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Intermodal bike transit in Germany: Survey results on satisfaction, parking types and usage effects of improvements

COLLECTION: MOBILITY AND TRANSPORT

PEER-REVIEWED PAPER

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ABSTRACT

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Bike transit, the intermodal combination of rail and bicycle transport, can help shift traffic from cars to energy-efficient and climate-friendly modes – to a greater extent than rail alone can achieve, as bicycles substantially increase the catchment area of railway stations. Bike transit passengers are rail users who combine their rail journey with an (e-)bike for the first or last mile, by parking their bike at the station, using bike sharing for the first and/or last mile, or taking their bike with them on the train.

To estimate expansion needs and analyse the contribution to the mobility transition, the study 'BikeTransit' quantitatively examines the potential for modal shift from the combination of rail and bicycle by improving the framework conditions. Two types of surveys were conducted, a Germany-wide representative survey and online user-surveys at selected good practice locations. The user surveys at bicycle parking locations are discussed in this paper. They covered the use of bike transit and its changes over time in relation to quality improvements, as well as general mobility behaviour and socio-demographics.

The results show that bike and ride is primarily used by regular commuters: over 80% of respondents use bicycle parking at least weekly, and more than 70% of trips are work-related. The bike is mainly used as a first-mile feeder mode (62%), typically over distances of 1–3 km.

Overall satisfaction with the improved infrastructure is high (82%), particularly regarding accessibility, proximity to platforms and weather protection. However, security-related aspects remain a critical weakness: only 59% of users are satisfied with protection against theft and vandalism. Bivariate analyses show that infrastructure quality strongly correlates with user satisfaction. Secure, access-controlled facilities achieve the highest levels (over 90% satisfied) and are associated with higher-value bicycles and longer access distances, indicating that infrastructure quality is a relevant determinant of system performance.

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Regarding behavioural effects, the findings reveal a differentiated impact. While the majority of users report no change in usage frequency, 17% use bike transit more often after infrastructure improvements. Among these users, improved parking quality and increased capacity are the most frequently cited drivers. There are also indications of modal shift, with a share of users previously accessing stations by car or bus.

The findings suggest that improved bicycle parking infrastructure primarily stabilises and enhances existing bike transit use, while also enabling increased usage and potential modal shifts for a relevant subgroup. The results underline that not only the quantity but especially the quality and security of infrastructure are decisive for expanding bike transit in Germany.

INTRODUCTION: BICYCLE–RAIL INTEGRATION, BIKETRANSIT DYNAMICS AND RESEARCH GAPS IN GERMANY

The integration of bicycles and rail transport – commonly referred to as *bicycle–transit integration*, in our project called "*BikeTransit*" – is increasingly recognised as a critical component of sustainable mobility systems. In particular, it represents a key lever for the transformation towards sustainable mobility, as it addresses a structural gap in the transport system: medium-distance commuter trips for which cycling alone is too slow while rail alone lacks sufficient accessibility compared with private cars. By combining the door-to-door flexibility of cycling with the speed and capacity of rail transport, bike transit systems can significantly enhance the competitiveness of the environmental transport network (Martens, 2004; Kager et al., 2016; Kosmidis and Müller-Eie, 2024). The effectiveness of bike transit systems depends on the reliability of the entire travel chain. A crucial factor is that services are available for both the first and last mile. Only when passengers are confident that straightforward connecting transport is available at their destination will switching to a bike at the starting point become attractive. In this context, the limited capacity for carrying bicycles must be taken into account.

CATCHMENT AREAS AND SPATIAL DYNAMICS

A central mechanism underlying the effectiveness of bicycle–rail integration is the expansion of railway station catchment areas. While walking generally limits effective access to approximately one kilometre, bicycles can extend this radius to roughly 3–5 km for conventional cycles and up to 7–10 km for e-bikes (Midenet et al., 2018). This substantial increase in station accessibility allows rail systems to serve larger spatial areas without expanding physical infrastructure.

Empirical evidence from the Netherlands illustrates the magnitude of this effect. Average bike transit journeys reach distances of around 41 km, while the cycling component of these trips typically remains below five kilometres (Shelat et al., 2018). These findings underline the complementary relationship between cycling and rail: bicycles are primarily used for short feeder trips, while rail provides the long-distance component of the journey.

Importantly, travellers do not necessarily choose the geographically closest station. Instead, they often cycle further in order to access "higher-order" stations offering better service frequencies or direct connections (Jonkeren et al., 2021). This behaviour highlights the strategic role of station hierarchy and service quality in shaping bike transit demand. At the same time, the competitive relationship between access modes remains critical. Studies show that a high availability of free car parking at railway stations correlates with lower active mobility whereas restrictive car parking management combined with high-quality bicycle facilities can encourage modal shift toward cycling as an access mode (Chan and Farber, 2020; Weliwitiya et al., 2019).

INFRASTRUCTURE QUALITY AND USER SATISFACTION

While early bike and ride strategies focused primarily on the quantity of bicycle parking spaces, recent research emphasises a shift toward infrastructure quality and user experience. Secure and well-designed facilities are particularly important in the context of increasingly expensive bicycles, including e-bikes. For owners of high-value bicycles, perceived safety – such as visible and socially controlled spaces – and effective theft protection through access-controlled lockers or staffed facilities represent the most important determinants of facility use (Van der Spek and Scheltema, 2015).

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The importance of infrastructure quality is also reflected in user satisfaction levels. In Germany, only around five percent of users report being fully satisfied with current bicycle parking conditions at railway stations (Infostelle Fahrradparken, 2022). International experiences suggest that high-quality bicycle hubs can substantially increase the attractiveness of BikeTransit. These service-oriented facilities typically combine secure parking, repair services and bicycle sharing or rental, and have been widely implemented in countries such as Switzerland and the Netherlands (Molin and Maat, 2015).

Another critical factor concerns micro-accessibility at the station interface. Cyclists are highly sensitive to delays in the final metres of their journey, meaning that transfer infrastructure must allow rapid drop-off and retrieval of bicycles. For example, large vertical bicycle parking facilities must ensure efficient access systems in order to remain competitive with simple ground-level racks. This highlights that the success of bicycle–rail integration depends not only on network-level connectivity but also on the quality of the intermodal interface.

DIGITAL INTEGRATION AND INFORMATION SYSTEMS

Beyond physical infrastructure, digital service layers are increasingly shaping the seamlessness of bike transit journeys. Real-time information systems can significantly reduce uncertainty in the access stage of multimodal travel chains. In Utrecht, for example, the "P-route fiets" system provides real-time occupancy data for bicycle parking facilities via mobile applications and street-level signage, thereby reducing search time and improving the reliability of intermodal travel (Municipality of Utrecht, 2019).

Similarly, the integration of bicycle services into Mobility-as-a-Service (MaaS) platforms lowers barriers for occasional users. The Dutch *NS Business Card*, for instance, allows integrated access to rail travel, bicycle parking and bicycle sharing within a single payment and booking system, thereby simplifying the use of bike transit services (Kager and Harms, 2017). These digital integration strategies highlight the growing importance of service coordination in enabling seamless multimodal travel.

POLICY TRADE-OFFS: BICYCLE CARRIAGE VERSUS STATION PARKING

A recurring debate in the literature concerns the relative importance of bicycle carriage on trains (*bike-on-board*) compared with stationary bicycle parking at stations. Different national approaches illustrate distinct policy strategies (Martens, 2007; Nello-Deakin and Brömmelstroet, 2021).

The Dutch model relies heavily on extensive bicycle parking infrastructure combined with a "dual-bike" strategy, where commuters maintain separate bicycles at origin and destination stations or use bicycle sharing services such as the *OV-fiets* system. Despite strict restrictions on bicycle carriage during peak hours, the Netherlands maintains high bike transit usage rates due to the quality and scale of station parking infrastructure (Nello-Deakin and Brömmelstroet, 2021).

In contrast, regions such as Copenhagen or the Austrian region of Vorarlberg emphasise bicycle carriage through dedicated multi-purpose train compartments. While this approach is popular among users, it faces physical scalability limits under peak demand conditions, particularly in dense commuter corridors (Kosmidis/Müller-Eie, 2024). These contrasting strategies illustrate the importance of balancing infrastructure investments between stationary and mobile solutions within bike transit systems.

RESEARCH GAPS AND RELEVANCE FOR GERMANY

Despite the substantial body of international research, important knowledge gaps remain in the German context. While cycling accounts for approximately 11–12% of all trips in Germany, systematic data on bicycle access to rail stations remain limited because national travel surveys often focus only on the main transport mode and neglect access stages of multimodal journeys (BMDV, 2025). Consequently, reliable empirical insights into the determinants and impacts of bike transit behaviour are scarce.

Existing studies in Germany have primarily examined specific aspects of multimodal mobility – such as the spatial relationship between bike-sharing systems and public transport stations – rather than the broader dynamics of bicycle–rail travel chains (Schimohr and Scheiner, 2021). At the same time, current research highlights the need for better understanding of

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behavioural elasticities. In particular, it remains unclear how strongly improvements in bicycle infrastructure – such as enhanced parking quality – translate into modal shifts from car access to bicycle access at railway stations (Schüte et al., 2026).

This knowledge gap is particularly relevant given the significant theoretical potential of bike transit in Germany. Although bicycle–rail combinations currently account for only around 0.5% of all trips, estimates suggest that up to 40% of commuter trips could potentially be served by bike transit if infrastructure barriers were reduced (Allianz pro Schiene, 2022). Addressing this gap therefore represents an important step toward evidence-based policies supporting multimodal transport and the broader mobility transition.

METHOD: USER SURVEY ON IMPROVED BIKE PARKING AT RAILWAY STATIONS

The quantitative surveys conducted as part of the project aim at examining the use patterns of and satisfaction with three aspects of bike transit – bike and ride, bike sharing on the way to or from a train station and taking a bike on the train. Two types of surveys were conducted for this purpose, a Germany-wide representative survey and user surveys at selected good practice locations.

The user surveys for the use case bike and ride have already been concluded and are discussed here. For these surveys, 15 German railway stations have been selected that have experienced significant expansions and/or improvements in their bike parking infrastructure in the last 5 years. The selection covers a range of different spatial categories, train station types and bike parking types, ranging from unprotected and uncovered bike racks to protected bike parking garages. The selected stations were: Coesfeld (Westf), Dülmen, Eberswalde Hbf, Freising, Hamburg-Neugraben, Heitersheim, Koblenz Hbf, Köln-Süd, Niebüll, Nürnberg Hbf, Oranienburg, Rosenheim, Treysa, Tübingen Hbf.

At the bike and ride facilities of the stations and at bike parking in the direct surroundings, swing cards with QR-Code links to the online surveys and additional information were attached to all parked bicycles and to empty bike racks on a selected weekday in September and October 2025, supplemented by posters at selected spots at the bike and ride facilities. The surveys put a focus on the before-and-after perception of parking facilities after expansion or improvement, including questions on:

- type of bike transit use (first mile, last mile combined with train, both, different trip),
- bike and ride facility (type, overall and specific satisfaction, ticket type for paid parking, reasons for non-use of secured/paid),
- bicycle type and value,
- improvement of the facility (perception of improvement, usage before/since/after the improvement, impact on mobility behaviour),
- specific trip on the day of parking (distance by bike, type and distance of railway trip, other means of transport used on the trip),
- change in use of the bike and ride facility (use today and before improvement, reasons for difference in use, other means of transport used before),
- general mobility behaviour (use frequency of different modes) and
- sociodemographics (age, gender, education).

1,832 valid respondents participated in the online surveys, ranging from 5 respondents at the station with the lowest participation to 375 at the station with the highest response. Plausibility checks were applied to sort out replies with relevant inconsistencies.

A possible bias of the sample structure could be due to a self-selection of regular bike and ride users. Since the survey was only conducted at bike and ride facilities, it probably reached a higher share of regular bike and ride users than occasional users compared to the bike and ride user population. Additionally, regular users could show a higher interest in participating in the survey, potentially leading to a further self selection of this respondent group.

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The dataset was evaluated using the open-source statistics program JASP. In the preparation process of this article, the AI tool Google Gemini was used for formulation refinement, the tool DeepL was used to translate parts of the text from German to English language.

RESULTS: INFRASTRUCTURE CAN TRIGGER BEHAVIOURAL CHANGE

This section presents the results of the user surveys conducted at 15 selected good-practice railway stations in Germany where substantial improvements to bicycle parking infrastructure had been implemented in recent years. The analysis focuses on users of bicycle parking at stations, providing insight into their profile, travel behaviour and assessments of those already making use of bike and ride infrastructure under comparatively favourable conditions. Unless stated otherwise, percentages refer to valid responses. Where follow-up questions were only asked to subsamples, the corresponding denominator is reported in the text.

CHARACTERISTICS AND BEHAVIOUR OF THE PARTICIPANTS

Sample structure and sociodemographic profile

The survey comprises 1,832 respondents. The sample is slightly male-dominated: 57.2% identify as male, 41.5% as female, and 1.4% as other. In occupational terms, the sample is strongly shaped by regular commuters. Nearly four out of five respondents are employed, with 57.9% working full-time and 21.0% part-time. A further 15.2% are in education or training, most notably in higher education. This commuter-oriented structure is mirrored in educational attainment: 61.3% hold a university degree and another 8.4% a doctorate; together, almost 70% of respondents have tertiary education. The surveyed bike and ride users thus constitute a comparatively highly educated and economically active user group.

Household structures reveal a slightly bigger household size compared to the German average. The largest group lives in two-person households (37.6%), followed by four-person (20.2%) and three-person households (17.1%). Among respondents with valid information on children in the household, 38.2% report at least one child under 18. Overall, the sample can therefore be characterised as a predominantly employed, highly educated and everyday-mobile population with regular mobility obligations, compared with the average in Germany.

General mobility patterns and spatial context

The survey suggests that bike and ride at improved stations is primarily an element of routine mobility. Current use frequency of the bicycle parking infrastructure is high: 6.1% use it daily, 37.0% on four to six days per week, and 37.4% on one to three days per week. In total, 80.5% use the infrastructure at least weekly. Only 19.5% use it less than weekly. The distribution of respondents across the different frequency categories is illustrated in Figure 1. This is an important finding for the interpretation of all subsequent results: among the respondents of the survey the analysed infrastructure is used predominantly by habitual rather than sporadic users.[1]

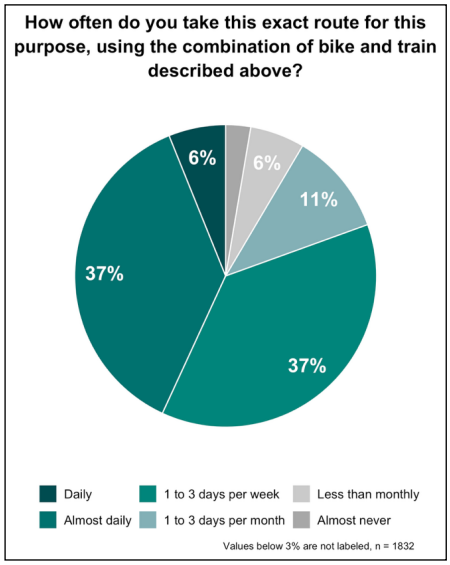

Figure 1 Answers to the question "How often do you take this exact route for this purpose, using the combination of bike and train described above?".

1 This could also be due to a self-selection of more frequent users, see methods chapter.

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The trip chains are oriented towards first-mile access to rail. 61.6% of respondents use the bicycle on the first mile only, i.e. from home to the departure station. Another 25.4% use the bicycle on both the first and last mile, while 13.0% use it on the last mile only. This is partly due to the survey design: While the survey just addressed those who parked a bike at the station and thus excludes bike-on-train-users who use the bike on the first and last mile, there are still users that use a second private bike or a sharing bike for the last mile. The dominant role of first-mile access underlines the function of bike and ride as a station-access strategy rather than a purely destination-oriented bicycle service.

The spatial structure of origins and destinations reinforces this interpretation. Respondents' residential locations are predominantly suburban or rural: 34.1% live in suburban areas, 28.7% in village contexts, and 20.8% in rural settings. Taken together, more than four fifths of the sample come from non-urban residential environments. In contrast, activity locations are more urbanised: 21.9% are in highly urban areas and 19.2% in urban areas, with a further 21.2% in suburban contexts. The data therefore point to a pronounced suburban-rural-to-urban commuting pattern in which bicycle access to rail helps bridge the first-mile accessibility deficit of non-urban residential areas.

This reading is also supported by rail use and ticketing. 92.8% of respondents use regional rail only, while just 3.1% use only long-distance rail and 4.2% use both. Moreover, 89.9% hold a *Deutschlandticket*, a national flat rate ticket for public transport. The improved bicycle parking infrastructure is thus embedded mainly in daily regional mobility rather than in long-distance travel.

Bicycle type, bicycle value and trip purpose

The bicycle fleet used at the surveyed stations is still dominated by conventional bicycles, which account for 88.7% of all responses. E-bikes and pedelecs represent 10.2%, while cargo bikes and bicycles with trailers remain a small niche at 1.0%. At the same time, the distribution of bicycle values shows that bike and ride users are not parking only low-cost bicycles. Although 55.3% of bicycles are valued below EUR 400, 30.6% are worth EUR 600 or more, and 17.4% exceed EUR 1,000. Figure 2 shows the distribution of the estimated values of bicycles parked at the surveyed stations. The presence of a substantial share of higher-value bicycles is highly relevant for the assessment of infrastructure needs: protection against theft, weather exposure and damage is not a marginal quality feature, but a central precondition for use.

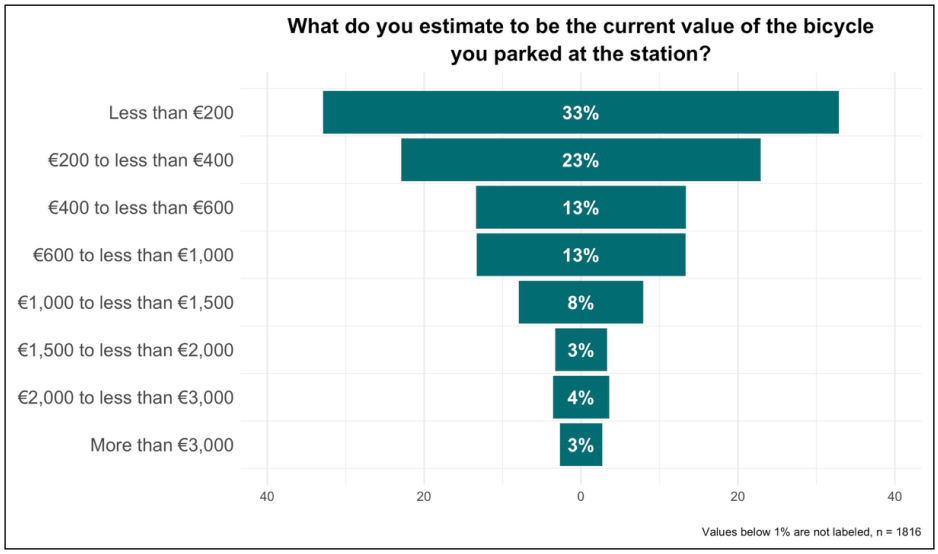

Figure 2 Answers to the question "What do you estimate to be the current value of the bicycle you parked at the station?".

The surveyed bike and ride trips are strongly work-related. Work is cited as trip purpose by 70.8% of respondents. Education follows at 12.4%, while leisure (9.3%) and visits (8.8%) are clearly less frequent. Shopping, errands and business trips each remain below 4%. The distribution of trip purposes is presented in Figure 3. In combination with the high weekly use frequency, this confirms that the observed demand of the respondents[2] is driven primarily by regular commuting rather than by occasional discretionary trips.

2 Again, this could partly be caused by the sample structure dominated by more frequent users, see method section.

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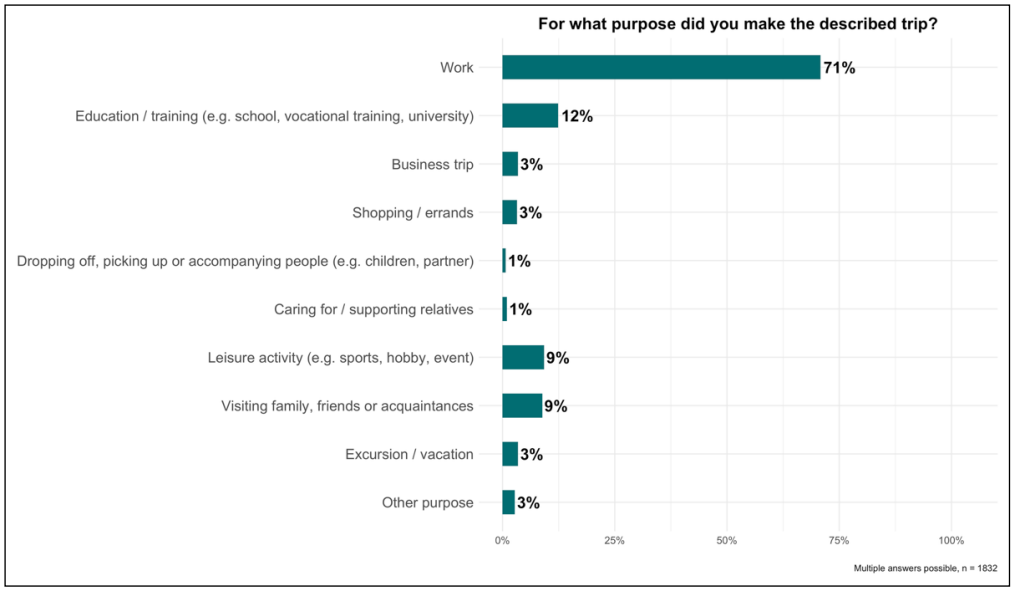

Figure 3 Answers to the question "For what purpose did you make the described trip?".

The access distances by bicycle are moderate but clearly beyond typical walking catchments. The largest groups cycle 1 to under 2 km (34.5%) and 2 to under 3 km (29.2%) to or from the station. In total, 83.9% cover less than 4 km, and 90.8% less than 5 km. The distribution of bicycle access distances is illustrated in Figure 4. This distribution corresponds closely to the expected feeder function of the bicycle and confirms that improved parking infrastructure is particularly relevant in the classic bike and ride range of short to medium station access trips.

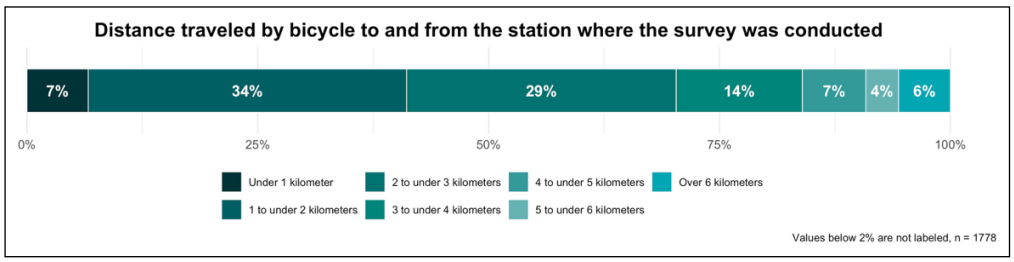

Figure 4 The reported distance travelled by bicycle to and from the station.

IMPACT OF INFRASTRUCTURE IMPROVEMENTS

Assessment of the improved infrastructure

Overall satisfaction with the current parking situation is high. Across all respondents, 34.9% are very satisfied and 46.6% rather satisfied, resulting in a total satisfaction rate of 81.5%. Only 18.5% are rather or very dissatisfied. Overall satisfaction and the ratings of individual infrastructure attributes are presented in Figure 5. At first glance, this suggests that the selected stations do indeed function as good-practice cases from the user perspective.

A differentiated view of the individual quality dimensions, however, reveals a more nuanced pattern. Satisfaction is highest for proximity to the platform or tracks: 71.9% are very satisfied and another 24.8% rather satisfied. Accessibility is also rated very positively, with 88.8% satisfied overall. Protection from weather is similarly strong at 84.2% satisfied. These dimensions indicate that the surveyed facilities largely succeed in delivering convenience and functional integration into the station environment.

By contrast, the more security-related dimensions are evaluated less favourably. Satisfaction with protection against theft and vandalism reaches only 58.6%, while 35.5% are dissatisfied. Cleanliness is likewise mixed, with only 62.2% satisfied and 37.1% dissatisfied. Perceived personal safety is better than theft protection but still clearly weaker than the functional dimensions, with 72.2% satisfied and 26.1% dissatisfied. Service aspects are the weakest dimension overall, although this result is partly driven by a large share of "don't know" responses. The pattern is analytically important: improved infrastructure appears to have solved problems of accessibility and weather protection more consistently than problems of security and service quality.

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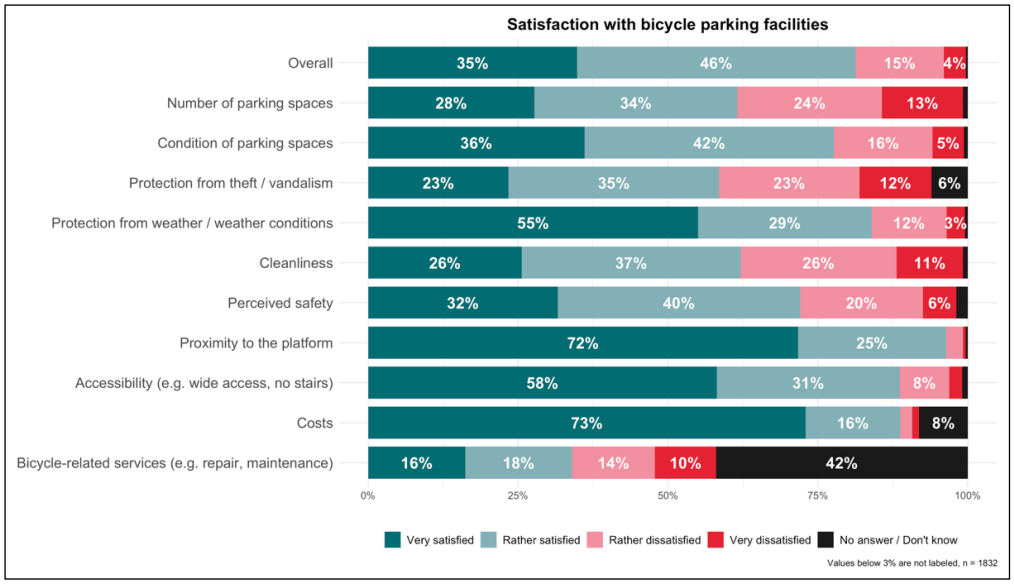

Figure 5 Reported satisfaction with the bicycle parking facilities.

Two further findings sharpen this interpretation. First, 66.0% of respondents report that they noticed the infrastructure improvements, while 10.9% say they did not and 23.1% are unsure.[3] Second, although the stations were selected as good-practice cases, only a small minority of users report complete satisfaction with some crucial quality dimensions, especially anti-theft protection. This suggests that even among improved sites, qualitative upgrading remains incomplete from the user perspective.

Reported behavioural effects of the infrastructure improvements

The central question for the policy relevance of Bike and ride infrastructure is whether improved facilities merely enhance comfort for existing users or whether they also induce behavioural change. The survey points to both effects.

Among the respondents who had already used the same trip before the infrastructure upgrade (46.8% of the full sample; n = 857), 70.2% report using the bicycle-rail combination just as often as before. At the same time, 17.0% report using it more frequently today, whereas 12.7% state that they use it less frequently. This indicates that infrastructure upgrades do not automatically transform behaviour for the majority of existing users. Rather, the dominant effect is stabilisation and quality enhancement of an already established Bike and ride practice. Nevertheless, the share reporting more frequent use is substantial enough to be policy-relevant.

This is reinforced by the follow-up items on reasons for increased use. Within the subgroup reporting more frequent use and answering the corresponding item battery, 39.7% mention better bicycle parking facilities and 34.9% mention a greater number of bicycle parking spaces as a contributing factor. These shares are remarkably high given that modal behaviour is usually shaped by multiple simultaneous influences. Improvements in parking quality therefore emerge not merely as background conditions, but as explicitly perceived drivers of changed behaviour.

At the same time, the survey indicates that the effects are heterogeneous rather than universal. In another follow-up item with a broader response base, 54.7% report that the improvements had no influence on their bicycle-rail use. Similarly, among respondents with valid answers to a dedicated item on behavioural response to the improvement (n = 548), 76.8% state that they now use the bicycle-rail combination more frequently, but this item clearly refers to a selected subgroup and should not be generalised to the full sample. Taken together, the results suggest a differentiated interpretation: infrastructure improvements often increase the attractiveness of Bike and ride and can trigger additional use in a relevant subgroup, but they do not mechanically produce frequency increases for all users.

There are also first indications of modal substitution. Among the subgroup that reports more frequent current use and provided information on previous behaviour (n = 146), 32.9% state that they had previously used the private car as driver, and 28.8% report former bus

3 With a filter question, the survey controls for the fact that the respondents have used the infrastructure before the improvement.

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use. Although these items are multi-response and relate only to a restricted subgroup, they nevertheless indicate that improved Bike and ride infrastructure can support shifts away from motorised access modes.

CORRELATIONS BETWEEN BICYCLE PARKING TYPE, BIKE TYPES AND USER SATISFACTION

Bivariate analyses of selected aspects deepen these findings in different respects.

Satisfaction with bike parking and parking type

First, satisfaction differs strongly by bicycle parking infrastructure type. The association between parking type and overall satisfaction is statistically highly significant (χ^2 = 384.0; df = 18; $p < 0.001$; N = 1,781). Access-controlled facilities perform best. For bicycle boxes, 72.2% of users are very satisfied; for access-controlled collective facilities or secured bicycle parking garages, the share is 63.3%. Freely accessible parking garages also score highly, with 47.0% very satisfied. In contrast, only 21.1% of users of covered racks or double-deck systems are very satisfied, and among users of freestanding parking not a single respondent reports being very satisfied. These ratings show: not all additional bicycle parking is equal. Security and enclosure matter systematically for the level of user acceptance.

The freely accessible bicycle parking garage and covered bicycle racks are the most common types (N = 600 and N = 583, respectively). While most users are satisfied with these facilities, the increasing number of responses in the 'somewhat dissatisfied' category shows that free access can come at the expense of a sense of security.

The lowest acceptance rates are found for free-standing parking and bicycle racks without leaning options ('rim killers'). Significantly, not a single user in the 'free-standing' category stated that they were 'very satisfied'; instead, more than half of this group is dissatisfied (42 out of 69 users).

Kendall's tau-b value of 0.371 ($p < 0.001$) shows the strength of this correlation. Since the facility variable was recoded hierarchically (from 1 = high protection to 7 = no protection) and the satisfaction scale is also coded in ascending order (1 = very satisfied to 4 = very dissatisfied), the positive coefficient confirms that as the level of protection of the facility decreases, user satisfaction decreases systematically and significantly.

By dichotomising the different types of bike parking regarding a) weather protection and b) theft protection, we could show how relevant these factors are for user satisfaction. Regarding weather protected bike parking (N = 1,496), over 86% of users (1,291) in this group are satisfied ('very' or 'somewhat satisfied'). The 'very satisfied' group is strongly represented here with 602 people. For the non- weatherproof parking (N = 285), satisfaction drops significantly. Only 11% (31 out of 285) are 'very satisfied'. In contrast, the proportion of dissatisfied users ("somewhat" and 'very') is almost three times higher at just under 41% (116 out of 285) compared to 14% in the protected group (χ^2 156.18, df = 3, $p < 0.001$, Kendall's Tau-b 0.271).

Contrasting secured vs. non-secured bike parking shows: secured parking, like lockable bicycle boxes and secured parking garages, scores significantly higher on user satisfaction. Almost 95% of users (293 out of 307) are satisfied. The percentage of those who are 'very satisfied' is particularly impressive: at 63.8% (196 people), this figure is well above the average for all other categories. For non-secured parking (N = 1,474), the picture is much more diffuse, but differs strongly from the secured ones. Although many users are 'somewhat satisfied' (730 people), the proportion of dissatisfied users is 20.8% (307 out of 1,474), more than four times higher than in the secure group, with approx. 4.5% (χ^2 139.23, df = 3, $p < 0.001$. The results show that both a roof and a secured parking lead to a high rate of highly satisfied users and reduce the ratio of unsatisfied ones.

Another finding is that: Only 34% of people who do not use secure, paid-for facilities are satisfied with the alternatives: 51% do not want to pay anything, and 19% consider the service to be too expensive (Multiple answers were allowed). A review of the above results shows that, while many Bike and ride users would like greater security, they are comparatively unwilling to pay for it. This is also evident from the fact that secure, paid-for bicycle parking facilities are often less utilised than free ones.

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Type of bicycle and satisfaction with infrastructure

Additionally, we took a closer look to the connections between the type and value of the used bikes and the evaluation of the infrastructure quality – which also correlate significantly. E-bike users are more satisfied overall than users of conventional bicycles: 51.3% of e-bike users are very satisfied, compared with 32.9% among users of conventional bicycles. At the same time, descriptive analyses by parking type show a clear sorting effect by bicycle value. The median bicycle value is highest in bicycle boxes (EUR 1,250) and in access-controlled facilities (EUR 800), but much lower in freely accessible parking garages (EUR 300) and particularly in simple covered racks and double-deck systems (EUR 300). This suggests that higher-quality facilities attract or enable the parking of more valuable bicycles. In turn, this likely strengthens the relevance of secure parking as e-bike diffusion continues.

INTERPRETATION

Overall, the results portray improved Bike and ride infrastructure at German good-practice stations as a functional backbone of routine commuter mobility. The users are predominantly regular regional rail commuters from suburban and rural residential contexts, and they use the bicycle primarily as a first-mile feeder mode over distances of roughly one to five kilometres. The improved infrastructure is assessed positively in overall terms, particularly with regard to location, accessibility and weather protection.

However, security-related dimensions remain clearly more contested, which is especially relevant in light of the non-negligible share of higher-value bicycles in the sample.

The analyses reveal a close interplay between users' need for security, the value of their bicycles and their willingness to pay for parking. The 'station bike' is a rational strategy. The prevalence of low-cost bicycles (with over 55% costing less than EUR 400) could be a direct response to perceived insecurity. Concerns about theft and insufficient secure parking may encourage users to leave lower-value bicycles at stations in order to reduce financial risk. Quality as an enabler of reach: The bivariate analyses illustrate that the quality of the infrastructure is crucial; secure, access-controlled facilities are associated with significantly higher satisfaction (Kendall's tau-b = 0.371; $p < 0.001$), more valuable bicycles (averaging up to EUR 1,556) and longer feeder distances. In essence, this suggests that mobility outcomes depend not only on the quantity of parking spaces, but also on the level of security. A critical finding is the discrepancy between the desire for security and the willingness to pay for it. 51% of non-users of secure facilities reject pay-to-use models outright, while only 34% are truly satisfied with free alternatives. This suggests that bicycle parking is perceived as part of the state's free public services.

From a behavioural perspective, the findings point less to a simple "build it and everyone will switch" effect than to a dual mechanism. For the majority, better infrastructure does not change the behaviour. A higher satisfaction with a better system could stabilise an existing bike and ride practice – this would need to be shown in a longitudinal study. For a relevant minority, the improvements are associated with more frequent use and, in some cases, with shifts away from car-based or bus-based access. The bivariate analyses further indicate that the quality of infrastructure is decisive: secure, access-controlled facilities are correlated with markedly higher satisfaction, more valuable bicycles and longer access distances.

The results show that the impact on mobility depends largely on whether bike and ride infrastructure suppliers succeed in closing the safety gap without creating new economic barriers. For a large-scale modal shift that relies on the use of e-bikes, the provision of high-quality yet accessible infrastructure seems to be the key prerequisite.

DISCUSSION: BARRIERS AND POTENTIALS

The findings of the user survey provide valuable insights into the dynamics of bike transit in Germany, but represent only an interim stage of the research. The findings raise questions that will need to be examined in greater detail as the project progresses and the non-representative regional good practices will be compared with survey results from the Germany-wide sample.

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ECONOMIC BARRIERS TO ACCESS AND USER EXPECTATIONS

A key area of tension emerges regarding willingness to pay. Whilst the need for security is high, the rejection of payment models by 51% of non-users suggests that the economic design of the facilities is a critical success factor. As the project progresses, it must be examined to what extent the current pricing of secure facilities, compared to often free car parking spaces (P+R) in suburban areas, constitutes a barrier. Further analysis is required to determine whether alternative financing models – such as greater integration into existing fare structures or the Deutschlandticket – could significantly increase acceptance, or whether other factors, such as ease of access, carry greater weight.

QUALITY AS A PREREQUISITE FOR THE E-BIKE SECTOR

The correlation between facility quality and bicycle value suggests that high-quality infrastructure acts as a technical 'enabler'. Nevertheless, we must critically examine why some of these facilities are underutilised despite their high quality. The project still needs to clarify whether this is due to the choice of location, pricing or insufficient information flows. It must be examined what level of security is actually necessary for which user group (station bike users vs. e-bike commuters) in order to design a comprehensive scaling strategy efficiently.

SYNERGIES AT THE DESTINATION: SHARING AND SECOND BIKES

The survey highlights the importance of the 'first mile'. However, the applicability to the 'last mile' remains open. As capacity for carrying bikes on trains is limited, further research must examine the role played by bike-sharing schemes and the parking of second bikes at destination stations. Further analysis is required here regarding the optimal integration of these services to enable seamless intermodal travel chains.

SCALABILITY AND TRANSFERABILITY

The study of the 15 good-practice sites provides initial insights into the conditions for success. However, it remains to be verified to what extent these findings can be applied to the more than 5,000 railway stations in Germany, each with highly varied spatial conditions. Further analyses within the project must clarify which specific packages of measures achieve the greatest leverage for different types of stations (from rural stops to urban hubs).

PRELIMINARY CONCLUSIONS AND FURTHER RESEARCH NEEDS

The user surveys at 15 good-practice railway stations provide targeted insights into the role of improved bicycle parking infrastructure for bike transit in Germany. With regard to the paper's scope – usage patterns, user satisfaction and behavioural effects – three main findings emerge.

First, Bike-and-Ride is clearly a routine, commuter-based mobility practice. Most users access stations by bicycle on a weekly basis, mostly for work trips and over distances of one to five kilometres. The spatial patterns underline the role of bike and ride as a relevant solution for the first mile – and, for a strong minority, also for the last mile.

Second, infrastructure quality and especially security emerges as a decisive factor. While overall satisfaction is high, significant deficits remain regarding theft protection. Bivariate analyses show that secure, access-controlled facilities achieve substantially higher satisfaction levels and are associated with higher-value bicycles and longer access distances. This indicates that infrastructure quality is not merely a comfort feature, but a key enabling condition for bike transit use.

Third, the behavioural effects of infrastructure improvements are differentiated. A majority of users report no change in usage frequency. However, a relevant minority reports increased use, and improved parking quality and capacity are identified as important drivers. There are also indications of shifts from car- and bus-based access modes, although these effects remain limited.

A key tension emerges between high demand for secure infrastructure and low willingness to pay. While secure facilities generate the highest satisfaction, many users reject paid options, pointing to the importance of pricing and institutional design for scaling bike transit.

Overall, the findings suggest that expanding Bike-and-Ride in Germany requires a stronger focus on quality – particularly security – rather than quantity alone. At the same time, the results are limited by the focus on existing users at good-practice sites and potential self-selection effects. Further analyses are needed to assess transferability and to quantify the impact of infrastructure improvements on modal shift at the system level. In particular, the question of how to resolve the discrepancy between the desire for safety and the low willingness to pay remains a key research task for the next phase of the project.

DATA ACCESSIBILITY STATEMENT

After finalisation of the research project, the survey data will be made accessible. A link to the data will be added to the project website: https://wupperinst.org/p/wi/p/s/pd/2408/.

ADDITIONAL FILE

The additional file for this article can be found as follows:

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The authors have no competing interests to declare.

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