environmental, social and economic indicators, as well as highlighting unresolved issues related to the standardisation of indicators and the problems of their consistent application across regions (Suprayoga *et al.*, 2020). Furthermore, the authors demonstrate that smart mobility is essential for developing sustainable and efficient smart cities by enhancing quality of life, reducing pollution, and improving accessibility, but emphasise the need for better integration of diverse transportation solutions, data privacy protection, and more vital collaboration with the private sector (Brčić *et al.*, 2018).

Many studies in this field concern regional cases, particularly in Asian countries. Innovative mobility initiatives in Singapore and Tokyo are analysed in terms of technological integration, public transport systems, and sustainability efforts, highlighting the use of the Internet of Things (IoT) and data analytics to enhance urban mobility, improve efficiency, and promote eco-friendly transport, while also addressing unresolved challenges like congestion, equitable access, and long-term social equity impacts (Wolniak and Grebski, 2023). The overview of smart cities in Asia emphasises the need for innovative solutions to address urbanisation challenges, such as congestion, pollution, and resource management while exploring strategies to improve livability, sustainability, and economic growth in the region (Joo and Tan, 2020).

Research on European cities highlights the integration of electric mobility in reducing emissions, improving air quality, and developing charging infrastructure while addressing challenges like high EV costs and battery disposal (Ruggieri *et al.*, 2021). Additionally, studies about smart mobility initiatives in cities like Copenhagen and Barcelona focus on leveraging data analytics and IoT to enhance urban mobility and sustainability but face ongoing issues such as equitable access and integration of different transport modes (Wolniak, 2023).

The authors of another study examine the potential and challenges of implementing smart mobility and public transport solutions in urban and rural settings, highlighting how new technologies can improve transport infrastructure by increasing efficiency and addressing issues of social equality (Porru *et al.*, 2020), discuss the role of smart mobility in urban environments, emphasising the importance of collaborative approaches to create inclusive transport systems (Benevolo, Dameri and D'Auria, 2016). Other scientists present a comparative study of smart mobility initiatives in Italian metropolitan areas, focusing on key indicators and best practices while addressing sustainability challenges (Battarra *et al.*, 2018). Other researchers provide an overview of the current technologies underlying smart mobility solutions, highlighting the need for integration into urban planning to combat congestion and pollution (Savithramma, Ashwini and Sumathi, 2022). Some researchers evaluate innovative smart mobility solutions designed to improve urban transport, highlighting their effectiveness in addressing congestion and emissions and emphasising the need for stakeholder collaboration (Butler, Yigitcanlar and Paz, 2020). In addition, the scientists advocate a holistic approach to integrating smart mobility in cities, addressing infrastructure gaps and the importance of stakeholder engagement for successful implementation (Peprah, Amponsah and Oduro, 2019), and analyse sustainable and smart mobility strategies in different countries, highlighting the importance of individual solutions and local context to achieve sustainable mobility goals (Kunyska *et al.*, 2023).

Many researchers consider different aspects of sustainable transport, emphasising the importance of integrated approaches in achieving low-carbon and socially inclusive mobility. In the Netherlands, pathways to low-carbon transport transitions are analysed using a multi-level perspective, highlighting the need for coordinated efforts across macro, meso, and micro levels to implement sustainable passenger transport policies and technologies (Köhler, Turnheim and Hodson, 2020). Similarly, a study in South Tyrol concludes that environmental awareness alone is insufficient for sustainable mobility, requiring infrastructure improvements, public engagement, and comprehensive transport policies (Isetti *et al.*, 2020). Sustainable evaluation methods for transport investments are examined through a multi-criteria and cost-benefit analysis of a highway project in Italy,

stressing the consideration of economic, environmental, and social impacts in decision-making (Henke, Carteni and Di Francesco, 2020). Urban design scenarios in Madrid's "Centro" district are analysed to assess walking accessibility, emphasising the need to cater to residents and tourists to improve walkability and create a more sustainable urban environment (Ortega *et al.*, 2021). Furthermore, road infrastructure projects are assessed for social sustainability, with recommendations for more inclusive and community-focused development (Vijayakumar *et al.*, 2024). Finally, the impact of rural transportation infrastructure on socio-economic development in low- and middle-income countries is reviewed, underscoring the critical role of integrated transport policies in improving access to markets, education, and health services for sustainable development (Kaiser and Barstow, 2022).

These studies show that smart city technologies can optimise transport systems, reduce CO₂ emissions, and improve energy efficiency. However, challenges remain in standardisation and ensuring equitable access. For example, data from mobile devices can optimise traffic but raise privacy concerns and show varying effectiveness in different urban areas. Researchers emphasise the need for balanced sustainability indicators, stronger private-public partnerships, and the integration of diverse transportation systems. Although progress has been made, especially in cities like Singapore and Copenhagen, social equity and long-term efficacy still need further exploration.

Current research often lacks a global perspective, focusing mainly on regional case studies, which limits broader applicability. There's also a need for universal standards and more attention to social equity issues.

Research is growing needed to ensure equitable access to smart city technologies, addressing social equity and inclusion challenges in diverse urban environments. Developing universal standards for smart mobility solutions is crucial to enable consistent implementation and scalability across regions. Cross-regional analysis, particularly between developed and developing countries, is essential to identify unique challenges and opportunities for smart mobility adoption. Finally, further evaluation of private-public partnerships is required to explore their role in driving innovation and ensuring sustainable, long-term smart city development.

The CIVITAS initiative was selected as the foundation for this analysis due to its significant role and extensive reach in promoting sustainable urban transport and mobility across Europe. Established in 2002, CIVITAS has facilitated over 60 projects in more than 100 cities, enabling the tracking of various trends and innovative strategies in urban transport management. The initiative encompasses many projects that address multiple facets of urban mobility, allowing for insights into long-term trends and shifts in transportation priorities. Its project data is accessible and transparent, supporting rigorous analysis of qualitative and quantitative metrics.

The CIVITAS initiative includes various projects to advance sustainable urban mobility and smart city management across Europe, each contributing valuable insights and solutions for urban challenges. Some research papers are devoted to the general concept of the initiative (Villanueva *et al.*, 2013); in others, the successful projects in the initiative's framework are investigated. A study on French cities' engagement with CIVITAS reveals the importance of tailored political approaches for successful sustainable mobility initiatives (Pflieger, 2014). The CIVITAS ECCENTRIC project in Madrid provides lessons in promoting transport equity making mobility more accessible and fair for all citizens (Aparicio, 2023). Bologna's Mobility Credit System encourages

eco-friendly transport by rewarding sustainable behaviours, helping to reduce traffic and pollution (Ramazzotti, Liguori and Dziekan, 2012). These projects demonstrate effective methods for creating healthier, more efficient urban spaces.

CIVITAS is a vital framework for examining the dynamics of key urban mobility sectors, offering a detailed perspective on the progress of sustainable transport initiatives within European cities. Launched by the European Union, it is a flagship program to foster cleaner and improved transport solutions in urban areas. The initiative focuses on integrating advanced mobility technologies, encouraging behavioural changes, and enhancing public involvement in developing urban transport systems. It has backed numerous European projects covering diverse thematic areas, including active mobility, clean vehicles, urban logistics, and road safety.

This study investigates the progression of project themes within the CIVITAS initiative from 2002 to 2024, analysing how the program has responded to evolving urban mobility priorities. It mainly emphasises which thematic areas have gained prominence over time, shifts in investment trends, and the broader implications for sustainable urban mobility policies. Additionally, it assesses the frequency with which different countries have launched projects under the CIVITAS initiative.

The primary goals of this research are to evaluate how consistently CIVITAS projects have addressed various thematic areas over time, identify investment trends within these areas, analyse the influence of external factors on investment priorities, and gauge the involvement of different countries in executing CIVITAS projects.

Two hypotheses were formulated to guide the analysis.

1. Certain foundational thematic areas are increasingly prioritised and remain crucial despite technological advancements or new trends in transportation.
2. Recently, cities pursuing more sustainable transportation are shifting towards technology-driven solutions such as smart mobility and clean vehicles instead of relying on traditional methods like demand management and infrastructure-heavy active mobility strategies.

2.2. Methodology

The data utilised in this study was sourced from the CIVITAS official website, encompassing projects initiated between 2002 and 2024 (*CIVITAS Initiative: official website*, 2024).

Each project was categorised based on its thematic focus areas, including Active Mobility, Clean & Energy-Efficient Vehicles, Smart, Sustainable, Connected and Shared Mobility, and Public Participation & Co-Creation. The analysis included 69 projects across 10 thematic areas in 28 countries.

The research employed descriptive statistics and trend analysis to explore the evolution of thematic focus and investment trends over time. The methodology featured a Thematic Area Frequency Analysis, which tracked how frequently each thematic area was addressed annually. This approach enabled the identification of dominant themes and those that fluctuated in importance. Furthermore, Trend Analysis involved constructing linear trend lines to observe changes in the number of projects associated with each thematic area, helping to pinpoint stable, emerging, and declining interests. The Investment Trend Analysis assessed the total funding allocated to CIVITAS projects each

year, focusing mainly on significant fluctuations or declines. Additionally, to evaluate the influence of external factors, the study compared annual investment levels with the total number of projects, offering insights into how global crises may have shifted urban mobility priorities.

The findings were represented through various visual tools such as line graphs, bar charts, and geographic diagrams, which facilitated the identification of patterns, trends, and anomalies within the data.

One limitation noted in the study is the uneven distribution of projects over the years. Specific periods experienced fewer projects due to factors like economic downturns or changes in EU funding mechanisms, potentially affecting the observed trends.

This study provides significant insights into shifts in urban mobility priorities over the last two decades by analysing how thematic areas within CIVITAS projects have evolved and tracking investment pattern changes. The results highlight an increasing emphasis on smart mobility solutions, public engagement, and behavioural change while revealing a decline in focus on areas like active mobility and urban space management. This research guides future urban mobility initiatives, stressing the need for flexible policies that can adapt to emerging trends and external challenges.

3. Results and discussion

The analysis of project activity from 2002 to 2024 shows varying trends. From 2002 to 2005, the number of projects remained relatively stable, averaging between three to four projects yearly. However, between 2006 and 2012, the numbers fluctuated significantly, with a drop to just one project in 2006, followed by a rise to four projects in 2008. A notable expansion occurred from 2012 to 2015, culminating in a peak of ten projects in 2015. In contrast, from 2016 to 2020, there was a downturn, with the count falling to a low of three projects in both 2020 and 2022. A recovery began in 2023 with ten projects initiated, though this slightly decreased to five in 2024.

The COVID-19 pandemic significantly affected project activity, leading to a sharp decline in 2020. However, recovery started in 2023, indicating a rebound from the disruptions caused by the pandemic, although the numbers have not yet returned to the peak levels seen in 2015 (Fig. 1).

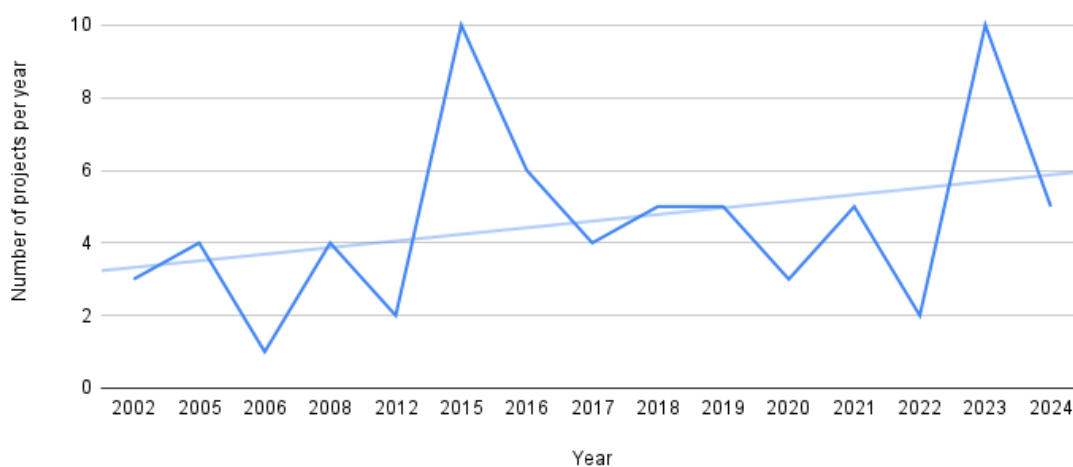


Figure 1: Total number of projects under the CIVITAS initiative from 2002 to 2024
Source of data: (CIVITAS Initiative: official website, 2024)

An analysis of the focus areas within CIVITAS projects from 2002 to 2024 through an evaluation of dominant thematic areas was conducted to gain insights into the evolution of transport infrastructure in European cities (Fig. 2). This analysis reveals which thematic areas and innovative spheres have emerged as key priorities for CIVITAS projects and those that have received less attention, providing a clear picture of trends and focal points in urban transport infrastructure over the years.

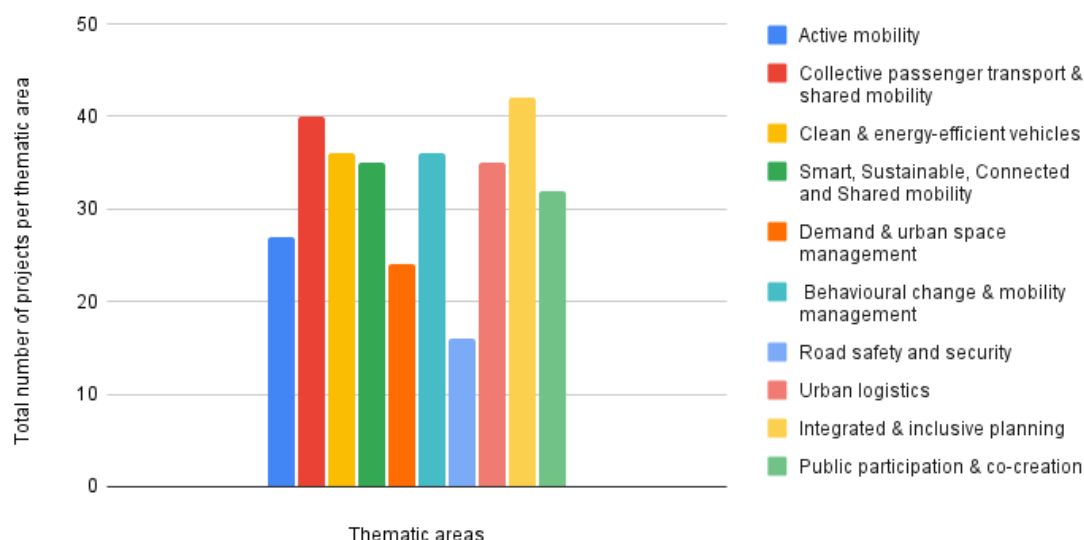


Figure 2: Frequency with which thematic areas are addressed under the CIVITAS initiative from 2002 to 2024

Source of data: (CIVITAS Initiative: official website, 2024)

The thematic area that has been most frequently addressed is Integrated & Inclusive Planning, with a total of 42 projects dedicated to this aspect of urban transport. This prioritisation indicates a keen demand for urban mobility planning that integrates various infrastructure elements to foster inclusiveness, reflecting a trend for comprehensive strategies that attempt to cover a variety of community needs. European cities are placing greater emphasis on strategic, integrated approaches that attempt to balance mobility efficiency with social equity and accessibility.

Following closely is Collective Passenger Transport & Shared Mobility, which includes 40 projects. The ongoing focus on this area is reflective of a policy direction toward shared and collective mobility solutions as an alternative to private car ownership. This trend highlights European policymakers' dedication to decongestion and reducing emissions while fostering sustainable and affordable solutions. Importantly, it also aligns with broader societal trends, such as the growth of the sharing economy and shifting attitudes toward car ownership, especially in urban centres.

Key theme areas of Clean & Energy-Efficient Vehicles and Behavioural Change & Mobility Management, with 36 projects each, underscore the twin-track strategy being followed by most cities. This involves investing in green technology while also trying to modify user behaviour. This synergy reflects a pragmatic realization that technological advancement is not enough and must be complemented with efforts to transform the mindset of the people and transportation behaviour.

Concurrently, Urban Logistics and Smart, Sustainable, Connected & Shared Mobility (each with 35 projects) exhibit an increased appreciation for the vital role goods transport

and digital connection play in getting the city to function. Both themes reflect a forward-looking perspective, anticipating the complexity of the urban lifestyle in the future to be characterized by growing e-commerce, digital platforms, and the need for data-based decision-making.

In comparison, the themes of Public Participation & Co-Creation (32 projects) and Active Mobility (27 projects) are comparatively less prioritized. While their presence indicates recognition of their significance, the fewer number of projects may indicate institutional or pragmatic difficulties in more actively incorporating participatory approaches and non-motorized transportation modes into existing systems. This appears particularly accentuated given growing demands for people-centered, liveable urban environments.

Demand & Urban Space Management (24 projects) and Road Safety and Security (16 projects) are the least addressed areas, suggesting potential gaps. The comparatively low focus on urban space management, safety and security is particularly noticeable, given the historic concerns urban areas have with road accidents and public perceptions of transport safety. This would either suggest implicit assumptions that these issues are being dealt with under other frameworks or competing priorities which have overshadowed them in the CIVITAS agenda.

The spread of thematic priority shows that the CIVITAS portfolio is most driven by system integration, technological innovation, and environmental concerns, with themes such as safety, public involvement, and active mobility receiving less priority. This imbalance is both a challenge and an opportunity because future projects can pick up on these shortfalls to develop more integrated, inclusive, and resilient urban mobility systems.

The analysis of investment trends in CIVITAS projects from 2002 to 2024 indicates notable fluctuations and an overall decline in funding levels. Initially, in 2002, investments reached a high of around €88 million, marking a solid start for the initiative. However, between 2005 and 2012, there was a significant decrease in funding, with a drop to approximately €22 million by 2012. This decline can be largely attributed to the 2008 financial crisis and shifting policy priorities in the European Union, as economic pressure required a reallocation of resources towards economic stabilisation and fiscal adjustment policies.

There was a brief resurgence of investments in 2015 and 2016, which totaled €64 million and €52 million, respectively. This brief resurgence was likely a result of renewed policy focus on sustainable urban development and climate goals, which was in line with the growing salience of environmental issues in EU agendas. However, investments plummeted dramatically from 2017 to 2020, hitting a low of €11 million in 2020. This decline highlights the vulnerability of mobility projects to global crises and geopolitical reconfigurations. More precisely, the synergistic impact of Brexit and the COVID-19 pandemic played a key role in disrupting financing flows. Brexit generated uncertainties around EU-wide collaborations, funding commitments, and long-term mobility planning, while the pandemic diverted substantial fiscal resources towards the public health response, emergency services, and economic recovery initiatives. This episode demonstrates how urban mobility projects, however strategically important they might be, can fall in priority during crises, exposing the volatility of investment commitment in this area.

The sharp rise in investments in 2023, at more than €116 million, is somewhat of an outlier in the data. The peak likely reflects the initiation of delayed projects along with strategic post-pandemic recovery measures, as urban mobility returned to prominence in green recovery strategies, digital transitions, and climate resilience planning. The subsequent fall to approximately €66 million in 2024, though relatively high, suggests a return to normal levels of investment. However, it also raises questions about the stability and long-term continuity of funding for urban transport initiatives (Fig. 3).

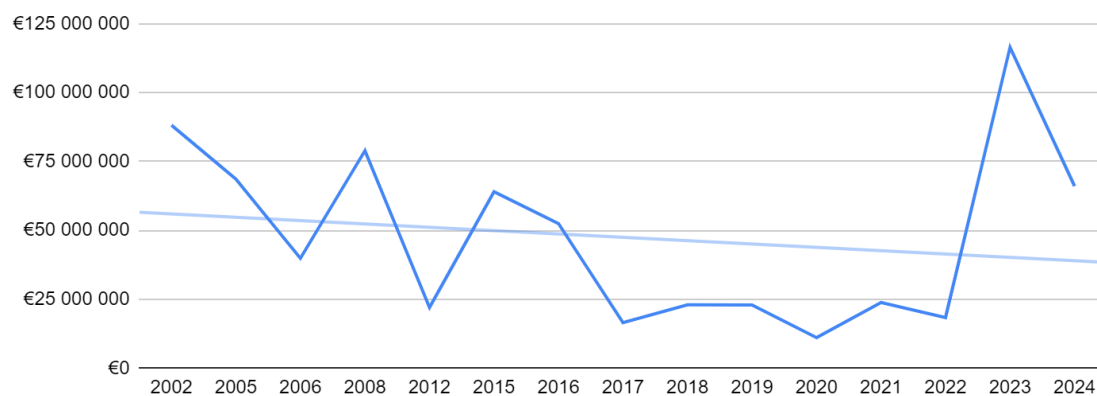


Figure 3: Funding of projects under the CIVITAS initiative from 2002 to 2024
Source of data: (CIVITAS Initiative: official website, 2024)

The fluctuations in CIVITAS investments over the past two decades mirror the broader economic, political, and social contexts influencing urban mobility policy in Europe. This volatility highlights the sensitivity of transport funding to macroeconomic shifts and crisis events, as well as its responsiveness to evolving policy narratives like green recovery and digitalization. This dynamic underscores the necessity for stronger and more adaptive funding mechanisms that can support strategic mobility programs in periods of uncertainty. Sustaining consistent and stable investments is essential to achieving long-term urban sustainability objectives and preventing disruptions that would impede the progressive development of urban mobility systems.

The linear trend analysis of CIVITAS projects indicates a consistent increase in the frequency of several thematic areas, reflecting a growing focus on these elements in urban mobility solutions (Fig. 4).

The rise in Smart, Sustainable, Connected, and Shared Mobility projects reflects not only the impact of technological advancements but also a redefinition of mobility as a service-oriented, integrated, and environmentally responsible system. At the same time, the rise in Behavioural Change & Mobility Management projects indicates a growing understanding that achieving sustainable mobility outcomes relies as much on social and cultural transformations as it does on infrastructure or technology.

There has been a gradual increase in projects focused on Road Safety and Security highlighting the need for safer transportation systems as urban populations grow and regulatory standards tighten.

The emergence of Urban Logistics initiatives recognizes the growing evolving patterns of goods transport, mainly driven by e-commerce, and emphasizes the efforts of cities to balance economic activities with social and environmental sustainability.

The increasing emphasis on Public Participation & Co-Creation constitutes a profound cultural and political shift from conventional top-down transport planning towards

participatory governance systems. Such systems give power to the community to shape the mobility system they depend on, building in inclusiveness and transparency.

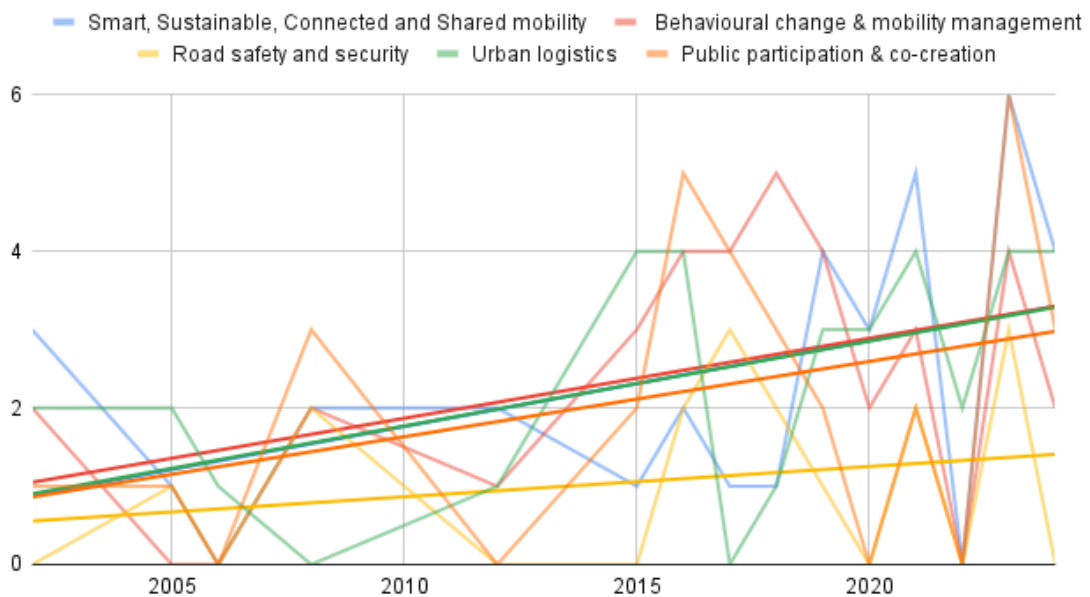


Figure 4: Linear trend analysis: thematic areas addressed with increasing frequency under the CIVITAS initiative from 2002 to 2024

Source of data: (*CIVITAS Initiative: official website, 2024*)

The continuous expansion of such thematic areas shows a paradigmatic shift in the way urban mobility is envisioned and managed on the European continent. Overall, such new project categories reflect a strategic realignment of urban mobility policies towards integrated, user-oriented, and adaptive schemes. This evolution addresses future prospects where green transport is not only clean vehicles and infrastructure improvement but also demand management, community participation, public space preservation, and the integration of new technologies to deal with broader urban issues.

The linear trend analysis of CIVITAS projects has identified three thematic areas that consistently receive attention: Collective Passenger Transport & Shared Mobility, Clean & Energy-Efficient Vehicles, and Integrated & Inclusive Planning. While these areas have not shown significant increases in frequency over time, they consistently rank among the top three topics, highlighting their crucial role in urban mobility strategies (Fig. 5).

Collective Passenger Transport & Shared Mobility: This thematic area remains a key focus within CIVITAS projects, demonstrating a stable commitment to improving public transport and fostering shared mobility solutions. Its enduring popularity is linked to its fundamental role in sustainable urban transport systems and policy efforts aimed at reducing traffic congestion and emissions, alongside the rise of ridesharing and carpooling initiatives.

Clean & Energy-Efficient Vehicles: Projects centred on clean and energy-efficient vehicles continue to be a priority, consistently receiving attention without significant increases in frequency. Their ongoing relevance is driven by strict environmental regulations, electric and hybrid vehicle technology advancements, and their importance within broader climate change initiatives.

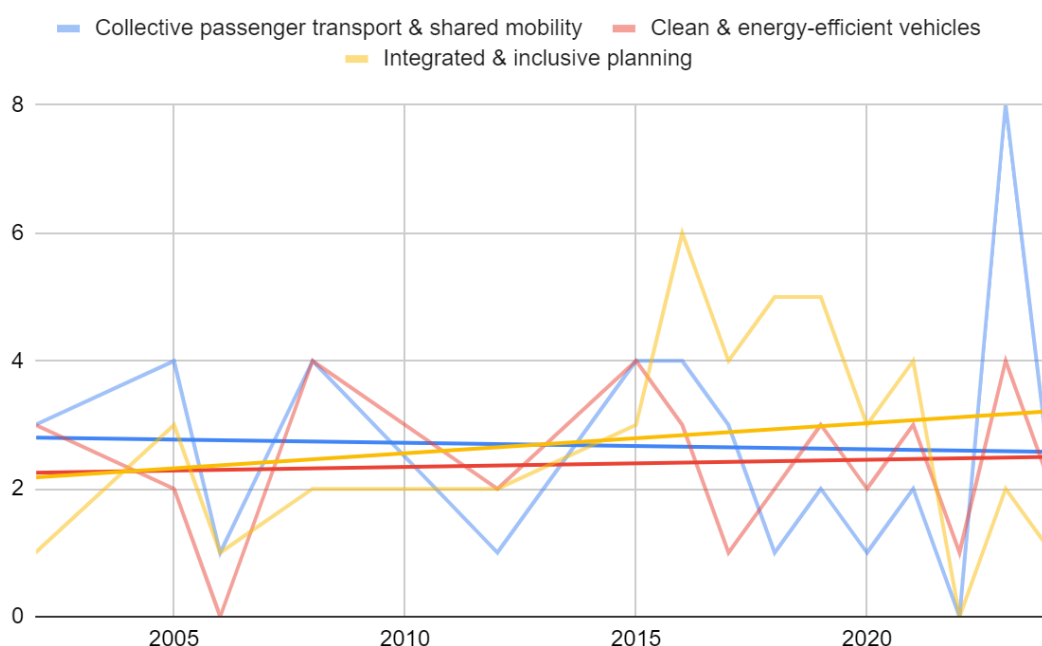


Figure 5: Linear trend analysis: thematic areas addressed with consistency under the CIVITAS initiative from 2002 to 2024

Source of data: (*CIVITAS Initiative: official website*, 2024)

Integrated & Inclusive Planning: This area focuses on developing cohesive and accessible urban transport systems. Its steady prominence is fueled by the need for comprehensive urban development strategies that cater to diverse populations and address the complexities of urban challenges through coordinated planning efforts.

Collective Passenger Transport & Shared Mobility, Clean & Energy-Efficient Vehicles, and Integrated & Inclusive Planning long-term durability within CIVITAS projects indicates how essential they are as fundamental elements in sustainable urban mobility planning.

The continued focus on Collective Passenger Transport & Shared Mobility, Clean & Energy-Efficient Vehicles, and Integrated & Inclusive Planning in CIVITAS projects reflects the longer-term structural problems for European cities such as congestion, emissions, and accessibility. Relative to more dynamic areas like smart mobility or behavior change that accommodate technology innovation or sociopolitical change, these three areas require sustained, system-level interventions as well as policy consistency.

In conclusion, the stable focus on these areas highlights that urban mobility resilience depends not only on adopting novel solutions but also on preserving and progressively improving the essential components that support daily mobility. Their steady presence within CIVITAS projects serves as a stabilizing force in a rapidly evolving policy and technological landscape, ensuring that long-term urban mobility objectives remain central to planning and investment strategies.

The linear trend analysis indicates a consistent decline in the focus on Active Mobility and Demand & Urban Space Management within CIVITAS projects, making these topics some of the least frequently addressed (Fig. 6).

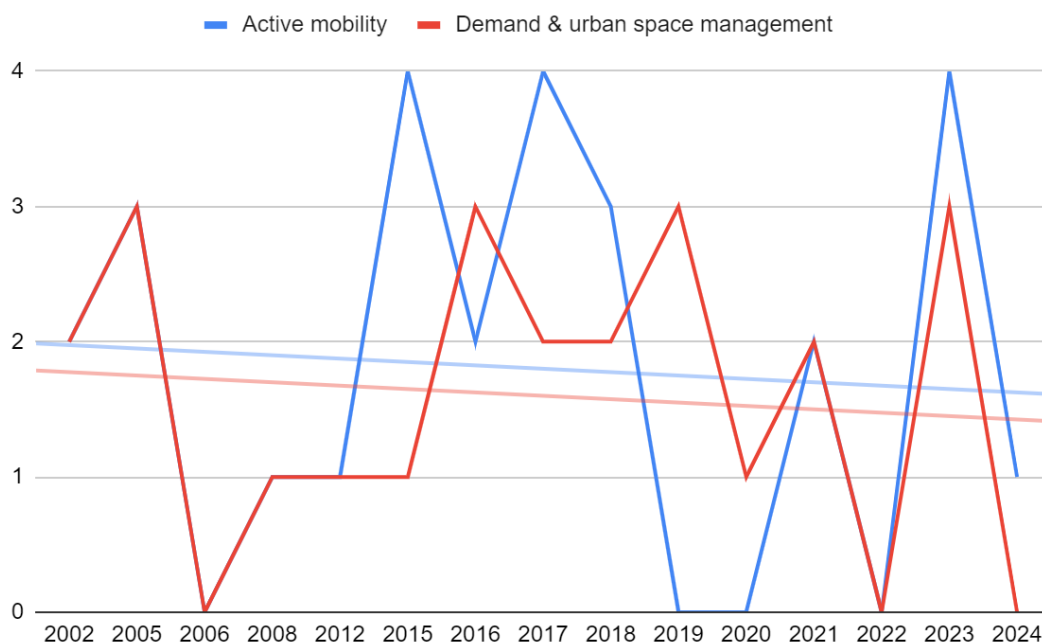


Figure 6: Linear trend analysis: thematic areas addressed with declining consistency under the CIVITAS initiative from 2002 to 2024

Source of data: (*CIVITAS Initiative: official website, 2024*)

Active Mobility has experienced a steady reduction in emphasis, likely due to a shift towards more technologically advanced solutions like smart mobility and clean vehicles. Promoting active mobility often necessitates substantial investments in safe infrastructure, such as bike lanes and pedestrian zones, which can be challenging to implement. Additionally, encouraging a shift in behaviour towards non-motorized transport presents its challenges.

Similarly, Demand & Urban Space Management, including strategies such as congestion pricing and parking management, is also declining. This decrease can be linked to the complexities involved in policy implementation, which often encounters resistance due to concerns about personal freedoms and economic impacts. Political sensitivities and a lack of public support can further impede these initiatives. Moreover, new technologies and mobility solutions may overshadow traditional demand management strategies.

The decline in Active Mobility and Demand & Urban Space Management projects under CIVITAS is more attributable to practical and political obstacles than to reduced necessity. Developing infrastructure for walking and cycling or implementing policies to regulate car use and public space often encounters significant challenges, such as public resistance, political opposition, intricate legal frameworks, and competing interests over urban space. This trend serves as a cautionary signal for policymakers and urban planners: neglecting these critical areas in favor of trend-driven, technology-focused solutions risks creating policy gaps in the future.

Despite their decline, both areas could regain significance as cities face increasing congestion, air quality, and public health challenges. Renewed attention to Active Mobility and Urban Space Management may be crucial for sustainable urban development. While these themes have diminished in focus in recent years, they remain

essential for future urban mobility strategies to create healthier and more livable environments.

The map (Fig. 7) visualises the frequency of CIVITAS projects in European countries and Israel, where darker shades of green indicate high project counts (Italy and Spain) and lighter reds indicate low counts (Switzerland and Latvia). Italy and Spain have the highest number of projects, reflecting their commitment to sustainable development, while Eastern European countries and some Scandinavian states show low participation rates. Along with geographical differences, the tendency of interaction with sustainable urban mobility agendas reveals deeper structural and strategic disparities among European countries. Italian and Spanish front-running participation is not merely a reflection of proactive urban sustainability politics but also reflects their networked presence, institutional capabilities, and coordination with EU mobility agendas that enable them to effectively leverage CIVITAS opportunities.

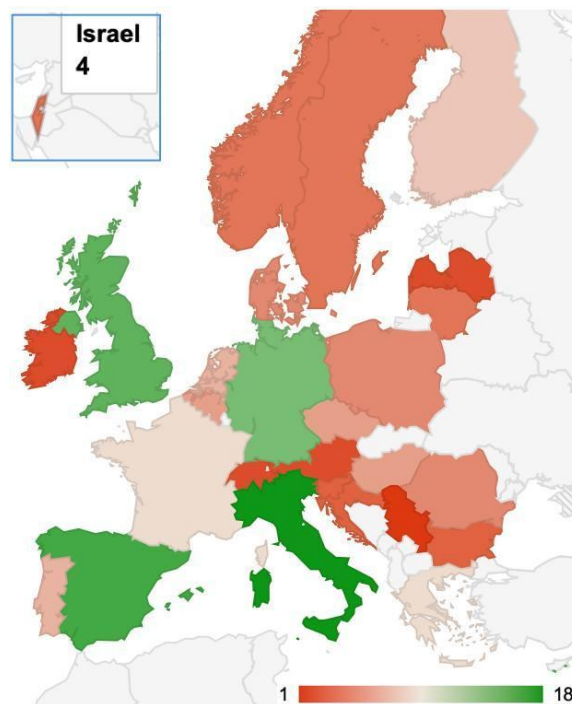


Figure 7: Distribution of CIVITAS Project Implementation in European Countries and Israel

Source of data: (*CIVITAS Initiative: official website*, 2024)

In contrast, lower participation rates in Eastern Europe and parts of Scandinavia suggest underlying disparities in resource availability, institutional readiness, and policy prioritization. Factors such as limited financial and administrative capacity or differing urban development paths may impede active engagement in EU-funded initiatives. This divergence raises concerns about equitable access to innovation networks and funding tools across Europe, potentially leading to a two-speed Europe in the transition to sustainable mobility.

Despite not being part of the EU, Israel is actively involved in CIVITAS programs due to its participation in Horizon 2020, underscoring its innovative potential in technology and mobility.

The spatial unevenness in urban mobility transformation is not merely a matter of project quantity; it reflects profound structural, political, and economic factors that influence how different regions approach this transformation. Addressing these disparities is crucial to create a more cohesive and inclusive European mobility landscape, where every region, regardless of its initial conditions, can both contribute to and benefit from the shared goal of achieving sustainable urban futures.

In the future, CIVITAS will likely focus on expanding smart mobility solutions, such as autonomous vehicles and IoT, and decarbonising urban transport. The program may also enhance international collaboration to address joint mobility issues and ensure accessibility for underserved regions. CIVITAS continues to play a critical role in shaping sustainable urban mobility by integrating technological innovations with urban planning, contributing to reducing the environmental impact of transportation.

4. Conclusions and further research

The study comprehensively examines how European cities have transformed their transport systems to meet sustainable and smart mobility objectives, influenced by urban growth, environmental issues, and technological advancements. Relying on data from the CIVITAS initiative from 2002 to 2024, the study analyses trends and shifts in urban mobility priorities through descriptive statistics and trend analysis, focusing on the frequency and investment in various thematic areas over time.

From the analysis of CIVITAS projects, several conclusions regarding the evolution of urban mobility priorities in European cities emerge. The study validates two main hypotheses. Firstly, it identifies that certain thematic areas remain fundamental and consistently prioritised, such as Collective Passenger Transport & Shared Mobility, Clean & Energy-Efficient Vehicles, and Integrated & Inclusive Planning. The enduring significance of these areas signifies that, despite the continuous evolution of urban mobility innovation, they remain essential priorities that necessitate ongoing preservation and improvement, regardless of shifting trends or emerging technologies. Improvements in public transport, vehicle efficiency, and integrated planning lay the vital infrastructure and policy groundwork that underpins the development of subsequent innovations.

Secondly, there is a confirmed transition towards technology-driven solutions like smart mobility and clean vehicles, moving away from traditional infrastructure-heavy methods. There has been a significant rise in projects centred on Smart, Sustainable, Connected, and Shared Mobility, along with Behavioral Change & Mobility Management, Urban Logistics and Public Participation & Co-creation. This trend indicates an increasing preference for technology-enabled, user-focused solutions that align with the global movement towards smarter, greener urban transport options. Together, these emerging project groups point towards a strategic orientation of urban mobility policy in the direction of integrated, user-centered, and adaptive systems. This orientation suggests a future for sustainable transport that includes not just clean vehicles and infrastructure investment, but also demand management, community engagement, public space protection, and the integration of innovative technologies to address broader urban challenges.

This research distinguishes itself from previous studies in several significant aspects. A considerably larger dataset encompassing CIVITAS projects from 2002 to 2024 was employed, enabling a more thorough and comprehensive analysis of European urban

mobility trends. In contrast, earlier studies conducted in 2012, 2013, and 2014 primarily focused on data from limited time frames, which restricted their capacity to fully capture the evolving priorities in urban mobility over the years (Ramazzotti, Liguori and Dziekan, 2012; Villanueva *et al.*, 2013; Pflieger, 2014). These earlier investigations also relied on smaller sample sizes and frequently overlooked recent technological and social developments.

A significant limitation of this study is its exclusive reliance on data from the CIVITAS initiative, which may not fully represent the broader landscape of urban mobility projects across Europe or globally. While CIVITAS projects are substantial in scope, they only constitute a portion of initiatives within the EU framework, potentially limiting the generalizability of findings. Cities or regions not involved in CIVITAS might have different priorities, resource distributions, or innovative strategies regarding urban mobility. To gain a more holistic understanding of urban mobility trends and challenges, future research could benefit from integrating a more comprehensive array of data sources, including national and regional mobility programs or global urban initiatives. By broadening data sources, researchers can better grasp how diverse approaches and innovations are adopted across various urban settings and socio-political contexts.

Transitioning from identifying urban mobility solutions to actual implementation poses several challenges. While there is a clear trend towards technological mobility solutions, it is hard to ensure equal access, data security, system integration, and acceptance by the public. Cities are faced with challenges like overcoming digital divides, regulation constraints, and capacity gaps. Cities have to design adaptive, crisis-resilient funding mechanisms in order to effectively scale these innovations and guarantee investment stability during recessions and crises.

Furthermore, the highlighted lack of long-term attention to Active Mobility and Urban Space Management points to a critical area to be intervened through policy and investment action. Integrating pedestrian and cycling infrastructure into smart city strategies is essential for creating sustainable, healthy, and resilient urban environments.

Investment trends within the CIVITAS program are vulnerable to outside factors such as economic downturns, geopolitical developments, and the COVID-19 pandemic. This highlights the necessity of building resilience into urban mobility planning and finance. Project developers and policymakers must design flexible financial arrangements and responses that are crisis-sensitive to protect mobility projects under uncertainty. Future research could explore effective risk-mitigation practices and policy tools that have allowed some cities to sustain progress despite challenging conditions.

In addition, for future research, it would be useful to go beyond the superficial allocation of project numbers and explore the structural, political, and economic processes underlying the regional engagement with urban mobility initiatives. Investigating these disparities can provide valuable insights into the barriers and facilitators of participation, helping to craft more inclusive policies and funding mechanisms as well as identify transferable solutions for implementing smart mobility projects, fostering global collaboration and knowledge sharing. There is also the need to devise universal frameworks and standardized measurement benchmarks for the evaluation of smart mobility initiatives. This would enable cities to better measure progress, share best practices, and enhance the effectiveness and interoperability of urban mobility systems.

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