

Secure Bicycle Parking Infrastructure as a Driver of Sustainable Urban Mobility: The Case of Bikeep

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Abstract

Cities worldwide are increasingly promoting sustainable mobility solutions such as cycling, e-bikes, and micro-mobility in order to reduce traffic congestion, CO₂ emissions, and environmental impact while improving urban quality of life. However, bicycle theft, lack of secure parking infrastructure, and insufficient charging facilities for e-bikes remain significant barriers to wider bicycle adoption as a daily transportation method.

Research shows that bicycle theft significantly reduces cycling frequency and often causes users to return to less sustainable transportation methods, particularly private cars. The impact is especially strong among e-bike users and occasional cyclists. Therefore, secure bicycle parking and charging infrastructure is becoming an increasingly important component of sustainable urban development.

This paper presents the Bikeep smart bicycle parking and charging system as a practical example of sustainable mobility infrastructure and demonstrates international best practices from cities, public transportation systems, airports, universities, and commercial environments. The paper combines findings from recent research on bicycle theft and rider behaviour with real-world examples of smart bicycle parking implementation.

The findings indicate that secure and digitally supported bicycle infrastructure can significantly increase bicycle usage, reduce car dependency, improve users' sense of security, and contribute to environmental and social sustainability goals.

Keywords: sustainable mobility, bicycle parking, bicycle theft, e-bike charging, smart cities, Bikeep

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1 Introduction

Cities worldwide are facing increasing traffic congestion, greenhouse gas emissions, and growing pressure to develop more sustainable transportation systems. As a result, many governments and municipalities are actively promoting cycling, e-bikes, and other forms of micro-mobility as part of the green transition.

Cycling represents an environmentally friendly mode of transportation that reduces traffic congestion, improves air quality, and positively impacts public health. In recent years, e-bikes have become particularly important because they enable longer commuting distances and make cycling accessible to a wider population.

Despite these benefits, wider bicycle adoption is often limited by fear of bicycle theft and the lack of secure parking infrastructure. Many users continue to rely on private cars because they do not feel confident leaving their bicycles unattended in public spaces.

An additional challenge is related to e-bike charging. Due to increasing concerns regarding lithium-ion battery fires, cities and organizations are searching for safer outdoor charging solutions that reduce the need for charging e-bikes inside residential or office buildings.

The purpose of this paper is to present the importance of secure bicycle parking infrastructure through the example of Bikeep smart parking systems and to demonstrate the impact of such infrastructure on sustainable urban mobility and reduced car dependency.

2 Methodology

This paper is based on a qualitative analysis of sustainable mobility challenges related to bicycle theft, secure bicycle parking infrastructure, and e-bike charging systems.

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The research combines:

- review of recent scientific literature related to bicycle theft and sustainable mobility,
- analysis of international case studies,
- and practical evaluation of Bikeep smart parking infrastructure deployments in different urban environments.

The theoretical framework is based on sustainable urban mobility principles, smart city infrastructure concepts, and practical implementation examples of IoT-enabled bicycle parking systems.

The paper also includes analysis of real-world implementations in public transport systems, airports, commercial environments, and urban mobility hubs.

3 Theoretical Background

The study *The Impact of Bicycle Theft on Ridership Behavior* (2024) demonstrates that bicycle theft significantly affects the use of sustainable transportation methods.

The study found that:

- 45 % of users reduced bicycle usage or stopped cycling after experiencing theft,
- 15 % of users completely stopped cycling,
- approximately 40 % of users switched to less sustainable transportation methods, primarily private cars.

The research also highlights:

- the strong impact of theft on e-bike users,
- the importance of secure parking infrastructure,
- the role of surveillance systems,
- and the importance of perceived security in sustainable mobility adoption.

The findings confirm that secure bicycle parking infrastructure should not be considered merely an additional urban service, but rather an essential component of sustainable urban mobility systems.

4 Impact on Sustainable Development

Smart bicycle parking infrastructure generates important environmental, social, and economic benefits.

According to Bikeep impact assessments:

- cycling frequency increases,
- car usage decreases,
- CO₂ emissions are reduced,
- fuel consumption decreases,
- and public health benefits improve.

The system also contributes to several United Nations Sustainable Development Goals (SDGs), particularly:

- Sustainable Cities and Communities,
- Climate Action,
- and Industry, Innovation and Infrastructure.

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In addition to environmental benefits, secure parking infrastructure positively affects:

- users' sense of security,
- the adoption of e-mobility,
- integration with public transportation,
- and the reduction of fear related to bicycle theft.

5 Bikeep Smart Parking Infrastructure

Bikeep is a smart bicycle parking and charging system based on IoT technology, digital management, and multi-layer bicycle protection.

The system includes:

- mechanical locking,
- alarm systems,
- digital access management,
- mobile applications,
- video surveillance integration,
- remote monitoring,
- and integrated e-bike charging.

Users can:

- securely park bicycles,

- charge e-bikes,
- reserve parking spaces,
- access stations using smartphones or RFID cards,
- and communicate with operators through the mobile application.

One of the key advantages of the Bikeep system is its universal e-bike charging approach, where users charge their bicycles using their own chargers. This ensures compatibility with nearly all e-bike brands and models.

The system also enables operators to:

- monitor usage,
- access statistical reports,
- remotely manage stations,
- communicate with users,
- and integrate the infrastructure with smart city systems.

6 International Best Practices

6.1 Christchurch, New Zealand

Christchurch developed a city-wide network of Bikeep charging stations for e-bikes. The project demonstrated that secure parking and charging infrastructure can significantly increase e-bike adoption and reduce car usage.

6.2 BART – San Francisco Bay Area

Bikeep stations were installed at BART railway stations to reduce bicycle theft and encourage the integration of cycling with public transportation.

6.3 Ronald Reagan National Airport, Washington DC

Bikeep charging stations at Ronald Reagan National Airport provide employees and travellers with secure parking and charging for light electric vehicles directly near the terminal area.

6.4 ICA – Sweden

Sweden's largest grocery retail chain implemented Bikeep stations to improve accessibility for cyclists and support environmentally friendly customer behaviour.

6.5 APCOA – United Kingdom

Europe's largest parking operator APCOA integrated Bikeep systems into the development of future mobility hubs focused on sustainable transportation solutions.

7 Results

The analysis demonstrates that secure bicycle parking infrastructure has a significant positive impact on sustainable mobility adoption.

The reviewed research indicates that bicycle theft reduces bicycle usage and increases the return to private car transportation. International Bikeep case studies demonstrate that secure parking and charging infrastructure can:

- increase cycling frequency,
- improve user confidence,
- support e-bike adoption,
- reduce fear of theft,
- and improve integration between cycling and public transportation systems.

The results also show that smart infrastructure equipped with IoT functionality, remote monitoring, and integrated charging systems provides additional operational and sustainability benefits for cities and organizations.

8 Discussion

This paper demonstrates that secure bicycle parking infrastructure should no longer be viewed as an additional urban service but rather as an essential component of sustainable urban mobility systems.

The originality of this paper lies in combining scientific findings related to bicycle theft with practical international examples of smart bicycle parking implementation. The paper connects sustainability theory with real-world mobility infrastructure solutions.

The research has practical implications for:

- cities,
- public transportation operators,
- universities,
- airports,
- commercial organizations,
- and smart city planners.

The findings contribute to:

- reduced car dependency,
- improved urban sustainability,
- lower CO₂ emissions,
- increased adoption of e-bikes,
- and safer integration of micro-mobility into urban environments.

One limitation of the research is that the paper is primarily based on qualitative analysis and practical case studies rather than quantitative field research. Future research could include long-term comparative studies measuring the direct impact of secure parking infrastructure on modal shift and urban sustainability indicators.

9 Conclusion

Secure bicycle parking infrastructure is becoming an essential element of sustainable urban development and modern mobility systems.

Research demonstrates that bicycle theft significantly reduces the use of sustainable transportation and increases dependence on private cars. Therefore, secure parking and charging systems represent an important measure for achieving environmental and sustainability goals.

The Bikeep case demonstrates that modern digitally supported bicycle infrastructure can:

- increase bicycle usage,
- improve user security,
- support e-mobility development,
- and significantly contribute to reducing emissions and supporting sustainable urban mobility.

Secure bicycle parking infrastructure should therefore no longer be viewed as an optional additional service, but rather as a necessary component of sustainable city planning.

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