INTERNATIONAL UNION OF RAILWAYS

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Optimizing Bikes and Luggage Transportation in Railway Systems

UIC Workshop within the Customer Experience Platform (CEMP) Framework. Conclusions

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1 INTRODUCTION

This paper aims to explore the strategies and best practices for optimizing bike and luggage transportation in railway systems, as discussed during the workshop "*Optimizing Bikes and Luggage Transportation in Railway Systems*" organised by UIC Customer Experience Platform (CEMP) in October 2024.

The integration of bikes and luggage transportation within railway systems is becoming increasingly significant as urban areas strive to address the growing challenges of mobility, congestion, and environmental sustainability. With the rise of multimodal transportation solutions, rail operators are recognizing the importance of providing seamless options for cyclists and travellers with luggage, which enhances the overall customer experience and reduces dependency on personal vehicles. This shift towards a more holistic approach to transport is driven by the need to cater to urban dwellers who seek flexible and eco-friendly travel options.

By analysing the current technologies, highlighting relevant case studies, and examining operational challenges, this paper will provide recommendations for future innovations that could enhance the efficiency and customer experience of bike and luggage handling in rail networks.

This study incorporates insights from a comprehensive survey of railway operators to understand current practices and challenges in integrating bicycles and luggage into train systems.

1.1 Key EU Regulations and Initiatives (Jean Brumagne, Legal Officer, DG Move)

The EU's ongoing legislative efforts reflect a clear strategy to position cycling and rail as complementary modes of transport, essential for achieving the goals outlined in the European Green Deal and the EU's broader sustainability agenda, and the strong commitment to promoting sustainable mobility, with a particular focus on integrating cycling with railway travel.

These efforts do not only consist of guidelines but also of legally binding commitments that require member states to adapt their national railway networks to accommodate bicycles.

European Declaration on Cycling

The European Declaration on Cycling plays a crucial role in shaping policies that integrate cycling into broader transport strategies. This declaration is a collaborative effort by the European Commission, the European Parliament, and the Council of the EU, and it aims to promote cycling as a sustainable and efficient mode of transport.

The declaration supports the development of cycling infrastructure, encourages multimodal transport solutions (such as bike-train combinations) and sets a political framework to ensure that cycling is fully integrated into the EU's transport and mobility policies.

Regulation (EU) 2021/782 on Rail Passengers' Rights and Obligations (PRR)

This Regulation strengthens the rights of passengers traveling by train, including provisions for carrying bicycles on board. This regulation mandates that new and refurbished trains in the EU must have in principle a minimum of **four dedicated spaces for bicycles**, ensuring that cycling is a viable and accessible option for travellers throughout Europe.

This requirement aims to standardize the accommodation of bicycles on trains across all EU member states, ensuring that passengers can more easily combine cycling with train travel, thereby promoting sustainable and multimodal transport options.

The goal is to make it easier for passengers to travel with their bikes and to promote intermodal transport solutions, encouraging more passengers to choose cycling as their first- and last-mile solution.

TEN-T (Trans-European Transport Network)

The EU's TEN-T policy also indirectly supports the integration of cycling with rail transport by developing a comprehensive network of roads, railways, airports, and water infrastructure across Europe. The focus is on creating a seamless, sustainable, and efficient transport system that encourages the use of environmentally friendly modes of transport.

TEN-T's development aims to facilitate easy connections between different modes of transport, including cycling and rail, promoting the reduction of carbon emissions and congestion in urban areas.

The Legislative Commitment to Cycling and Rail Integration

The EU's legislative framework pushes for greater multimodal connectivity by incentivizing railway operators to invest in infrastructure that supports the integration of bicycles on trains, making them a natural part of everyday travel.

The regulations also address practical challenges, such as ensuring secure bike storage at train stations and creating policies that require adequate facilities for bicycles on both urban and long-distance trains.

The focus on sustainability and green mobility aligns with the EU's broader goals of reducing carbon emissions and promoting eco-friendly transportation solutions.

Future Directions

There is a need for continuous improvements in infrastructure to further encourage the use of bicycles in conjunction with railway travel.

The future initiatives will likely focus on increasing the number of bicycle spaces on trains, enhancing the digital integration of bike-train services through booking apps, and implementing user-friendly designs that cater to the needs of all passengers, including those with limited mobility.

1.2 European Cyclists' Federation (Fabian Küster, Director of Advocacy and EU Affairs)

Minimum Number of Bike Spaces on Trains

European Cyclists' Federation (ECF) advocates for the implementation of clear requirements regarding the number of dedicated bike spaces on trains, highlighting that such regulations are essential to accommodate the growing demand for bike-and-train travel.

The specific number of bike spaces required can vary depending on the train type and its intended service route. For example, regional and commuter trains, which serve areas where short-distance travel is common, typically need to allocate more spaces for bikes than long-distance or high-speed trains.

This ensures that passengers can easily use bikes as a complement to their train journeys, especially in urban and suburban areas where cycling is most prevalent.

Flexibility in Implementation

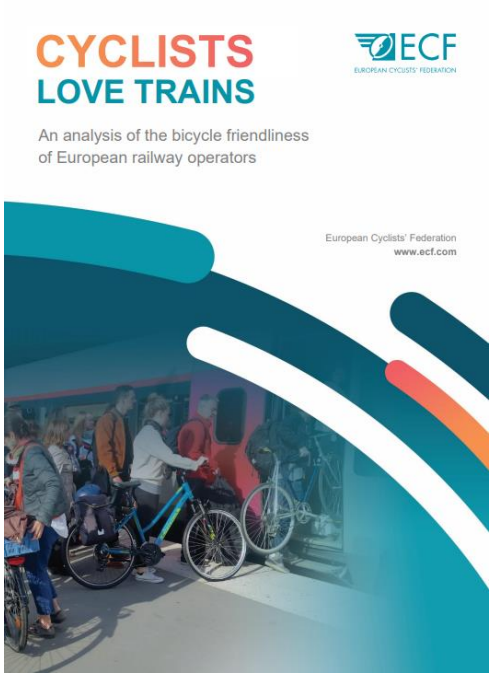
While setting a minimum standard is crucial, flexibility is also necessary to adapt to varying levels of demand. During the workshop it was mentioned that bike usage on trains often fluctuates seasonally, with higher demand during warmer months or in regions with established cycling cultures.

Therefore, railway operators may need to consider modular or adaptable solutions, such as removable bike racks or the use of carriages that can be adjusted based on demand.

Case for More than Just the Minimum

Beyond the minimum requirements, it is suggested that railway operators who go above and beyond to provide ample bike spaces on trains are more likely to attract cyclists and encourage greater use of sustainable transport options.

Investing in sufficient bike spaces not only improves the customer experience but also aligns with broader environmental goals, reducing traffic congestion and emissions by making cycling and train travel more appealing.



Policy Alignment and Future Directions

Ensuring a minimum number of bike spaces on trains is also in line with the EU's sustainability objectives outlined in the European Green Deal. This initiative aims to cut carbon emissions and promote green mobility across the continent.

In the long run, adopting these measures is not just about meeting regulatory requirements but also about making a significant contribution to environmental protection and quality of life in European cities.

1.3 The Industry Perspective (Alessandro Vannucchi, Head of Portfolio Management, Hitachi)

Key Design Principles and Flexibility

1. **Interior Layout Flexibility**: the importance of designing train interiors with flexibility in mind to accommodate various needs, such as bike racks, luggage storage, ski racks, vending machines, and other facilities. This modular approach allows the train interior to be reconfigured to meet different passenger requirements and optimize the use of space without compromising on comfort or safety.

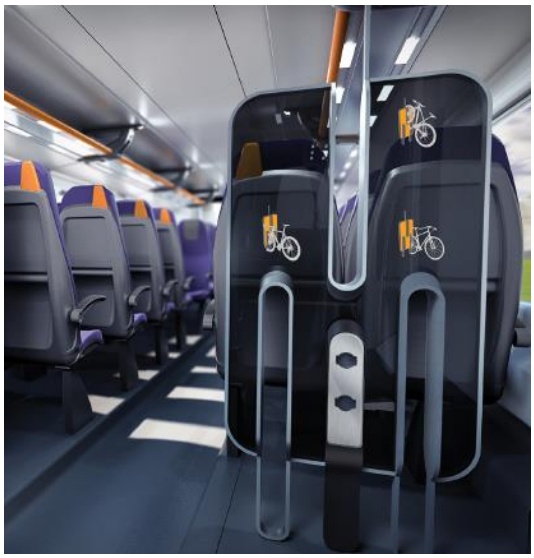
2. **Use of Configurable Spaces**: the implementation of configurable multiple areas within the train, which can be adapted to suit different user needs. This adaptability is critical, especially for modern trains, to balance between passenger seating and additional facilities for bikes, luggage, and other equipment. There are solutions like using sea rails on the side

walls to allow for easy reconfiguration of the seating layout.

3. **Ergonomics and Modular Design**: A focus was placed on ergonomic design to enhance passenger comfort and reduce physical strain, especially when handling heavy bicycles or luggage. The use of modular solutions not only improves standardization but also facilitates easier maintenance and adaptation to future needs.

Technological Innovations and Security

1. **Advanced Luggage Storage Solutions**: There are various solutions for luggage storage, ranging from floor-to-ceiling luggage racks to under-seat spaces and overhead shelves. These designs are intended to maximize available space within the passenger compartment while maintaining accessibility and safety for all users.



2. **Artificial Intelligence (AI) and Safety Enhancements**: The growing role of AI in enhancing passenger safety and security. Innovations like the use of security cameras, sensors, and AI-driven analytics are becoming more mature, providing passengers with a safer and more comfortable journey. These technologies also help manage bike and luggage storage more effectively by predicting demand and optimizing space allocation.

Collaboration and Customer-Centric Approach

1. **Collaborative Design with User Groups**: It is of the upmost importance of involving user groups and associations in the design process. He provided an example from Italy, where they collaborated with bicycle associations and customers to develop new bike rack solutions for regional trains. This collaborative approach ensured that the design met the needs and expectations of all stakeholders, leading to more user-friendly and practical solutions.
2. **Accessibility and Inclusivity**: Ensuring that bike and luggage storage facilities are accessible to all passengers, including those with physical impairments, was highlighted as a critical factor. The use of tactile maps for visually impaired passengers and induction loops for those with hearing impairments to enhance inclusivity in train design.

Future Directions and Technical Challenges

1. **Flexibility in Seating Arrangements**: While flexibility in train seating is often seen as challenging due to safety and structural concerns. New market solutions can enable reconfiguration of seating arrangements. Although these changes may not be immediate, the ability to adjust the interior

layout over time is essential for responding to evolving passenger needs.

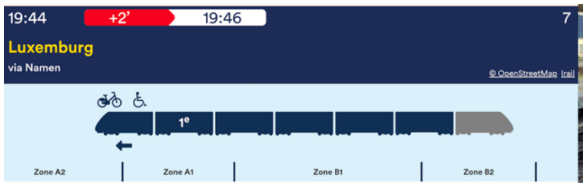
2. **Overcoming Rigidity in Train Design**: It is acknowledged that traditional seating and interior layouts in trains are perceived as rigid, making it difficult to adapt quickly to changing requirements. However, advancements in design technology are making it possible to introduce more dynamic solutions that can be implemented without significant disruptions.

2 THE INTERNATIONAL LANDSCAPE OF BIKES AND LUGGAGE MANAGEMENT ON RAILWAYS

2.1 Denis Brachet (SNCB, Belgium Railways)

Denis Brachet from SNCB highlighted Belgium's strategic approach to enhancing bike capacity on trains by aiming for a 50% increase by 2032. His focus was on implementing technical solutions that ensure greater accessibility for all passengers, particularly those with bikes or reduced mobility.

Brachet discussed the importance of standardizing high-platform designs and lift installations to facilitate easy boarding for cyclists and passengers with disabilities. He stressed that the integration of user-centric design in station infrastructure will play a critical role in reducing barriers to multi-modal travel.



Additionally, Brachet emphasized the need for innovations in rolling stock design to incorporate more flexible and secure bike storage options that can be adapted to different train configurations and usage patterns.

2.2 Brigitte Matheussen (NS, Dutch Railways)

Brigitte Matheussen from Dutch Railways focused on the need for diverse and adaptable bike storage solutions to accommodate various types of bicycles, including electric bikes and cargo bikes. Her technical conclusions pointed to the necessity of creating modular storage units that can be easily reconfigured to fit different bike sizes and shapes.

Matheussen also emphasized the importance of digital tools to streamline the reservation process for bike spaces, allowing passengers to book and monitor bike availability in real-time. This approach aims to minimize congestion and ensure a more organized boarding process, especially during peak travel times.

2.3 Magnus Just Hansen (DSB, Denmark Railways)

Magnus Just Hansen highlighted Denmark's success with the integration of free bike transport on S-trains, noting that this policy has been a significant driver in increasing bike usage among commuters in Copenhagen. Hansen's technical insights centred around the need for robust bike parking solutions at railway stations, including the deployment of automated bike parking systems that optimize space usage and enhance security.

He also shared the existence of locked bike sheds already available in 72 DSB stations.

2.4 Marc Guggenheim (SBB, Swiss Railways)

Marc Guggenheim from Swiss Federal Railways (SBB) underscored the importance of managing bike capacity through mandatory reservations, particularly for intercity trains where space is limited. He highlighted that SBB adjusts their bike storage offer annually, leveraging increasing volumes of data to identify where and at what times demand is highest. This process has also involved the planning of additional service staff to assist customers in using separate logistic compartments for bike storage.

Guggenheim also discussed the challenges of balancing seat capacity with bike storage, proposing modular storage compartments that can be adjusted depending on demand. This approach would allow for greater flexibility in managing peak and off-peak travel periods.

Looking toward the future, Guggenheim emphasized that SBB plans to eliminate vertical bike hooks on upcoming train models, as bikes have become heavier (especially e-bikes), and such hooks need to remain accessible to passengers of all ages, from 8 to 80 years old.

Additionally, the demographic of bike users has shifted, with older customers and heavier bikes becoming more common.

2.5 Silvia Toffoli (Trenitalia, Italian Railways)

Silvia Toffoli emphasized the dual approach used by Trenitalia for bike transport, where passengers can either disassemble their bikes to carry as luggage or transport them fully assembled with a specific ticket. Toffoli's technical conclusions revolved around the need for adaptable interior train designs that can accommodate various forms of micromobility devices. She suggested that trains be equipped with convertible storage areas that can handle electric scooters, bikes, and other small vehicles.

Toffoli also proposed the implementation of dynamic reservation systems that adjust to passenger needs in real-time, ensuring maximum utilization of available storage space without compromising passenger comfort.

2.6 Petra Privsek (SZ, Slovenian Railways)

Petra Privsek focused on the importance of integrating smart security solutions into bike storage at railway stations. Her technical recommendations included the use of smart lockers and secure bike parking stations equipped with digital locking mechanisms that are connected to mobile apps.

These lockers not only provide high security but also allow users to check availability and reserve spaces in advance. Privsek discussed the technical challenges associated with maintaining these systems, emphasizing the need for regular software updates and robust cybersecurity measures to prevent hacking and unauthorized access.

2.7 Maria Gusarova (UIC, RidetoRail EU Project)

Maria Gusarova highlighted the importance of leveraging digital tools to enhance the passenger experience related to bike and luggage transportation.

She proposed the integration of real-time information systems into train operators' mobile apps, which would provide passengers with up-to-date details on bike storage availability, train layouts, and accessibility features.

Gusarova's technical focus was on the development of user-friendly digital interfaces that can seamlessly guide passengers through the process of boarding and storing their bikes and luggage, thereby reducing stress and improving the overall travel experience.

2.8 Reflections on Global Approaches to Bike and Luggage Management

The main conclusions from the block of interventions under ***"The International Landscape of Bikes and Luggage Management on Railways"*** can be summarized as follows.

The interventions collectively highlighted the need for a holistic approach that combines flexible train design, advanced digital tools, collaborative development, and standardized solutions to optimize bike and luggage transportation in railway systems. The focus on sustainability, accessibility, and user-centric innovations is essential for transforming railway networks into truly multimodal and future-ready transport systems that cater to the evolving needs of modern travellers.

Flexibility and Adaptability in Train Design

Several speakers, including Denis Brachet, Brigitte Matheussen, and Marc Guggenheim, emphasized the need for flexible and adaptable train interiors that can accommodate different types of bikes and luggage. The focus on modular and configurable designs allows railway operators to maximize space utilization and adapt storage solutions based on varying demand. This flexibility is crucial to balancing the needs of passengers who travel with bikes and luggage without significantly compromising seating capacity.

Importance of Digital and Smart Technologies

The use of digital tools and smart technologies was a recurring theme in the interventions. Speakers like Petra Privsek and Maria Gusarova highlighted the integration of real-time information systems and digital lockers that enhance the security and accessibility of bike storage. The implementation of IoT-enabled sensors and AI-driven analytics for monitoring bike rack availability and predicting travel patterns was also stressed as a way to optimize passenger services and streamline operations.

Reservation Systems for Better Capacity Management

Marc Guggenheim and Silvia Toffoli discussed the critical role of reservation systems for managing bike and luggage capacity on trains. The adoption of mandatory bike reservations, especially during peak times, was recommended to reduce congestion and ensure a more organized boarding process. These systems also contribute to better resource allocation, enhancing both operational efficiency and the overall passenger experience.

Collaboration with User Groups and Stakeholders

The need for a collaborative approach in designing bike and luggage solutions was emphasized by Alessandro Vannucchi and other speakers. Engaging with cycling associations, passenger groups, and other stakeholders during the design phase ensures that the solutions are user-friendly and meet the diverse needs of all passengers. This collaboration is crucial for developing train services that are both practical and inclusive.

Infrastructure and Accessibility Improvements

A common thread in the discussions was the focus on enhancing station infrastructure to support bike and luggage integration. Denis Brachet and Magnus Just Hansen pointed out the importance of upgrading platforms, installing lifts, and providing secure bike parking to make stations more accessible for all users, including those with mobility impairments. These improvements are essential to creating a seamless multimodal travel experience that encourages more people to choose cycling and public transportation.

Standardization and Interoperability

Several speakers noted the importance of standardizing bike and luggage handling solutions across different railway networks. The lack of consistency in design and technology was identified as a barrier to creating a cohesive multimodal transport system. Standardization would facilitate interoperability between different rail operators, making it easier for passengers to travel with bikes across regions without facing logistical challenges.

Sustainability and Encouraging Bike Use

Magnus Just Hansen and others underscored the role of cycling as a key component in sustainable urban mobility. By integrating bikes into railway transport, cities can significantly reduce their carbon footprint and promote healthier, greener travel options.

Policies that encourage free or low-cost bike transport on trains, coupled with robust infrastructure, are vital to achieving these sustainability goals.

Security and Safety Enhancements

Petra Privsek emphasized the importance of incorporating security measures into bike storage solutions at stations and on trains. The adoption of smart lockers with digital locking systems and enhanced cybersecurity protocols is crucial to protect passengers' belongings and maintain trust in the railway service. These safety features also play a significant role in encouraging more people to use bikes as part of their daily commute.

3 BALANCING ACCESSIBILITY, CAPACITY, AND SUSTAINABILITY IN RAILWAY SERVICES

This balance is crucial to ensure that trains are accessible to all passengers, including those with reduced mobility, while also maximizing the use of space for bikes and luggage without compromising overall passenger comfort.

- **Accessibility**: The EU legislation mandates accessibility standards for railway services, ensuring that stations and trains are designed to be inclusive for all users. This includes considerations for passengers with disabilities, who require specific accommodations, as well as cyclists who need convenient and secure storage for their bikes.
- **Capacity**: Optimizing the capacity of trains through innovative, modular design solutions is a solution to be considered. The need for configurable interiors that can adapt to different passenger requirements, whether it's for additional seating, luggage storage, or bike racks. Maximizing capacity goes beyond simply adding more space; it involves designing flexible spaces that can be reconfigured as needed.
- **Sustainability:** Promoting cycling as a viable first- and last-mile solution can significantly reduce carbon emissions, alleviate urban congestion, and encourage the shift from car dependency to greener transport modes.

Modular Train Design

One of the major themes discussed was the need for train designs that are both flexible and modular to adapt to changing passenger needs. This concept was strongly supported by Alessandro Vannucchi, who presented technical innovations like configurable seating areas and storage compartments that can be easily adjusted to cater to different types of luggage and bikes.

- **Configurable Interiors**: Modular interiors enable railway operators to quickly reconfigure train layouts based on demand. For example, during peak hours, certain compartments could be adapted to provide more seating, while off-peak times might see these areas converted into additional bike or luggage storage.

- **Adaptability for Different Bike Types**: One of the key challenges for rail operators is accommodating a variety of bikes, including electric bikes and cargo bikes. The need for adaptable storage solutions that can handle different bike dimensions without taking up excessive space was seen as critical for enhancing the passenger experience.
- **Importance of Real-Time Data and Digital Tools.** The integration of digital tools to provide real-time information about bike and luggage facilities was a significant focus of the discussion. Jorge Morera emphasized the need for these tools to be intuitive and accessible to passengers, offering real-time updates that help them plan their journeys more efficiently.
- **Digital Platforms**: Importance of user-friendly digital platforms that display information on bike storage availability,

train layouts, and platform accessibility. These digital solutions can help streamline the boarding process, reduce delays, and improve the overall travel experience.

- **AI and Predictive Analytics**: The role of AI in analysing travel patterns and predicting bike and luggage demand, using AI-driven analytics, rail operators can optimize space allocation on trains, manage reservations more effectively, and anticipate peak travel times, leading to more efficient resource use.

Collaboration with Stakeholders and User-Centric Design

The discussion also highlighted the importance of a collaborative approach in designing rail services that cater to the needs of all passengers.

Engaging with user groups, cycling associations, and passengers with disabilities was seen as essential to developing practical solutions that enhance accessibility and convenience.

- **Engaging the Cycling Community**: The collaboration with cycling organizations and advocacy groups is vital for understanding the specific needs of cyclists and ensuring that bike facilities on trains are designed to be both practical and attractive.
- **Feedback-Driven Design**: continuous feedback from passengers to inform the design of bike and luggage solutions. Involving the passenger community in the decision-making process leads to innovations that are directly aligned with their expectations and needs.

Harmonized Standards and Policy Support

The need for harmonized standards across the EU to facilitate a consistent approach to bike and luggage integration in railway systems. He highlighted that regulatory alignment is crucial to ensure that all railway operators across member states follow a unified set of guidelines that promote accessibility, safety, and sustainability.

- **Regulatory Framework**: Existing EU regulations are designed to support a multimodal transport network where cycling and train travel are seamlessly integrated. He called for continued policy support to ensure that these standards evolve in line with technological advancements and changing mobility needs.
- **Institutional Backing for Sustainability**: The importance of institutional support was also noted by the panellists, particularly in securing funding and resources for developing the necessary infrastructure. Government initiatives that incentivize sustainable transport modes like cycling are essential for achieving long-term environmental goals.

Conclusion

Achieving a balance between accessibility, capacity, and sustainability requires a multi-dimensional strategy that includes innovative train design, digital technology integration, collaborative stakeholder engagement, and strong policy support.

Emphasizing flexibility, modularity, and real-time data solutions will be crucial to creating a rail system that meets the evolving needs of modern travellers and promotes a sustainable, multimodal approach to urban mobility.

4 RELEVANT INTERNATIONAL CASE STUDIES

The case studies described in this section illustrate how different railway systems around the world have adopted innovative solutions to improve bike and luggage transportation:

4.1 The Netherlands: A Model for Bike and Train Integration

The Netherlands stands out as a leading example in the integration of bikes and trains, achieving an ideal ecosystem that many other countries strive to replicate. Approximately 40% of all train passengers in the Netherlands cycle to the railway station, and 10% continue their journey by bike after arriving at their destination.

This success can be attributed to several factors:

- **Extensive Bike Parking Facilities**: Dutch railway stations offer unparalleled bike parking infrastructure, with over 510,000 spaces available nationwide, and an ambitious goal to increase this to 600,000 by 2027.
- **Bike Sharing Systems**: The Netherlands has one of the most advanced bike-sharing systems operated by the national railway company, NS, which allows seamless integration between train and bike travel.
- **Accessibility and Infrastructure**: Low-access train design and well-placed bike compartments ensure easy boarding and deboarding for cyclists. These features are complemented by strategic placement of bike parking close to station entrances, enhancing the overall accessibility for multimodal travellers.

4.2 Belgium: A Strategy Focused on Flexibility and Accessibility

Belgium has developed a comprehensive strategy to improve bike and train integration, focusing on both infrastructure and policy innovations:

- **Flexible Train Configuration**: Recent modifications in Belgium's rolling stock include adding up to eight bike spaces per coach, with plans to extend this capacity further on routes with high demand.
- **Accessibility Enhancements**: The country is actively increasing the number of accessible stations, with a focus on high-platform accessibility and the installation of lifts to facilitate the movement of bikes and other mobility aids.
- **Pricing Innovations**: Belgium is working on differentiated pricing strategies to encourage bike travel during off-peak hours, which helps to manage demand effectively without overloading train services during peak times.

4.3 Denmark: Promoting Free Bike Transport on Suburban Networks

Denmark's DSB (Danish State Railways) has implemented several measures to encourage the use of bikes in conjunction with train travel, particularly on its suburban S-trains:

- **Free Bike Carriage**: Since 2010, DSB has allowed free bike transport on its S-trains, leading to a significant increase in bike usage, with over 10 million bike journeys recorded annually.

- **Innovative Pilot Programs**: DSB is currently testing free bike transport on specific regional lines outside of rush hours to understand its impact on ridership and network efficiency. This pilot has received positive feedback, indicating a strong preference for integrated bike and train solutions.
- **Infrastructure Enhancements**: Continuous upgrades to bike parking facilities at train stations ensure that they are safe, well-lit, and easy to navigate, further promoting the use of bikes as a first mile and last-mile solution.

4.4 Switzerland: Capacity Management and Collaboration with Cycling Associations

Switzerland has adopted a structured approach to managing bike transport on its trains, emphasizing collaboration with cycling organizations and logistical innovations:

- **Mandatory Bike Reservations**: SBB (Swiss Federal Railways) requires reservations for bikes on Intercity lines during peak periods, helping to manage demand and prevent overcrowding.
- **Logistics Solutions**: SBB uses logistic compartments in trains to accommodate up to 40 bikes on high-demand routes, a strategy that relies on efficient loading and unloading processes managed by trained staff.
- **Collaborative Design**: SBB engages with cycling associations to refine its bike transport policies, ensuring that future train designs meet the evolving needs of cyclists and promote a positive user experience.

4.5 Italy: Flexible Bike Storage and Seasonal Adjustments

Trenitalia, Italy's national railway company, has focused on flexible and seasonal adjustments to enhance bike transport on regional trains:

- **Seasonal Capacity Adaptations**: Trenitalia modifies its bike storage facilities based on seasonal demand, increasing capacity during peak travel periods when recreational cycling is more popular.
- **Innovative Ticketing Solutions**: The company is testing a reservation system for bike spaces to ensure that customers have guaranteed access to bike storage, aiming to reduce conflicts over space and improve overall satisfaction.

4.6 Key Takeaways from International Practices

These international case studies illustrate a variety of approaches to successfully integrate bikes and luggage into railway systems. Common themes across these examples include:

- **Flexible Infrastructure**: Many countries focus on adaptable train interiors and modular designs that can be adjusted based on demand and specific user needs.
- **Comprehensive Planning**: Successful systems incorporate bike and luggage transport into broader mobility strategies, ensuring alignment with public transport goals and user expectations.
- **Collaboration and Customer Engagement**: Engaging stakeholders, including cycling associations and passengers, plays a crucial role in developing user-centric solutions that address the diverse needs of train users.

- **Policy and Regulation**: Consistent regulations and clear communication about bike and luggage policies help manage passenger expectations and promote smooth interactions between train operators and cyclists.

4.7 Examples of Operator Innovations

The operator survey revealed several innovative practices and pilot initiatives aimed at improving bike and luggage integration. These examples provide valuable insights into how railway operators are addressing these challenges.

- **IoT for Luggage Tracking:** Some operators have introduced IoT-enabled luggage tagging systems that allow passengers to monitor their bags throughout the journey. These systems have significantly reduced concerns about theft and misplacement, improving the overall travel experience.
- **Dynamic Pricing Models**: Dynamic pricing strategies have been piloted to encourage off-peak usage of bike and luggage spaces. Operators report a positive impact on demand distribution, reducing congestion during peak hours.
- **Dedicated Bicycle Compartments**: Operators in urban and regional networks have implemented dedicated bike compartments with secure anchoring systems. This approach ensures the safety of bicycles and prevents disruptions to other passengers.
- **Mobile Apps for Real-Time Bookings**: Real-time digital platforms for bike and luggage reservations have been well-received. These tools not only streamline the booking process but also provide operators with valuable data on usage patterns.

5 KEY OPERATIONAL CHALLENGES AND IMPROVEMENT OPPORTUNITIES

Despite technological advancements, there are several operational challenges that railway operators face when integrating bikes and luggage into their systems. Addressing these challenges is crucial to achieving a seamless and efficient transportation network.

5.1 Challenges

Accessibility and Space Constraints

- One of the main operational challenges identified is the conflict between bike and luggage racks and the overall passenger flow. Improper placement of these storage solutions can obstruct pathways and reduce the accessibility for all passengers, especially during peak times. The need to balance bike and luggage storage without compromising seating capacity remains a significant hurdle for railway operators.
- Seasonal variations add another layer of complexity. Demand for bike spaces on trains fluctuates dramatically between winter and summer, with peaks during holiday seasons. This irregular demand puts pressure on operators to provide flexible solutions that can adapt to changing needs without permanently reducing seating capacity.

Coordination Between Customer Groups

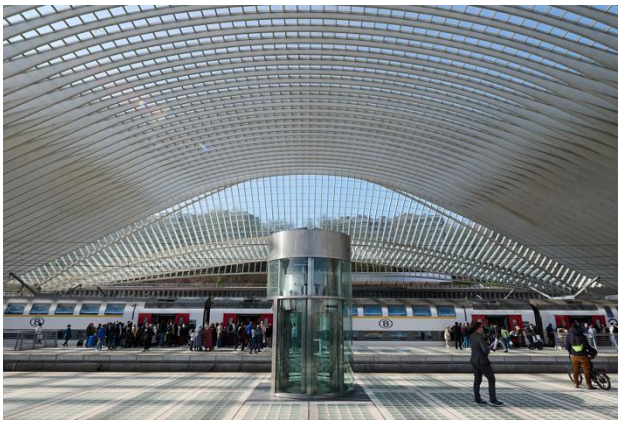
- Conflicts often arise when multiple passenger groups compete for limited space on trains. This issue is particularly challenging when cyclists, commuters, and passengers with reduced mobility share the same space. Effective management of these diverse needs requires not just physical infrastructure but also a proactive approach to onboard space organization.
- Train staff play a crucial role in managing these spaces, yet they frequently face difficulties in enforcing the flexible usage of areas designated for bikes and luggage. There is a need for clear guidelines and better training for train conductors to handle these situations professionally, ensuring that space is utilized efficiently while minimizing disputes among passengers.

Communication and Customer Awareness

- A significant challenge lies in communicating the available facilities and rules regarding bikes and luggage transport to passengers. Passengers often lack awareness of designated areas, resulting in confusion and suboptimal use of space. There is a need to enhance the visibility of these facilities through clear signage, digital apps, and onboard announcements to guide passengers effectively.
- Miscommunication between railway operators and cycling communities further complicates the issue. Establishing a continuous dialogue with cycling and passenger associations is essential to understand their expectations and adjust services accordingly.

Design Flexibility and Modular Solutions

- One of the most promising opportunities for improvement is to focus on flexible and modular train interiors. This approach allows railway operators to convert seating areas into bike and luggage storage spaces as needed, thereby maximizing the use of space depending on the time of day or season. Implementing tip-up seats and foldable racks can provide a practical solution to dynamically adjust the train's interior layout.
- Incorporating user feedback into the design process through collaborative workshops with passengers and cycling associations has shown to significantly improve the functionality of these spaces. This collaborative design approach ensures that solutions meet the actual needs of the users, making them more effective and widely accepted.



Technological Innovations

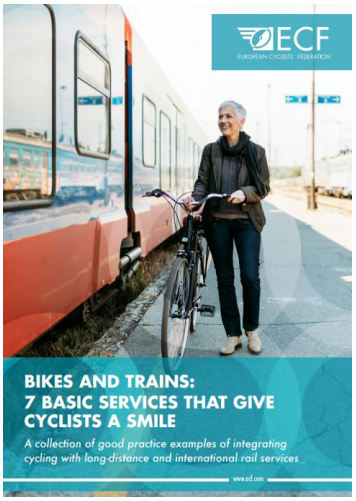
- Technological advancements, such as real-time monitoring of available bike and luggage spaces through apps and digital platforms, can greatly enhance the passenger experience. This information can help travellers plan their journeys more efficiently, reducing stress related to boarding and space availability.
- The integration of camera surveillance and tracking systems for luggage and bike storage areas can improve security, giving passengers peace of mind when storing their belongings away from their immediate reach. These technologies can also help railway operators manage and optimize the allocation of these spaces dynamically.

Enhancing Multimodal Connectivity

- Strengthening the connection between train services and other modes of transport, such as bike-sharing programs and bus networks, offers a significant opportunity to enhance the overall travel experience. Providing seamless transfers and integrated ticketing solutions can encourage more passengers to adopt multimodal journeys, thereby increasing the use of bikes and public transport over private cars.
- Developing station infrastructure to support bike storage and parking, including facilities for electric bikes and cargo bikes, is crucial for promoting sustainable mobility. Stations equipped with ample and secure bike parking options can reduce the need to transport bikes onboard, freeing up space on trains for other passengers.

Policy and Institutional Support

- Institutional backing plays a vital role in overcoming the challenges of integrating bikes and luggage into railway systems. Stronger policy frameworks and incentives from local and national governments can support investments in infrastructure and innovative designs that cater to both bikes and luggage on trains.



- Encouraging a shift in mindset among stakeholders—from treating bike and train services as separate entities to viewing them as complementary modes—can lead to more cohesive and user-friendly transport solutions. This shift can be facilitated through targeted campaigns and collaborative efforts across the transport sector.

5.2 Recommendations for Innovative Solutions

To address the challenges identified and capitalize on the opportunities for improvement, the following innovative solutions are recommended:

Enhancing Bike and Luggage Storage Solutions

- Flexible Interior Design
  - Implementing flexible and modular train interiors can significantly improve the accommodation of bikes and luggage without compromising seating capacity. Design innovations like foldable seats and adjustable bike racks enable quick reconfiguration of train spaces based on demand, providing passengers with a more versatile environment.
  - The use of charging sockets for e-bikes and secure holding mechanisms in bike storage areas will enhance last-mile mobility, encouraging more passengers to bring their bikes onboard and making their journey smoother and more convenient.
- Integration of Technology for Real-Time Information
  - Deploying real-time information systems that provide updates on available bike and luggage spaces can greatly enhance the passenger experience. Digital platforms and mobile apps that indicate the location and availability of these spaces before boarding can reduce stress and facilitate a smoother boarding process.
  - Technologies like AI-driven surveillance systems and smart locking mechanisms can be used to improve the security of bikes and luggage, addressing passenger concerns about theft or damage when items are stored away from their immediate reach.

Seamless Transfers Between Transport Modes

- Strengthening the connection between train services and other mobility options, such as bike-sharing systems, buses, and urban transport networks, will create a more cohesive travel experience. Enhanced intermodal integration allows passengers to move easily from one mode of transport to another, reducing the reliance on private vehicles.
- Building infrastructure like dedicated bike lanes leading directly to train stations and ensuring secure bike parking facilities are in place can make it more convenient for passengers to use bikes as their primary mode of transport for the first and last mile of their journey.

Collaborative Design Approaches. Involving Stakeholders in the Design Process

- Engaging passengers, cycling associations, and other stakeholders in the early stages of design through collaborative workshops can result in solutions that better address user needs. This approach helps create designs that

are not only functional but also widely accepted by the community they serve.

- Utilizing tools like 3D virtual models and full-scale mock-ups during the design phase allows stakeholders to visualize and provide input on proposed changes, leading to a more user-centric design that enhances overall passenger satisfaction.

Policy and Incentive Strategies

- Incentivizing Sustainable Mobility Choices
  - Offering incentives, such as discounts on train tickets for passengers who use bike parking areas or bike-sharing systems, can encourage more people to choose sustainable transport options. These incentives help to increase the adoption of bikes as a complementary mode of transport to trains.
  - Implementing policies that promote the use of bikes during off-peak hours through pricing strategies or reservation systems can help manage demand and reduce congestion during busy travel times.
- Support for Institutional and Policy Changes
  - Institutional support and clear policy frameworks are crucial for the successful integration of bikes and luggage into railway systems. Legislative backing can drive investments in innovative designs and infrastructure that meet the needs of modern travelers, promoting a more seamless multimodal transport experience

6 SURVEY INSIGHTS: OPERATOR PRACTICES AND CHALLENGES

As part of this study, a survey was conducted among several railway operators to gather insights into their current practices, challenges, and future directions for integrating bicycle and luggage services into rail systems.

The key findings are summarized below.

6.1 Current Practices

6.1.1 Bicycle Policies

Most operators allow bicycles onboard, with variations in restrictions based on train type (commuter, regional, long-distance) and service frequency. Some operators require advanced bookings, while others operate on a first-come, first-served basis.

Many operators provide dedicated bicycle spaces, but the capacity is often limited (typically 4-8 bikes per train). For high-speed rail, external or off-train bicycle transport solutions are more common.

6.1.2 Luggage Management

Most operators rely on self-managed luggage storage systems within trains, including overhead racks and dedicated luggage zones. However, concerns about safety, theft, and space availability were highlighted.

Advanced solutions like luggage delivery services, smart lockers, and tagging systems were mentioned as experimental or pilot initiatives.

6.2 Challenges Identified

- Balancing passenger seating with sufficient space for bikes and luggage remains a challenge, especially during peak hours. Operators often need to modify train layouts to accommodate both needs effectively.
- Handling oversized or unconventional luggage and coordinating with third-party services for bike transport adds complexity to operations.
- Boarding and alighting times are often impacted by inefficient luggage and bike handling.
- Many operators cited difficulties in managing customer expectations and ensuring seamless integration of bike and luggage services without disrupting other passengers.

6.3 Emerging Trends and Solutions

6.3.1 Digital Tools

Operators are increasingly leveraging mobile apps for reservations and real-time tracking of luggage and bike spaces. These tools improve operational efficiency and enhance customer satisfaction.

IoT-based luggage tagging and monitoring systems are under consideration for ensuring security and traceability.

6.3.2 Policy Adaptations

Dynamic pricing models, incentivizing off-peak bike and luggage use, and promoting external delivery services are emerging as practical strategies to balance demand and operational feasibility.

6.3.3 Sustainability Focus

Operators emphasize the role of bike integration in promoting sustainable mobility, with pilot projects aimed at improving first- and last-mile connectivity.

7 STRATEGIC SUMMARY AND FUTURE RECOMMENDATIONS

Integration of Bikes and Luggage in Railway Systems Enhances Multimodal Connectivity

- Successful integration of bikes and luggage in railway systems plays a crucial role in creating a seamless multimodal transport experience, encouraging the use of sustainable travel options over private vehicles.

Flexible and Modular Train Interior Design is Key

- Adopting flexible and modular interior designs in train carriages, such as foldable seats and adjustable bike racks, allows railway operators to dynamically adapt to passenger needs, maximizing space utilization during different travel periods.

Technological Innovations Improve Operational Efficiency

- Real-time information systems, AI-driven security features, and smart locking mechanisms for luggage and bike storage can significantly enhance passenger experience and streamline the boarding process.
- Digital platforms that inform passengers about available bike and luggage space prior to boarding help reduce confusion and optimize space usage.

Operational Challenges Persist in Accessibility and Space Management

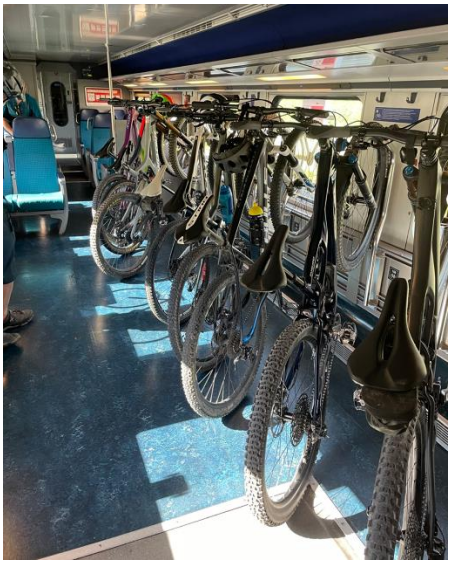
- Space constraints and accessibility issues remain a significant challenge, particularly during peak times when

competition between different user groups for limited space is high.

- Enhancing communication and customer awareness through better signage and clear instructions is crucial to minimizing these operational conflicts.

Collaboration with Stakeholders is Critical for Success

- Engaging with cycling associations, passenger groups, and other stakeholders during the design and implementation stages leads to more effective and user-centric solutions.
- Collaborative design approaches that involve stakeholders early in the process help to address their specific needs and expectations, resulting in higher acceptance of the solutions.



Policy Support and Incentives Drive Sustainable Mobility

- Strong policy frameworks and institutional support are essential for encouraging the integration of bikes and luggage into railway systems, promoting investments in necessary infrastructure and innovative designs.
- Offering incentives like reduced fares for bike users and differential pricing during off-peak hours can help manage demand and encourage sustainable transport choices.

Long-Term Vision for Sustainability

- In line with global sustainability goals, optimizing bike and luggage accommodations in railways can play a critical role in reducing carbon emissions and promoting eco-friendly multimodal transportation. By facilitating seamless connections between bicycles and public transit, rail operators can help decrease the reliance on individual cars and lower the overall carbon footprint of the transportation sector. This vision aligns with the European Green Deal and supports broader environmental policies aimed at promoting sustainable urban mobility.

Key Metrics for Success

- To evaluate the impact of bike and luggage integration efforts, it is essential to establish measurable indicators. Metrics such as increased bike usage on trains, enhanced passenger satisfaction scores, reduction in service delays related to luggage and bike accommodations, and maintenance cost savings can serve as benchmarks for success. These metrics provide a basis for assessing the effectiveness of specific initiatives and offer a clear framework for ongoing performance monitoring.

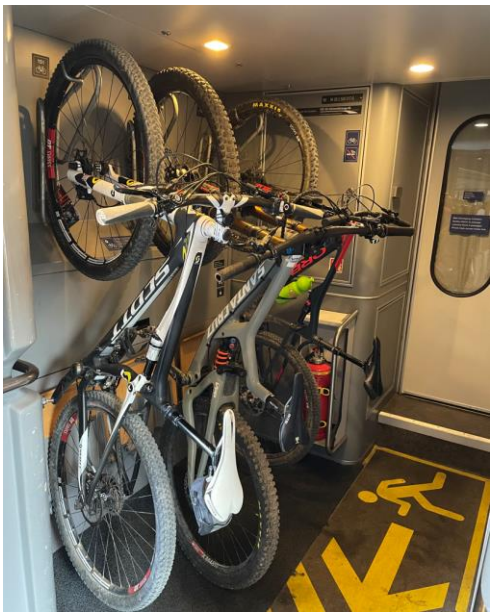
Technological Advancement and Adaptability

- To remain effective in the long term, bike and luggage transportation systems in railways must adapt to ongoing technological advancements. The rapid pace of innovation in digital monitoring, predictive maintenance, and secure storage solutions underscores the need for systems that can evolve with new technologies.
- Implementing modular, adaptable technology infrastructures will enable railway operators to incorporate future advancements, such as AI-driven asset management and enhanced IoT connectivity, without significant overhauls to existing infrastructure.

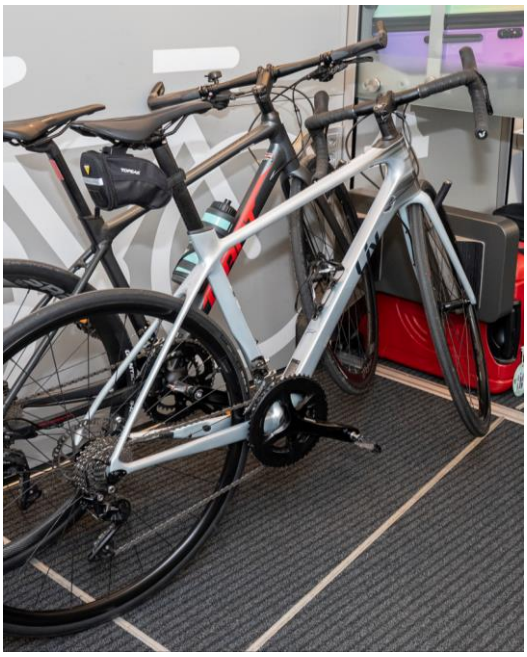
Operator Survey Recommendations

The insights from the operator survey underline the pressing need for practical and innovative solutions to address the challenges of integrating bikes and luggage into railway systems. Based on operator feedback, the following recommendations are proposed:

- **Modular Train Designs**: Train layouts should be adapted to include flexible, modular spaces that can accommodate bicycles and luggage during peak and off-peak times. Adjustable configurations can help optimize space utilization while balancing passenger comfort.



- **Advanced Digital Tools**: The adoption of mobile apps and IoT-based systems for real-time booking, luggage tracking, and bike reservations was highlighted as a key trend. Operators noted the positive impact of these tools on customer satisfaction and operational efficiency.
- **Dynamic Pricing Models**: Implementing pricing strategies that incentivize off-peak travel for bike and luggage users can help balance demand and reduce peak-hour congestion.
- **Collaboration with Third-Party Services**: Partnering with external delivery services for luggage and bicycles can offer seamless door-to-door solutions, especially for high-speed rail operators.
- **Sustainability Initiatives**: Integrating bicycles into rail systems as part of a broader push for sustainable mobility is a priority for many operators. Pilot projects aimed at improving first- and last-mile connectivity should be scaled and expanded.



Future Directions Should Focus on Enhancing Intermodal Connectivity

- Strengthening the links between train services and other modes of transport, such as bike-sharing schemes and urban transit systems, is crucial for developing a comprehensive mobility network.
- Investment in station infrastructure, including secure bike parking and charging facilities for e-bikes, will further support the integration of sustainable transport options into daily commutes.
- Integration with Broader Transportation Networks: The integration of bike and luggage transportation in rail systems should be viewed as part of a larger, interconnected transportation ecosystem. Enhancing coordination with bike-sharing systems, local transit networks, and regional transportation services can improve accessibility and provide passengers with a seamless travel experience.
- Creating multimodal hubs that facilitate easy transfers between bicycles, buses, and trains will further promote rail as a core component of sustainable urban transport.

Next Steps and Implementation Priorities

- Railways face the challenge of balancing between ensuring sufficient seat capacity on trains for regular daily users of our services (schoolchildren, students, commuters) and ensuring sufficient capacity for the growing needs of bicycle transport. They all face uneven demand depending on the desired travel time (peak hours, weekends, summertime, etc.). A combined strategy focus on giving the customer different alternatives (ensuring sufficient bicycle capacity on board but also at railway stations with enough and affordable bike-parking and bike-sharing, monitored transport of bikes in special wagons or using other means) seems the most reasonable answer to the current challenges.
- Immediate priorities for railway operators include standardizing bike storage facilities across networks, implementing real-time monitoring systems for luggage management, and developing staff training programs to improve operational handling.
- These steps will lay a foundation for efficient bike and luggage management, addressing current challenges while setting the stage for future improvements.
- Long-term goals should focus on system-wide integration, technology upgrades, and collaboration with policy makers to support sustained enhancements.

The presentations shared during the workshop are available online at https://uic.org/events/optimizing-bikes-and-luggage-transportation-in-railway-systems

To know more about UIC Customer Experience Platform do not hesitate to consult CEMP website