


Streamline Adaptability


Future of Sustainable Mobility
in Germany with Kalkhoff Bikes



Strategic Product Design Master's Thesis

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 KALKHOFF

 TU Delft

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Executive Summary

This project addresses the challenge of developing a clear and actionable product vision for Kalkhoff, an e-bike manufacturer, in the evolving landscape of sustainable mobility. The project leverages a structured design approach grounded in the context of Hamburg, Germany, a major European city committed to promoting cycling.

By employing a double diamond design process, the project explores future mobility trends, user needs, and competitor strategies. This analysis informs the creation of a future scenario for sustainable urban mobility in Hamburg by 2035. The scenario serves as a foundation for developing product concepts that address user needs and align with market demands.

The project utilizes co-creation with stakeholders and prototyping to refine the concepts. Ultimately, the project delivers three product concepts, a functional prototype of the most promising concept, and a strategic roadmap for product development. These outputs serve as boundary objects, enabling Kalkhoff to visualize its future product strategy and navigate the opportunities within sustainable mobility.

This project contributes to design research by demonstrating user-centered approaches to strategic product vision development for sustainable mobility, offering a valuable framework for companies seeking innovation in a rapidly changing market.

Key Outcomes of the Project

*2+ Product concepts
with 1 workable prototype*

1 Strategic Roadmap

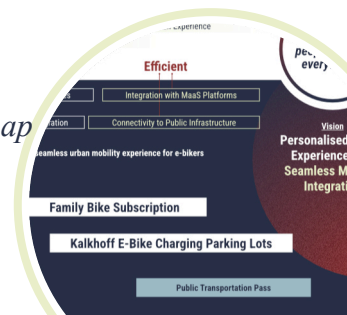


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Introduction

Ch. 1

Context and Background

By 2030, the EU aims for 100 cities to be climate-neutral, with a focus on reducing car usage and reallocating public space for sustainable mobility (European Commission, 2021). This trend is driving demand in Germany's bicycle market, particularly for electric bikes, with a projected annual growth rate of 0.21% and a market volume of \$7.69 billion by 2029 (Statista Research Department, 2024). In this context, Kalkhoff faces significant opportunities to strategically position itself within these evolving scenarios to enhance its business prospects.

Problem Definition

In the context of sustainable mobility, a significant challenge for mobility providers like Kalkhoff is the development of a practical product strategy that aligns with future-oriented trends. While the emphasis on sustainable mobility presents numerous opportunities, creating a concrete product vision based solely on speculative future scenarios is inherently difficult. **This project aims to bridge this gap by developing a clear and actionable product vision for Kalkhoff, enabling the company to better understand and navigate the opportunities and challenges presented by the shift towards sustainable mobility.** By creating a boundary object—such as a strategic roadmap or prototype—this project will provide Kalkhoff with a solid starting point for refining its product strategy and guiding iterative product design, ultimately adding value to the company's long-term objectives within the sustainable mobility landscape.



Hamburg

While the emphasis on sustainability offers numerous opportunities for mobility providers, formulating a concrete product vision based solely on speculative future scenarios is challenging and complex. To address this issue, this project will be grounded in a real-world context, employing a structured design approach based on empirical research. According to (Galvin & Morkel, 2001), the bicycle market in Germany is highly fragmented. Thus, it is necessary to select a representative German city to develop a comprehensive understanding of market conditions nationwide. Hamburg has been chosen as the target city for designing a future scenario of sustainable urban mobility for several reasons. First, as Germany's second-largest city, Hamburg reflects the demographic characteristics of the country, including an aging population, a diverse migrant community, and a significant proportion of younger families (Statistische Bundesamt, 2024). Second, Hamburg serves as a major economic hub within a large metropolitan region, characterized by high consumption patterns among middle-class and professional workers (Pohl, 2010). Finally, the city's local government has implemented ambitious policies to promote cycling, supported by extensive bike infrastructure, including at least ten dedicated bike routes that connect various parts of the region (Hamburg.de, 2024). This well-developed infrastructure fosters a culture of sustainable living and provides an ideal platform for launching innovative mobility solutions.

Methodology & Assignment

The outlined goals and research scope lead to the formulation of the following research questions:

How will the concept of mobility evolve by 2035, and what role can bicycles play in shaping sustainable urban mobility in Hamburg?

Addressing this question will provide a comprehensive understanding of the opportunities and challenges that stakeholders face in aligning with the broader trends in sustainable mobility. The insights derived from this analysis are essential for developing innovations that respond effectively to market expectations.

Consequently, it is necessary to explore:

What are the primary mobility needs and preferences of Hamburg residents in 2035?

How can Kalkhoff products be designed to meet customers' expectations in 2035?

These research questions aim to ensure that future product offerings are tailored to meet evolving consumer demands and align with the emerging landscape of urban mobility.

To develop a comprehensive future mobility scenario, the project will be structured following the double diamond design process, divided into two main phases. The first phase will concentrate on context analysis and problem framing, focusing on understanding global, industry, company, and user needs. This phase will involve a trend analysis

through an extensive literature review and PESTLE analysis, considering multiple perspectives. Concurrently, brand-product research will be conducted to gain a holistic understanding of Kalkhoff and its competitors within the e-bike market.

Additionally, user research will be undertaken in Hamburg using context mapping techniques to identify the values and goals of potential users. The insights obtained will be synthesized to construct a detailed future scenario, utilizing user journeys and customer segmentation to inform the design direction.

In the second phase, the focus will shift to concept development using methodologies such as Vision in Design, value proposition design, and co-creation with stakeholders. The concepts will be prototyped and evaluated to assess their effectiveness. Based on the most viable solutions and business models, a strategic plan will be developed to integrate these new minimum viable products (MVPs), ensuring both feasibility and alignment with future market demands.

The final outputs of this project—a functional prototype of the MVP and a strategic roadmap—will serve as boundary objects. These deliverables will effectively map the future mobility scenario, providing Kalkhoff with a robust foundation for refining its product strategy and adding value to the company's long-term objectives within the sustainable mobility landscape.

METHODOLOGY - DOUBLE DIAMOND DESIGN PROCESS

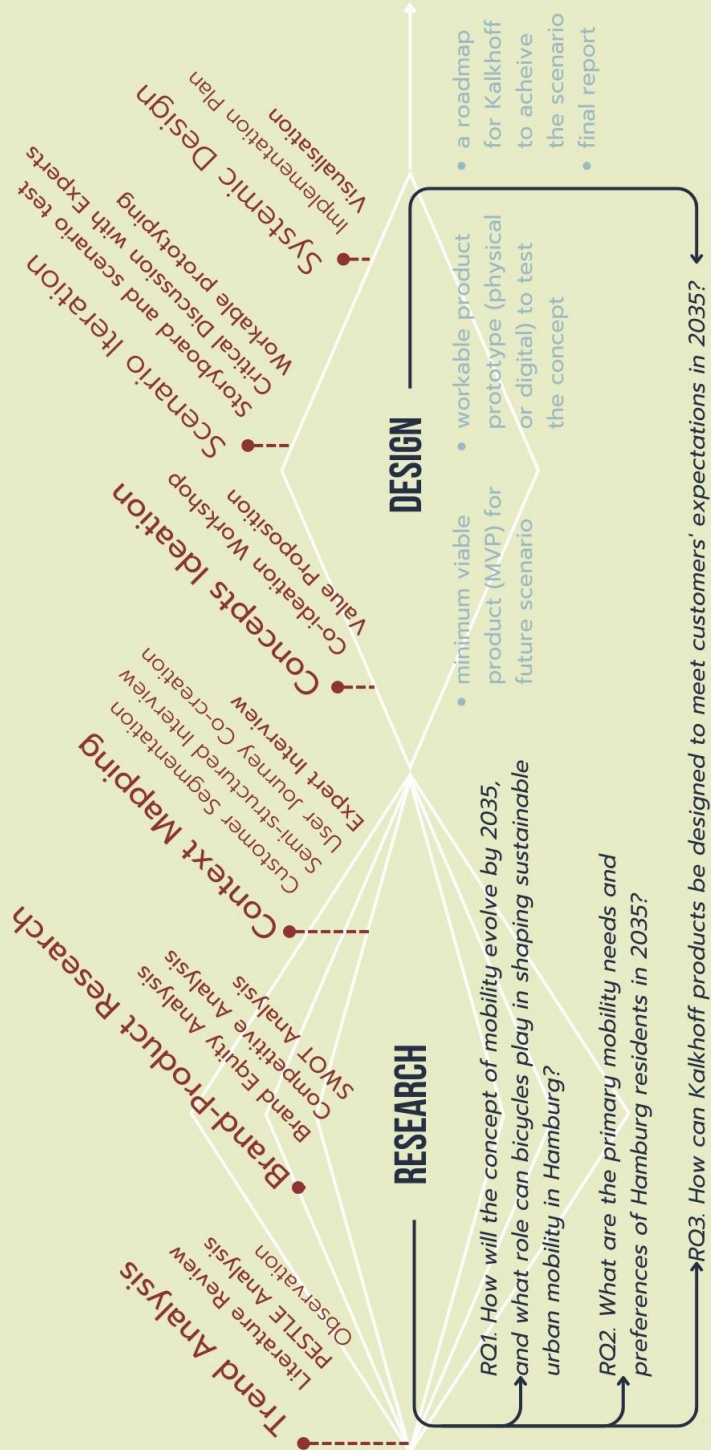


Figure 1. Methodology

Trend Analysis

Ch. 2

Trend Analysis

Research Question 1

How will the concept of mobility evolve by 2035, and what role can bicycles play in shaping sustainable urban mobility in Hamburg?

Research Question 1 serves as the foundation and starting point for examining the factors influencing mobility choices. A literature review has been conducted to synthesize existing research and identify knowledge gaps. This approach not only provides a contextual framework but also highlights critical influential factors that inform further analysis. These insights are integrated into a PESTEL analysis, which systematically evaluates six macro-environmental dimensions to anticipate future shifts. The analysis identifies four key themes, offering valuable insights from trend analysis that can be strategically applied in the design phase to address emerging mobility needs effectively.



Literature Review

Urban mobility faces numerous challenges as cities grow and evolve. Urban traffic congestion in Europe and globally leads to significant time and economic losses. Studies estimate that congestion wastes billions of hours and gallons of fuel annually, costing billions of dollars (Bertini, 2005). The average time lost in congestion varies across cities, with some experiencing up to 82 hours of delay per commuter annually (Schrack et al., 2015). Car-centric urban planning has led to significant space allocation for automobiles at the expense of sustainable mobility options and liveable environments (Gössling, 2020; Szell, 2018). This imbalance results in traffic congestion, air pollution, overcrowded public transport, and reduced quality of life (Gatarin, 2022; Rode, 2013). Cities are implementing Intelligent Transport Systems (ITS) and sustainable mobility solutions to solve these problems and improve the quality of life, reducing environmental impact, and creating liveable cities (Waqar et al., 2023).

Intelligent Transport Systems (ITS) use technologies like GPS and IoT to improve transportation efficiency, safety, and sustainability, addressing issues such as traffic congestion and accidents (Zear et al, 2016).

E-micromobility, including e-scooters and e-bikes, provides sustainable options for short urban trips, growing rapidly through sharing services and appealing to younger users. Key benefits are flexibility and speed, while concerns include safety and road user conflicts (Şengül et al, 2021).

Sustainable mobility aims to meet society's transportation needs without compromising future generations' ability to do the same (W. Black, 2004). Some strategies to promote sustainable mobility include promoting walking and e-micromobility, public transit, and shared mobility options as alternatives to private car use (Arsić & Jovanović, 2024). The rise of e-micromobility, including e-bikes and e-scooters, offers an affordable, higher-quality alternative to public transport and can replace some car-based trips (Bai et al., 2019). To follow the shift in urban mobility behaviour and promote sustainable mobility, it is essential to design products that incorporate external factors and shape user behaviour (Weiser et al., 2016). Additionally, understanding the context and dynamics is important when formulating service responses to urban mobility needs (Dimitriou, 2006).

PESTEL Analysis



Various trends influence mobility, including economic factors, urbanization, environmental concerns, the rise of the digital society, the emergence of new business models, safety and security issues, and legislative frameworks .

To examine the external factors impacting Kalkhoff, an e-bike manufacturer in Germany, particularly in Hamburg, a PESTEL analysis is utilized. PESTEL is a strategic framework designed to evaluate macro-environmental factors affecting an organization's performance. It systematically explores six key dimensions: Political, Economic, Social, Technological, Environmental, and Legal, with some variations including additional factors. According to Hekkert and van Dijk (2011), factors can encompass observations, theories, laws, considerations, beliefs, or opinions. This analysis primarily draws on factors identified in scholarly journals and reputable news sources to ensure relevance and credibility.

PESTEL is particularly valuable for identifying opportunities and risks associated with new business ventures or market entry and is frequently employed alongside complementary frameworks, such as SWOT analysis, to provide a comprehensive strategic evaluation (Helmold et al., 2020).

2.2.1 Political Factors

Government Promotion of Sustainable Mobility

The German government has actively pursued policies to support sustainable transportation transformation. Through funding programs and greenhouse gas reduction targets, these initiatives have significantly advanced e-mobility adoption (Cimen et al., 2014). E-bikes align with Germany's climate policy goals by demonstrating strong potential to replace car usage for shorter trips (Kämper et al., 2016). National policy frameworks actively facilitate this transition by investing in cycling infrastructure and implementing regulatory measures that encourage sustainable urban mobility (Buehler, 2009).

Limitations of E-Mobility Policies and Pressure from the Traditional Auto Industry

The National Platform for Electric Mobility (NPE) has played a significant role in shaping Germany's e-mobility strategies; however, its focus has predominantly centred on electric cars, often neglecting broader mobility solutions such as e-bikes (Richter & Haas, 2020). This narrow emphasis represents a missed opportunity to leverage e-bikes as a scalable and sustainable alternative for urban mobility. Furthermore, evolving local political dynamics significantly influence the implementation of transportation strategies (Hinkelmann, 2024). Germany's transition to e-mobility has also revealed underlying tensions within its traditional automotive-centric economic model. The lack of coordination among automotive stakeholders, state entities, and private businesses poses a risk to the stability and evolution of the nation's established economic framework (Jackson, 2024).

Nationale Plattform

Elektromobilität, a German government advisory board founded in 2010, monitors and analyzes developments in electromobility, connecting key actors from industry, science, politics, unions, and syndicates (Nationale Plattform Zukunft der Mobilität, 2024).

Urban Modification and Infill Development

Local governments in Germany are increasingly prioritizing sustainable urban development to foster healthier communities and environmentally friendly mobility (Pooley, 2013). Urban mobility strategies have shifted focus from expansion to modification, with an emphasis on sustainability and integration (Zumkeller et al., 2004).

A key approach is infill development, which involves repurposing underutilized urban land to support sustainable mobility initiatives. This strategy mitigates urban sprawl, enhances population density, and revitalizes neighbourhoods (McConnell & Wiley, 2012). Germany has effectively implemented infill development to create car-free zones and expand cycling infrastructure. These efforts often include reallocating road space from cars to cycling lanes and integrating land-use planning with mobility hubs. However, successfully implementing such strategies requires collaborative decision-making, specialized expertise, and active engagement of stakeholders (Puustinen, 2015). Recognizing this, the German Ministry of Transport and Mobility Transition launched the Alliance for Cycling and Pedestrian Traffic for the Hamburg metropolitan region. This initiative aims to develop systematic solutions for sustainable mobility through collaboration with various stakeholders (Hamburg.de, 2022).

Alliance for Cycling and Pedestrian Traffic (Bündnis für den Rad- und Fußverkehr) is a cooperative agreement between 28 partners, including city and district authorities and political representatives. Its goal is to promote cycling and pedestrian traffic and implement Hamburg's cycling strategy (Hamburg.de, 2022).



Figure 2. Pop-up bike lane in Hamburg preserves space for cyclists during infill development (Hamburg.de, 2023).

Infrastructure Strategies in Hamburg

Hamburg exemplifies Germany's commitment to sustainable urban mobility through its comprehensive infrastructure policies. The city's Alliance for Cycling, established in 2016 and expanded in 2022, aims to increase the share of bicycle traffic from 15% to 30% by 2027. To date, 70% of the planned cycling route network has been completed. Efforts to enhance pedestrian infrastructure include better lighting, tactile elements, improved accessibility, and clearer signage, ensuring a safer and more user-friendly environment (Hamburg.de, 2022).

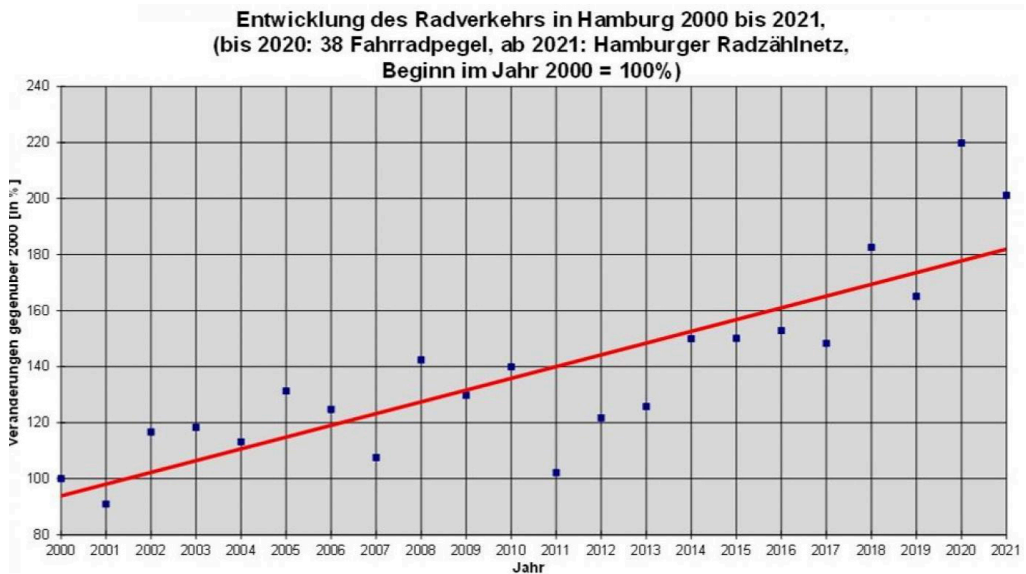


Figure 3. Cycling Development in Hamburg since 2000 (Hamburg-business.com, 2022)

Hamburg also emphasizes multimodal transport integration by linking cycling infrastructure with bus and rail systems, and expanding bicycle parking at transit stops from 24,000 to 40,000 spaces by 2030 (Hamburg.de, 2022). These policies foster a cohesive environmental network that prioritizes walking, cycling, and public transit, reducing reliance on private vehicles (Buehler et al., 2021)

Conclusion

Government's targeted investments in cycling infrastructure create a favourable environment for e-bike adoption. Urban modification and multimodal transport integration, further support the shift toward cycling and reduce reliance on private vehicles. Cities like Hamburg, with their ambitious cycling infrastructure plans, represent ideal markets for bike manufacturers like Kalkhoff to demonstrate how e-bikes can seamlessly integrate into sustainable urban ecosystems, meeting the needs of both governments and consumers. However, challenges such as the tension between traditional automotive stakeholders and e-mobility innovators highlight the need for e-bike manufacturers to position their products as complementary, rather than disruptive, to existing transportation systems. Additionally, this situation encourages e-mobility providers to explore new opportunities for cooperation with traditional automotive stakeholders in developing innovative mobility solutions.

2.2.2 Economic Factors

Rising Energy and Transportation Costs

The increasing costs of fuel, energy, and transportation have heightened interest in alternative modes of transport, such as walking, cycling, and public transit (Litman, 2005). High expenses associated with car ownership further drive this shift, encouraging individuals to seek cost-effective and sustainable solutions (Heineke & Möller, 2023).

In Hamburg, rising energy and transportation costs are expected to promote compact, infill development and multimodal transportation options. Denser land use patterns are also associated with reduced automobile travel and energy consumption, indirectly fostering sustainable mobility behaviours among users (Litman, 2016).

Cost Beyond Price Factors in Mobility Choices

While cost remains a critical determinant in mobility decisions, other factors—such as service quality, time efficiency, comfort, convenience, safety, and environmental impact—play equally significant roles in shaping transport mode preferences (Cohen, 2019). Additionally, infrastructure improvements have been shown to encourage active and healthy travel behaviours (Kopal & Wittowsky, 2023). In Hamburg, notable progress has been observed in bicycle safety over the past five years, with 42% of respondents reporting a greater sense of safety compared to previous years (Allianz pro Schiene, 2024).

Economic viability alone is insufficient to guarantee the adoption of sustainable mobility solutions; aspects such as accessibility and user satisfaction are equally pivotal. Recognizing this, policymakers and urban planners are increasingly adopting user-centred approaches and prioritizing community engagement to refine mobility strategies and enhance overall quality of life (Nesbitt & Zacherle, 2019).

Flexible Working Arrangements and Mobility Needs

The COVID-19 pandemic has reshaped work patterns and their corresponding mobility demands. Flexible working arrangements have shifted commuting peaks, with Tuesdays and Thursdays now being the busiest days for travel instead of traditional Mondays. Additionally, the rising cost of living in urban areas has led to increased suburban migration, intensifying travel demand and diversifying transport needs (Tyrinopoulos & Antoniou, 2020). These trends have resulted in longer commute trips and underscore the growing need for mobility solutions that effectively address evolving travel patterns, particularly for suburban-to-urban commuters.

Emerging Markets Driven by New Mobility Solutions

The advent of innovative mobility solutions, such as shared mobility, autonomous vehicles, and Mobility as a Service (MaaS), is transforming the transportation landscape. These advancements optimize resource use and foster collaborative mobility models, challenging traditional transportation systems and planning approaches (Zhang & Kamargianni, 2023). Private sector involvement in shared mobility services is actively addressing evolving urban transportation needs, creating opportunities for collaboration and innovation (Tyrinopoulos & Antoniou, 2020).

Mobility as a Service (MaaS) integrates various transport options (public transport, ride-hailing, shared vehicles, etc.) into a single digital platform, typically a mobile app. It allows users to plan, book, and pay for journeys using different modes of transport as needed, shifting from private car ownership to consuming mobility as a service (Rijksoverheid, 2019).



Figure 4. Volkswagen's Moia is piloting an on-demand shuttle service in Hamburg (MOIA, 2024).

Conclusion

Rising energy costs and the increasing financial burden of car ownership create favourable conditions for alternative transport modes like e-bikes. Beyond monetary considerations, factors such as service quality, infrastructure, and convenience play pivotal roles in driving adoption. Trends like flexible work arrangements and suburban migration underscore the growing demand for versatile and efficient mobility solutions, these solutions necessitate new travel demand models that consider behavioural shifts and urban realities (Garus et al., 2022).

The emergence of shared mobility and MaaS platforms further diversifies the mobility market, offering opportunities for e-bike manufacturers to integrate their products into broader multimodal networks. By addressing these evolving needs, e-bike manufacturers can position their products as cost-effective, sustainable, and user-friendly solutions. To capitalize on these economic factors, e-bike manufacturers should focus on product innovation, partnerships with different stakeholders, and aligning with urban planning strategies to meet the demands of a changing transportation ecosystem.

2.2.3 Social Factors

Diverse Sustainable Mobility Preferences Among Younger Generations

By 2035, Hamburg is projected to experience population growth fuelled primarily by young immigrants, including students and professionals (Kühntopf et al., 2011; Pohl, 2010). Younger generations in urban areas exhibit distinct mobility preferences, favouring new, shared, and sustainable transportation options (Cohen, 2019). While they express strong support for environmentally friendly mobility, actual behaviour often deviates from these stated preferences (Basile et al., 2020).

Urbanization and Evolving Family Structures

Urbanization and changing family dynamics are significantly altering mobility patterns. In Hamburg, single-person and smaller households are becoming dominant family structures, particularly in city centres. These households typically exhibit lower car ownership rates and higher reliance on walking, cycling, and public transportation (Haustein et al., 2014).

Aging but Healthier Society

Although Hamburg's suburban areas are expected to see an aging population, improvements in life quality and health awareness are increasing mobility demand among older adults (Reis & Freitas, 2020). This demographic values active transportation to support a healthy lifestyle, yet physical limitations and lower levels of digital literacy present challenges (Rudinger et al., 2004).

Neoliberal Values and Individual Mobility Preferences

Neoliberal ideologies have shaped contemporary mobility behaviours by promoting self-reliance, efficiency, and active lifestyles (Bansel, 2007). These

Active mobility / transportation is human-powered transportation like walking, cycling, scootering, and skating. It's sustainable, health-promoting, and space-efficient, contributing to healthier people and cities (Rudinger et al., 2004).

values encourage individuals to adopt flexible and entrepreneurial approaches to life, with cycling often seen as a symbol of independence, freedom, and responsibility (Spinney, 2017). The adoption of private bikes or e-bikes aligns with this perspective, allowing users to maintain control over their mobility while projecting an active and self-governing lifestyle.

Conclusion

The social landscape in Germany reveals diverse and evolving mobility preferences that create significant opportunities for the e-bike industry. Younger generations and urban residents are increasingly drawn to shared and sustainable transport options, reflecting a shift toward greener mobility behaviours. At the same time, aging populations, particularly in suburban areas, are becoming more mobile but require transportation that balances accessibility, usability, and inclusivity. E-bikes promote sustainable transport while encouraging physical activity (Sampieri & Paoli, 2022).

E-bike manufacturers can capitalize on these trends by designing products that align with the growing appeal of compact, sustainable mobility solutions tailored to diverse demographic groups. The promotion of cycling as a reflection of independence and responsibility provides an opportunity to market e-bikes as a lifestyle choice that aligns with neoliberal values. Personalized interventions, inclusive technologies, and targeted marketing strategies can further nudge users toward adopting sustainable e-bike solutions.

2.2.4 Technological Factors

Digitalization

The integration of digital technologies such as the Internet of Things (IoT), data analytics, and mobile applications is reshaping user expectations for mobility solutions. Mobile apps are increasingly seen as essential tools in urban transportation, offering real-time information, route optimization, and insights into environmental impacts (Lopez-Carreiro et al., 2020; van Oers et al., 2020). Personalization features, enabled by location-based services, enhance the user experience by adapting transportation solutions to individual preferences, improving safety and convenience (Manasseh et al., 2009). Furthermore, IoT-powered smart products and digital twins are transforming product design and management, providing valuable data for innovation and supporting circular economy practices (Abadi et al., 2022).

Smart City Integration

Smart cities are driving a shift toward intermodally—integrating various transportation modes into cohesive systems. This shift is encouraged by reduced vehicle ownership and the increasing adoption of intelligent transportation systems (Goletz et al., 2020). Connected technologies like vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication improve safety and efficiency while reducing congestion and emissions (Abdelkader et al., 2021). Bicycle networks are critical for smart mobility solutions, with data-driven approaches optimizing infrastructure placement to meet user demand (Barbour et al., 2019). For cities aiming to boost cycling rates, comprehensive packages that combine infrastructure development, land use planning, and car use restrictions are essential (Pucher et al., 2010).

The Internet of Things (IoT) is a network of physical objects ("things") embedded with sensors and software that collect and exchange data over the internet. These "things" range from everyday items to industrial tools, using various connections to transmit data for analysis and automated actions (Lopez-Carreiro et al., 2020).

A **digital twin** is a virtual replica of a physical object, process, or system, using real-time data to mirror its behavior. It allows for simulation, analysis, and optimization without affecting the real-world counterpart, improving decision-making and efficiency across various industries like manufacturing, healthcare, and smart cities (Abadi et al., 2022).

E-Mobility Advancements

E-bikes and smart bicycles are emerging as innovative solutions to meet the increasing demands of urban mobility. They provide an accessible, cost-effective, and flexible alternative to traditional transportation modes by reducing physical effort and infrastructure requirements (Demaio, 2003). Innovations in battery technology, such as lighter and more efficient designs, and the development of convenient charging systems are crucial for expanding e-bike adoption (Nikolaeva et al., 2019). These advancements also enable on-demand (mobility) services and reshape perceptions of cycling, positioning e-bikes as central to future urban mobility systems.

On-demand mobility provides transportation services whenever needed, typically via a mobile app, offering flexible routing and real-time access. This includes ride-hailing, ride-sharing, on-demand shuttles, and shared bikes/scooters (Foldes et al., 2018).

Reconfigurable systems, which can change their functionality or structure after manufacturing or deployment. They enable adaptable manufacturing for diverse vehicle production, flexible vehicle designs for easy tech integration and multi-purpose use (Lapouchnian & Yu, 2014).

Augmented Reality (AR) overlays digital information (images, videos, 3D models) onto the real world, enhancing user perception and interaction. Using devices like smartphones or AR glasses, it combines real-time camera feeds and sensors to blend digital content with the real environment (Sharma et al., 2020).

Automation and Autonomous Technology

Technological advancements in automation and autonomous vehicles are transforming supply chains and mobility services. Users expect demand-driven, personalized options that enhance usability and enjoyment. However, a gap often exists between user expectations and actual service performance, highlighting the need for dynamic and adaptive systems (Foldes et al., 2018). Emerging technologies such as advanced sensing, analytics, and reconfigurable systems will be pivotal in meeting these shifting expectations (Lapouchnian & Yu, 2014).

Augmented Reality and Human-Machine Interaction

User satisfaction with in-vehicle and mobility-related technologies often stems from meeting psychological needs, such as autonomy, competence, and relatedness (Stiegemeier et al., 2024). Augmented reality (AR) navigation systems contribute to road safety and enhance visualization, making them valuable for improving the cycling experience (Sharma et al., 2020). Future mobility concepts, including AR and connectivity, are expected to shape user experiences and the evolution of human-

machine interaction technologies (Hermann & Singh, 2020).

Sports Tracking and Wearable Technology

Sports tracking technologies enhance the cycling experience by offering connectivity, interactivity, and personalized insights, enabling users to monitor their performance and health outcomes (Kuru, 2016). These features align with the growing consumer interest in active and healthy lifestyles.

Conclusion

Digitalization, including IoT, data analytics, and mobile applications, enhances user experience by providing real-time information, route optimization, and personalized mobility solutions. Smart city integration and intelligent transportation systems further bolster the relevance of e-bikes, enabling seamless intramodality and fostering urban sustainability.

E-mobility advancements, such as efficient battery designs and convenient charging systems, address critical user needs while supporting on-demand mobility services. Automation, augmented reality, and sports tracking technologies contribute to safer, more personalized, and engaging cycling experiences. However, challenges such as data privacy, security, and interoperability remain, requiring proactive industry responses.

For e-bike manufacturers, the focus should be on leveraging these technological trends to create user-centric products that integrate seamlessly with broader urban mobility ecosystems.

2.2.5 Environmental Factors

Climate Change and Low-Carbon Mobility

The urgency to address climate change has intensified the demand for eco-friendly and low-carbon mobility solutions, with users increasingly prioritizing sustainability in transportation. Strategies promoting low-carbon mobility include electrification, shared transportation models, public transit, and active transportation. These approaches collectively reduce emissions and enhance urban liveability (Pamidimukkala et al., 2023; Perez, 2023). Sustainable mobility solutions emphasize accessibility and inclusivity over speed, prioritizing public transit and non-motorized transport while reducing reliance on private cars (Zegras, 2011). However, their effectiveness depends heavily on user behaviour and adoption rates (Wang & Yang, 2023).

Electric vehicles (EVs) provide notable advantages, such as zero emissions and high efficiency, yet face challenges including infrastructure limitations, costs, government incentives, and penalties for conventional vehicle use (Etukudoh et al., 2024). Demographic differences also influence adoption; for instance, women often demonstrate a stronger preference for sustainable mobility options (Cordera et al., 2019).

Circular economy principles aim to minimize waste and pollution, keep products and materials in use as long as possible. This contrasts with the linear "take-make-dispose" model, reducing waste, conserving resources, minimizing pollution, and creating economic opportunities (Riesener et al., 2023).

Eco-Friendly Purchase and Sustainable Production

Environmental consciousness among consumers is reshaping demand, with more customers seeking sustainable production practices. The e-bike industry increasingly incorporates eco-friendly materials, energy efficiency, and lifecycle optimization into its product design. Circular economy principles, such as closed-loop design and waste valorisation, are critical to achieving these sustainability goals (Riesener et al., 2023).

Design approaches focusing on modularity, disassembly, maintenance, and recycling emphasize resource efficiency while reducing lifecycle environmental impacts (Van Den Berg & Bakker, 2015). Early-stage design decisions guided by eco-design principles have significant long-term implications for sustainability (Ramani et al., 2010).

Conclusion

For e-bike manufacturers, these environmental considerations emphasize the importance of incorporating sustainable materials, efficient production methods, and lifecycle-conscious designs into their strategies. Although e-bikes are a sustainable alternative for urban mobility, their environmental impact—such as emissions associated with production and the infrastructure for bike-sharing technologies—requires careful mitigation (Bonilla-Alicea et al., 2020). Adopting lightweight materials and implementing vehicle weight reduction strategies are critical for enhancing energy efficiency and reducing emissions (McAuley, 2003).

To ensure long-term sustainable mobility, business models must prioritize clean energy usage, resource optimization, and the delivery of societal benefits to align with sustainability goals (Valsecchi Ribeiro de Souza et al., 2019). Moreover, overcoming cultural and behavioural barriers to the adoption of eco-friendly mobility will be crucial for the continued growth and success of the e-bike industry (Sovacool & Griffiths, 2020).

2.2.6 Legal Factors

Improving E-Mobility Regulations and Progress

Germany is positioning itself as a leader in e-mobility through enhanced regulations and strategic initiatives (Hanke et al., 2014). Legal obligations embedded in the constitution underscore the commitment to sustainable mobility solutions, forming a strong foundation for advancing e-mobility policies (Hermes, 2020). Local authorities are implementing comprehensive traffic rules for e-mobility, including dedicated and clearly separated bike lanes, ensuring safety and operational efficiency. Furthermore, major car manufacturers are expanding into mobility services, recognizing strategic advantages in aligning with e-mobility trends (Czerlinsky et al., 2022). Businesses integrating e-mobility solutions can address energy certification requirements and improve employee satisfaction, though uncertainties in regulatory frameworks remain a hurdle.

Uncertainties in E-Micromobility Product Regulatory Frameworks

E-bikes and cargo bikes are increasingly recognized as sustainable alternatives to cars in urban environments. Research highlights their potential to significantly reduce car mileage, offering environmentally friendly options for short- to medium-distance travel (Kämper et al., 2016). Electrified cargo bikes further contribute to sustainability by enabling the efficient transportation of goods and children in densely populated urban areas (Şengül & Mostofi, 2021). The market for e-micromobility products has experienced rapid growth, but regulatory frameworks are struggling to keep pace with this expansion. This lag in regulation raises safety concerns and creates challenges in managing the evolving landscape of e-micromobility (Pimentel et al., 2020). Additionally, inconsistent regional regulations contribute to user confusion,

creating barriers to broader adoption and integration of these sustainable mobility solutions.

Conclusion

The e-bike industry in Germany is advancing toward regulatory standardization and integration with urban mobility systems, laying the groundwork for broader adoption and institutional stability. For German e-bike manufacturers to succeed, they must proactively align with evolving regulations while addressing user preferences and infrastructure challenges. Collaboration with urban infrastructure providers and engagement with stakeholders are vital for creating a robust ecosystem that supports e-bike adoption.



Figure 5. Dutch police check the maximum speed of a fatbike – insufficient regulation of fat bike usage by teenagers is correlated with a rise in accidents in Western Europe. (NS Times, 2024).



Key Themes in Future Urban Mobility

...and their influence on the adoption of e-bike usage

The concept of mobility is expected to undergo significant transformation by 2035, raising questions about how these changes will impact the adoption of e-bike usage in Hamburg. This trend analysis identifies key themes that provide insights into addressing the first research question:

How will the concept of mobility evolve by 2035, and what role can bicycles play in shaping sustainable urban mobility in Hamburg?

Well-categorized factors alone do not yet provide a contextual foundation for inspiring and innovative creation. To achieve this, the identified factors must be transformed into a unified and coherent set of themes that reveal the connections between them (Hekkert et al, 2011). In this process, factors with similar influences or underlying causes are grouped into clusters, which are then distilled into overarching themes.

These themes not only serve as guiding principles during the conceptual and pre-design stages but also provide valuable strategic insights for design planning. They also act as critical reference points for evaluating the effectiveness and alignment of the final design with the intended objectives.

2.3.1 Personalized Transportation and Multiple Purposes

The future of mobility in Hamburg will be characterized by increased flexibility and personalization, reflecting a growing preference for transportation modes that cater to individual lifestyles and situational needs (Zapp & Phleps, 2015). By 2035, the shift toward Mobility on Demand (MOD) and micro-mobility solutions will redefine how residents navigate the city.

E-bikes are uniquely equipped to address this demand, offering a versatile mode of transport for commuting, recreational trips, and multi-purpose journeys. The integration of advanced digitalization and connectivity further enhances their appeal, enabling features such as custom route navigation, battery optimization, and personalized fitness tracking through unified platforms. In a city like Hamburg, which is rapidly expanding its smart city initiatives, e-bikes can complement personalized mobility options, making them an essential tool for diverse urban travellers. However, challenges such as capacity constraints persist, necessitating innovative solutions to maximize their adoption and usability (Krizek & Stonebraker, 2010).

Micro-mobility encompasses small, lightweight vehicles like bikes, scooters, and mopeds, typically used for short urban trips at speeds below 25 km/h (15 mph). It aims to provide convenient, affordable, and sustainable first/last-mile transportation, reducing congestion and emissions.

2.3.2 Promoting Active Transportation in a Dynamic Urban Context

As Hamburg metropolitan continues to prioritize active transportation in response to an aging population and rising health awareness, bicycles will play a vital role in integrating physical activity into daily mobility. The city's urban planning strategies, including redesigned streets and bike-friendly infrastructure, align with broader goals of fostering healthier lifestyles.

E-bikes, which balance physical effort with electric assistance, are particularly suited for Hamburg's diverse population. They can accommodate older adults and those with physical limitations while maintaining the benefits of active transportation. By reducing dependence on cars and optimizing space utilization, e-bikes contribute to a more liveable urban environment. This focus on active transportation not only reduces the demand for extensive urban mobility infrastructure but also cultivates a cycling culture within cities, promoting sustainable and community-oriented mobility solutions.

2.3.3 Advancing Sustainable Urban Living through Bicycle Adoption

Hamburg's commitment to sustainability aligns closely with the global trend toward environmentally conscious urban living. By 2035, the city's mobility behaviours are expected to shift from car dependency towards cleaner alternatives such as e-mobility, shared mobility, and public transportation.

Bicycles, and particularly e-bikes, offer an effective solution to these challenges. Bicycle-friendly policies and infrastructure investments, such as expanded bike lanes and urban greenways, can stimulate local economies by attracting businesses and fostering vibrant community spaces (Arancibia et al., 2015). Increased bicycle adoption will support key sustainability metrics, including reductions in fuel consumption, CO2 emissions, and accident-related costs while improving public health outcomes and advancing social inclusion (Basto & Moraes, 2010).

2.3.4 Integrating Multimodal Mobility for a Seamless Urban Experience

The evolution of mobility by 2035 will be characterized by the integration of multimodal systems that create seamless transportation experiences. Mobility-as-a-Service (MaaS) platforms and smart city infrastructure will enable the convergence of public transit, shared mobility, and active transportation modes in Hamburg. This integration not only can improve user experiences but also advance the sustainability and resilience of urban mobility systems.

E-bikes are integral to this vision, offering an efficient and flexible connection to public transit systems through features such as bike-on-board facilities, secure parking, and shared bike networks. Technologies like IoT and movement analytics will further optimize their role in multimodal systems, enhancing connectivity and reducing travel time. E-bikes will bridge the gap between first-mile and last-mile solutions, ensuring accessibility and convenience for all residents. According to Singleton & Clifton (2014), while cycling and public transit may act as substitutes in the short term, they often evolve into complementary modes over time.

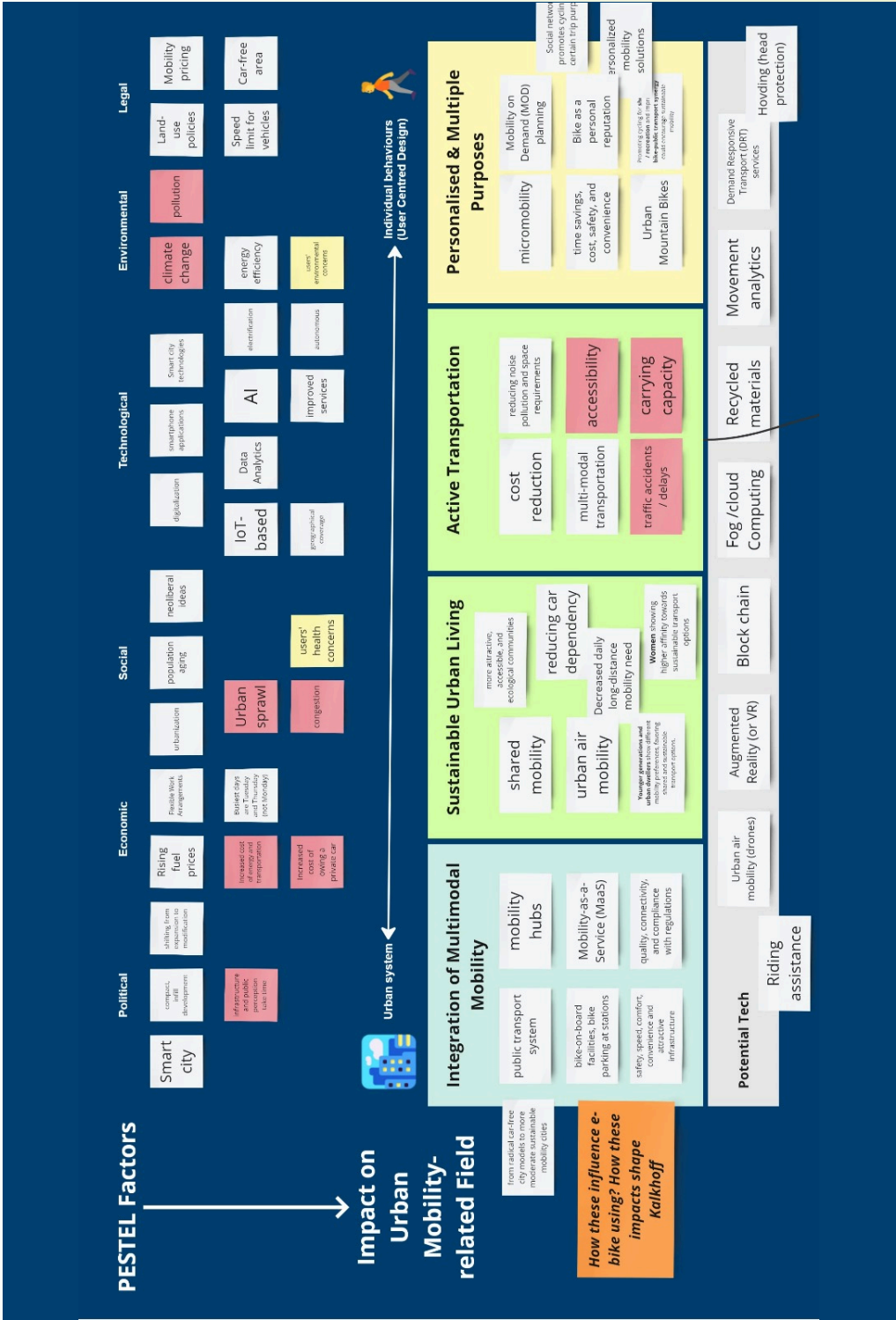


Figure 6. Key findings of PESTEL Analysis

Brand Product Research

Ch. 3

Brand - Product Research

"If you know the enemy and know yourself, you need not fear the result of a hundred battles," as stated in The Art of War; underscores the importance of strategic understanding.

Brand-Product Research aims to achieve this by comprehensively analyzing the company and market dynamics to identify a unique market position. This strategic positioning serves as a foundation for guiding product design effectively.

As part of Brand-Product Research, expert interviews are conducted to gain insights into production processes, the sales landscape, stakeholder dynamics, competitor strategies, and customer distribution patterns. These findings are synthesized through a SWOT analysis, which helps to align the organization's goals, programs, and capabilities with the external environment in which it operates, ensuring strategic alignment and competitive advantage when developing products.



3.1

Kalkhoff and PON

Pon Holdings, a leading global mobility group, has strategically positioned its subsidiary, Pon Bike, as a major player in the bicycle industry. Pon Bike's diverse brand portfolio, including Kalkhoff, Gazelle, Focus, Cervélo, and Santa Cruz, caters to various market segments, reflecting Pon's broader mobility vision. This is evident in their urban bike offerings, which range from lightweight city bikes to robust cargo bikes.

Pon's 2012 acquisition of Kalkhoff, known for its German engineering and innovative e-bikes, aimed to strengthen its e-bike market presence. This integration provided Kalkhoff with access to advanced technologies and a wider distribution network. The success of this strategy is reflected in e-bikes now representing over 50% of Pon Bike's sales, demonstrating the growing global demand for electric mobility (PON.Bike, 2024).

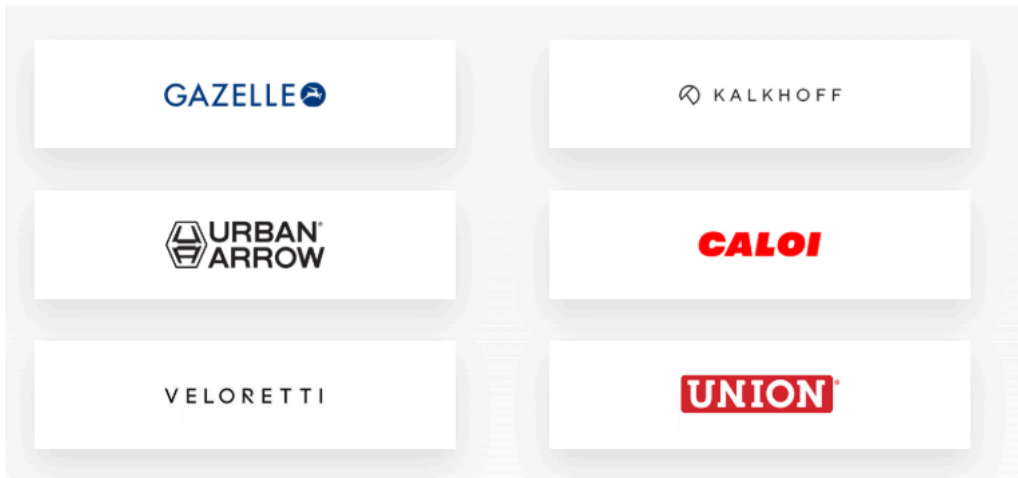


Figure 7. PON's bikes brands focus on daily biking (PON.Bike, 2024)



Brand DNA of Kalkhoff

Brand DNA is a concept used to define and communicate a brand's unique essence and characteristics, it encompasses both internal (Purpose) and external attributes (Personality) that distinguish a brand from competitors. It serves as a tool for differentiation and helps understand a company's operations better (Ceccato et al., 2012).



Figure 8. Brand DNA of Kalkhoff

3.2.1 Purpose: We get people moving everywhere.

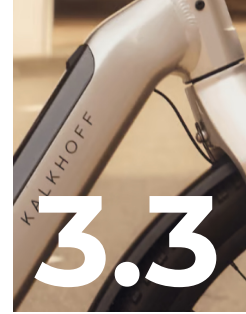
Kalkhoff is a renowned German e-bike brand with a heritage that dates back to 1919. Known for its emphasis on comfort, reliability, and everyday usability, Kalkhoff specializes in producing high-quality e-bikes that cater to urban commuters, leisure riders, and families. Its mission, "We get people moving everywhere," reflects its commitment to creating practical and versatile solutions for a wide range of users, ensuring seamless mobility across diverse contexts.

3.2.2 Positioning: We offer e-bikes with strong performance to inspire people to bring adventure into their everyday lives.

Kalkhoff positions itself as a provider of high-performance e-bikes that empower individuals to integrate adventure into their daily routines. With a strong market presence in Northern Germany, the brand is recognized for its durable and well-engineered products, designed to excel in urban commuting and city riding. Its brand mission, "We develop bicycles to inspire people and explore adventure in everyday life," emphasizes ergonomic design and comfort, ensuring an enjoyable riding experience even over long distances. Kalkhoff's products resonate with customers who seek reliable and versatile e-bikes for both practical and recreational purposes.

3.2.3 Personality: Reliable, Usable, and Authentic.

Kalkhoff is distinguished by its commitment to reliability and user-centric design, empowering riders to focus on meaningful experiences during their journeys. The brand's e-bikes are equipped with powerful motors and long-lasting batteries, ensuring adaptability across diverse terrains, from bustling city streets to suburban pathways. Through consistent storytelling and cohesive design language, Kalkhoff further solidifies its reputation as an authentic, steady, and trustworthy brand. By prioritizing usability and quality, the company appeals to consumers who value practicality, performance, and a dependable brand image in their mobility choices.



Kalkhoff's Product Series

Kalkhoff's product line is thoughtfully designed to meet the diverse needs of various user groups, structured into clear categories that correspond to specific usage scenarios and rider types. This strategic segmentation aligns seamlessly with the brand's positioning, ensuring that each product category resonates with its target audience. Below is a breakdown of the categories:

3.3.1 E-City

For urban commuters and everyday riders who want an efficient, stylish, and eco-friendly mode of transportation within the city, the E-City models prioritize convenience and ease of use, with integrated battery systems, step-through frames, and features like ABS for added safety. They are lightweight and come with practical accessories suited for urban lifestyles, including a frame lock and handle for easy manoeuvrability.

3.3.2 E-Trekking

E-Trekking series caters to those who prioritize efficiency and health on longer journeys, blending functionality with sustainability. These models offer premium components like Bosch Performance Line motors and large battery capacities, enabling riders to cover significant distances. The series includes ABS braking for safety and offers a range of comfort features to support long-distance riding. It is ideal for riders who use e-bikes for commuting and long-distance trips, particularly those seeking comfort and durability for consistent use.

3.3.3 E-Allroad

Designed for versatile and rugged performance, E-Allroad series is ideal for adventurers and active users who require a bike that can handle different terrains and conditions. E-Allroad is equipped with powerful Bosch motors and hydraulic ABS disc brakes, this series emphasizes stability, control, and off-road capability. Higher-end models feature advanced displays and durable frames, making them suitable for both urban commuting and countryside exploration.

3.3.4 Series Tiers

Kalkhoff's product line is further segmented into tiers (7+, 5+, 3, 1, C+, and L), each designed to offer varying levels of premium features, comfort, and suitability for diverse riding needs. This tiered approach provides a wide range of options, catering to users with different priorities and aligning with the growing trend toward personalized mobility solutions that address specific requirements.



Tier 7+ represents the pinnacle of the product line, featuring the most advanced equipment, exceptional comfort, and cutting-edge technology for riders seeking top-tier performance and luxury.

Tier 5+ introduces users to the premium range, combining robust performance with a sleek, integrated battery design that enhances aesthetics and functionality.

Tier 3 focuses on comfort and practicality, offering a dependable and accessible solution for everyday riders.

Tier 1 consists of entry-level models that emphasize functionality and reliability, making them ideal for new riders or those seeking budget-friendly options.

Tier C+ (Compact) is tailored for urban riders, offering compact, versatile designs that excel in navigating crowded city environments.

Tier L (Lightweight) prioritizes ease of use and high performance, featuring lightweight designs for riders who value simplicity and efficiency.

Figure 9. Kalkhoff bikes portfolio



Market Dynamics and Sales Strategies

Some insights gathered from expert interviews provide a current reflection of how Kalkhoff operates its business and defines its role within the market. These perspectives offer valuable understanding of the company's operation, competitive strategies, and its approach to navigating market dynamics effectively.

Heavily Location/Dealer-Dependent Sales

The sales of Kalkhoff e-bikes are significantly influenced by location, reflecting the fragmented nature of the German e-bike market. While customers now have the option to order bikes online, the majority of sales still rely on a strong network of local dealers. These dealers play a critical role in fostering community-based sales, offering personalized service and building trust among customers. Kalkhoff's standardized platform for accessories further reinforces this model by enabling users to purchase and install a wide range of bike accessories directly through their local dealers, enhancing both convenience and customer satisfaction.

Middle-aged (45+) People as Core Customers

Kalkhoff's primary customer base comprises middle-aged individuals seeking to maintain an active lifestyle through daily commuting. This demographic values reliability, comfort, and ease of use, representing a stable and dependable market segment. Upon retirement, this group tends to exhibit strong brand loyalty, although purchasing decisions are significantly influenced by recommendations from local dealers.

Emerging Young Customers

An increasing number of young people and families are entering the e-bike market, attracted by the practicality and affordability of e-bikes for transporting children or commuting. These customers are particularly interested in models priced below €5000, as they balance cost-effectiveness with quality. Young consumers are often drawn to Kalkhoff by its strong word-of-mouth recommendations. They may initially order their bikes online and collect their purchases from local dealers.

Sale Challenges in Urban

Compared to other urban e-bike brands with a chic and trendy aesthetic, Kalkhoff's comparatively conservative design is often perceived as less attractive to younger, style-conscious buyers. Additionally, the prevalent risk of bike theft in urban areas discourages potential customers from investing in higher-priced e-bikes.



Figure 10. Comparison of Urban Bike Styles in Germany

Usage Patterns

E-bikes are often regarded as secondary bikes, primarily used for specific purposes such as long commutes, exercise, or outdoor recreational activities. This usage pattern highlights the importance of versatility and adaptability, qualities that Kalkhoff's e-bikes are designed to embody.

Enhancing User Experience

In response to increasing demand for hands-on experiences, Kalkhoff has prioritized user engagement through customer support centre in Emstek and routine local community trials. These trials give potential buyers the opportunity to test e-bikes in real-world scenarios, fostering trust and confidence in the product. This customer-centric approach not only enhances the overall buying experience but also strengthens the brand's connection with its audience.

Sustainable Production

All packaging materials used by the company are recyclable, aligning with eco-friendly values. Additionally, Kalkhoff has implemented an automated production line to reduce waste and improve efficiency, further reinforcing its dedication to environmentally responsible manufacturing.



Figure 11. Kalkhoff 100% recyclable packaging standards set (Watts Not Gas, 2024).



Competitive Analysis

In 2012, e-bike sales in Germany reached approximately 0.4 million units, growing to 2.2 million by 2022, firmly setting up Germany as one of the largest e-bike markets globally, second only to China (Kohlrautz & Kuhnimhof, 2024).

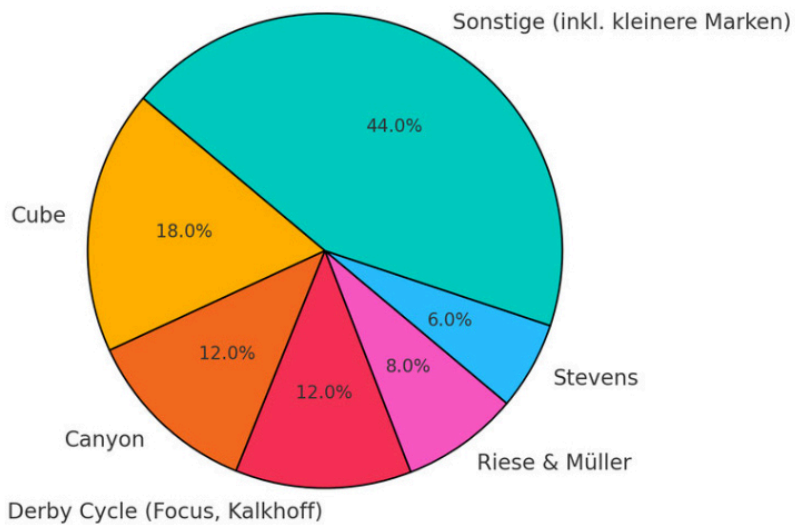


Figure 12. Share of the leading bike brands in German bike market (velotech.de, 2024).

As illustrated in Figure 12, the German bike market is highly fragmented, with brand sales heavily dependent on local dealer networks and regional brand preferences. Kalkhoff has built a formidable reputation and enjoys popularity in Northern Germany, while Riese und Müller is better known and preferred in the South. Customers across regions prioritize reliability and engine performance, which are often influenced by local geographical needs and biking culture.

Following the dramatic increase in sales during the pandemic, the market has since experienced a slowdown. Consumers are now showing a growing preference for more affordable e-bike options, reflecting a shift in buying priorities. Below are the two main competitors that Kalkhoff faces in the current urban market:

Riese und Müller

Riese und Müller is a premium German e-bike manufacturer renowned for its innovative designs, exceptional artisanry, and emphasis on technology integration. Positioned as a high-end brand, Riese und Müller offers a diverse range of e-bikes, including e-cargo bikes, long-range touring bikes, and versatile urban e-bikes tailored to the needs of urban commuters and families.

Unlike Kalkhoff, which focuses on mainstream commuter e-bikes, Riese und Müller prioritizes modularity and customization, enabling users to personalize their bikes to suit specific needs—whether for cargo transport, family outings, or long-distance travel. The brand's advanced technology, such as its proprietary smart systems, appeals to consumers seeking top-tier e-bike solutions that deliver performance, comfort, and functionality. Its modern and chic design aesthetic further attracts younger users. This premium positioning makes Riese und Müller particularly appealing in urban centres, where quality, adaptability, and style are highly valued.

KTM

KTM is an established Austrian brand renowned for its high-performance bicycles and e-bikes, with a powerful reputation across European markets. Initially recognized for its mountain bikes and off-road ability, KTM has expanded its e-bike range to cater to a wider audience, including urban commuters, leisure riders, and adventure enthusiasts. KTM's e-bikes are particularly valued for their ruggedness, durability, and powerful motor systems, making them well-suited to a variety of terrains, from city streets to challenging trails. Although KTM invests less in marketing compared to its competitors, the brand keeps a competitive edge with its attractive pricing.

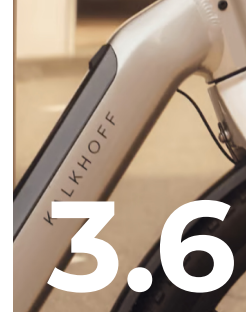


Figure 13. Competitors



Figure 14. SWOT Analysis of Kalkhoff Brand

Product Design Directions for Kalkhoff



Based on the key themes identified from the Trend Analysis and insights derived from the SWOT Analysis, two strategic visions have been built as guiding principles to illuminate Kalkhoff's design direction for future development. These visions aim to leverage Kalkhoff's strengths, address its weaknesses, capitalize on emerging opportunities, and effectively respond to external threats. Furthermore, they provide a partial answer to the second research question:

How will the concept of mobility evolve by 2035, and what role can bicycles play in shaping sustainable urban mobility in Hamburg?

3.6.1 Personalized Mobility Experience

Personalized Mobility Experience tackles the need for user-centric solutions by offering stylish, customizable, and connected e-bikes.

The future of urban mobility increasingly revolves around tailoring products to individual lifestyles and preferences. Kalkhoff can use its strong reputation for reliability and usability to create a personalized mobility experience that aligns with diverse customer needs.

Customization for Urban Lifestyles

Urban mobility is becoming a lifestyle choice.

Adding customizable design options, such as interchangeable colour panels and accessories, can attract younger, style-conscious riders who view their e-bike as an extension of their personal identity.

Smart Technology Integration

Kalkhoff should work with smart solution providers to enhance digital integration with mobile apps, offering AI-driven personalization features. These could include:

- *Adjustable power aid levels tailored to terrain and rider needs.*
- *Route suggestions based on riding habits and preferences.*
- *Fitness tracking and performance analytics for health-conscious users.*

Data-Driven Performance Insights

Incorporating big data analytics into products enables users to check their performance, riding patterns, and health metrics. Personalized insights strengthen customer engagement and create a unique and tailored riding experience.

Versatile and Durable Design

Kalkhoff's products should feature versatile and durable designs with ergonomic adjustments (e.g., adjustable seats and handlebars) to ensure rider comfort over extended journeys. This resonates with customers who use e-bikes for both commuting and recreational purposes.

Eco-Friendly and Circular Economy

By using sustainable materials and offering recycling programs, Kalkhoff can appeal to environmentally conscious consumers who prioritize sustainability. Circular economy practices, such as modularity and lifecycle optimization, further reinforce its green credentials.

3.6.2 Seamless Mobility Integration

Seamless Mobility Integration positions Kalkhoff as a key player in urban ecosystems, providing e-bikes that integrate effortlessly with public and shared mobility networks.

As cities like Hamburg prioritize multimodal and sustainable mobility, Kalkhoff can position its e-bikes as integral components of an interconnected urban ecosystem. This vision includes seamless transitions between e-bikes, public transport, and shared mobility platforms.

Lightweight and Compact Designs

Products should adopt foldable frames and lightweight designs to help easy transitions between e-bikes and public transit. These features cater to users in densely populated urban areas with limited storage space while aligning with the trend toward multimodal mobility.

Integration with MaaS Platforms

Kalkhoff can develop e-bike models compatible with Mobility-as-a-Service (MaaS) systems. Features like NFC-based access for shared bike networks and real-time mobility data sharing will help users switch effortlessly between transportation modes. This is particularly beneficial in cities like Hamburg, where multimodal connectivity is rapidly expanding.

High Load Capacity

Many urban customers are looking for e-bikes as car replacements. Kalkhoff should incorporate stronger frames, larger cargo racks, and modular attachments (e.g., for groceries or child seats) to meet these needs.

Advanced Security Systems

Urban theft risks stay a significant barrier to e-bike adoption. Kalkhoff should address this by

Near Field Communication (NFC) technology is a short-range wireless communication technology that enables devices to exchange data when they are in close proximity, typically within a few centimeters.

incorporating advanced anti-theft measures such as integrated GPS tracking, tamper-resistant locks, and proximity alerts to reassure customers investing in premium models.

Connectivity to Public Infrastructure

Seamless integration with public transport hubs through expanded bike parking facilities, shared docking stations, and charging infrastructure can reduce the friction of multimodal travel and enhance usability.

These design directions align with Kalkhoff's established strengths in reliability, sustainability, and customer engagement while addressing emerging trends and opportunities in urban mobility. Simultaneously, these strategies address weaknesses like conservative design and limited urban appeal, ensuring Kalkhoff stays competitive in a dynamic market by meeting the expectations of younger, tech-savvy consumers.

Context Mapping

Ch. 4

Context Mapping

The third research question is: What are the primary mobility needs and preferences of Hamburg residents in 2035? Understanding users' needs provides significant opportunities for companies to develop tailored products.

A user-centered design approach, specifically Context Mapping, was employed to gain deep insights into users' needs and contexts. This approach involves participants as experts of their own experiences, enabling a more comprehensive understanding of their perspectives (Visser et al., 2005).

The process began with a literature review to establish a preliminary understanding of current and future mobility behaviour patterns in Germany. Following this, field observations and quantitative research were conducted in Hamburg to gather specific insights into the mobility preferences of local residents. Findings from earlier stages were used as inputs for context mapping, ensuring the validation and enrichment of insights through iterative analysis.

Survey results and customer segmentation were then analysed to identify the target user group. Finally, these target users were invited to participate in completing a user journey, allowing for a more detailed understanding of their current needs and future preferences. This iterative process ensured that the research provided actionable insights to inform product design strategies effectively.



4.1 Current E-bike Usage Patterns in Germany

To gain a deeper understanding of e-bike usage patterns in Germany, two key studies by Kohlrantz & Kuhnimhof (2024) and Melia & Bartle (2022) were reviewed. The following outlines the key insights from these studies and their implications:

Motivations for Different Generations

E-bikes address both health and environmental concerns, attracting older adults and younger users alike. Middle-aged and older individuals adopt e-bikes to stay active with reduced physical strain, using them primarily for recreation. Younger, suburban commuters value e-bikes as an eco-friendly alternative to cars, aligning with goals to reduce car dependency. Ownership peaks around age 70, with significant appeal across working age and retired demographics.

Higher Adoption in Rural Areas

E-bike adoption is notably higher in rural areas where limited public transportation options make e-bikes a practical alternative to cars. Conversely, urban residents tend to rely more heavily on public transport, walking, and traditional bicycles. Additionally, urban-specific challenges such as theft risks and a lack of secure parking facilities further hinder e-bike adoption in cities.

Seasonal and Weather-Dependent Usage

E-bike usage peaks in warmer months, with sharp declines in autumn, winter, and spring, underscoring weather as a key deterrent. E-bikes excel as "range extenders," helping longer trips compared to conventional bikes (c-bike) but primarily complement rather than replace cars for longer or multi-stop journeys.

E-Bike Users Travel More than Public Transport Users

E-bike ownership significantly alters mobility patterns, with owners cycling greater distances and reducing reliance on cars and public transport. On average, e-bike owners travel 5.8 kilometres less by car and 9.4 kilometres less by public transport daily, highlighting their effectiveness for mid-range and first- and last-mile travel.

Financial and Structural Barriers

The prohibitive cost of buying e-bikes limits access for lower-income households, with ownership dominated by middle- and upper-income groups. Wealthier households often own both e-bikes and conventional bikes, using e-bikes as secondary options for commutes or leisure. Structural issues like a lack of secure parking and charging facilities further hinder adoption, particularly in urban and shared living environments.

Shared e-bikes and Subscription

According to Meerkamp (2024), shared city e-bike programs in Hamburg face low usage rates due to the convenience of the city's robust public transportation system and the lack of spots. Hamburg-Takt from Hamburger Hochbahn (2024) aims to ensure that by 2030 every Hamburg resident can access high-quality public mobility services within five minutes, will further reduce the motivation for city centre residents to rely on bicycles. This initiative underscores the need for alternative strategies to encourage bike usage within urban areas, particularly where public transportation already offers extensive coverage.

Hamburg-Takt is Hamburg's initiative to improve and expand public transport, aiming for higher frequency, network expansion, better integration of transport modes, and a focus on user needs and sustainability (Hamburger Hochbahn AG, 2024).

On the other hand, many individuals are reluctant to commit to purchasing high-quality investment items but are still eager to use them. This has led to a rising demand for e-bike subscription services in urban areas, offered by providers such as Swapfiets, Dance, and E-Bike-Abo (Wienefeld, 2024). These services offer a cost-effective alternative to car ownership, making them particularly appealing in cities. Additionally, cargo e-bikes and children's bikes, which are often only needed for limited periods, present further potential for subscription-based models due to their practicality and affordability in comparison to purchasing outright.

Future Mobility Behaviours



A user segmentation model was developed to project future e-bike users and inform the subsequent survey design. This model was based on insights from prior research and drew on the categorization framework proposed by Szmelter-Jarosz & Woźniak (2016), which identifies seven distinct types of future mobility behaviour in Western European countries:

4.2.1. Greenovator

Environmentally conscious individuals who prioritize sustainable mobility, work-life balance, and high-quality, durable products. They practice restrained consumerism and seek eco-friendly solutions.

Goals: Environmental sustainability, low running costs, product durability.

4.2.2. Everyday Commuter

Frequent commuters, often suburban job nomads, who need effective and flexible transportation solutions for their daily routines. These users may benefit from employer-subsidized transport options.

Goals: Affordability, speed, flexibility.

4.2.3. Silver Rider

Individuals aged 50 and above who value mobility as a means to enjoy life, explore new experiences, and participate in social activities.

Goals: Autonomy, comfort, safety.

4.2.4. Family Cruiser

Family-oriented users who require frequent transportation for errands and family visits. They often share vehicles among family members but seek solutions that enhance convenience for all.

Goals: Unlimited mobility for the entire family.

4.2.5. Global Nomad

Highly mobile professionals who frequently relocate and are adept at using multimodal transportation systems. They prioritize efficient, high-quality options that enhance their lifestyle.

Goals: Quality of life, comfort, luxury, speed.

4.2.6. Sensation Seeker

Individuals who associate mobility with freedom, individuality, and pleasure. They enjoy cycling for recreational purposes and seek options that align with ecological trends.

Goals: Recreation, high quality of life, self-

User Segmentation in Hamburg



4.3.1 Mobility Observation in Hamburg

Based on the seven types of future mobility behaviours, field research was conducted in Hamburg to gain a deeper understanding of real mobility experiences and attitudes within the city. To begin, a Kalkhoff e-bike was used to explore Hamburg's mobility infrastructure, providing an overview of the cycling experience. Concurrently, a questionnaire was developed and distributed to pedestrians and micro-mobility users (including cyclists, e-bike riders, and scooter users) to better understand their mobility habits, motivations, challenges in using or adopting e-bikes, and future mobility expectations in Hamburg. The brief, five-minute questionnaire was administered both offline and online, serving as a validation tool for insights gathered from prior research.

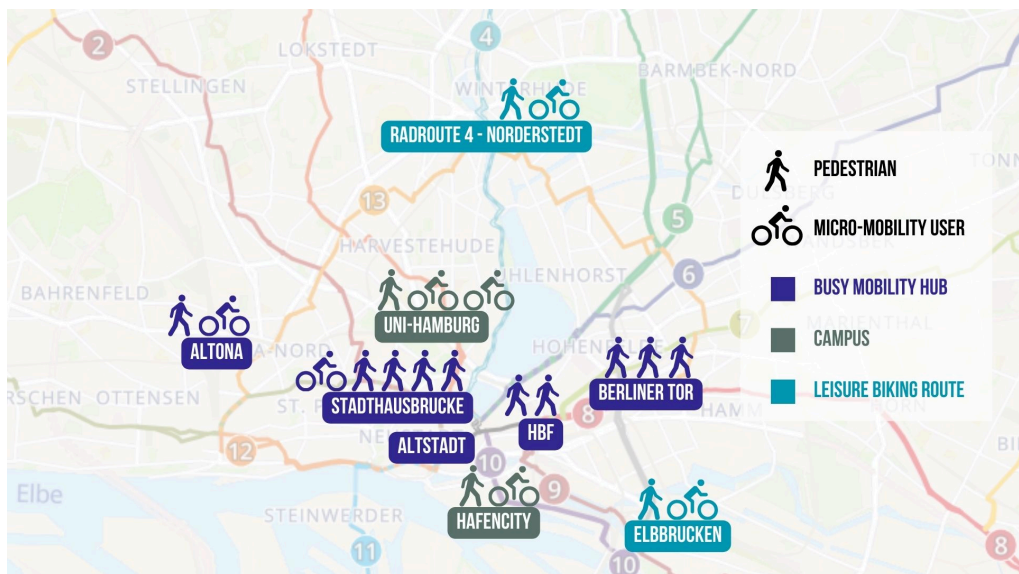


Figure 15. Execution map in Hamburg field research (routes and survey participants)

4.3.2 Insights from Biking in Hamburg

Extensive and Varied Bike Lane Network

Hamburg boasts a wide-ranging network of bike lanes designed for multiple purposes, including 14 commuter routes and 16 leisure routes. Additionally, district routes are in the early planning stages to complement the main Velorouten network (veloroute. hamburg, 2020)..

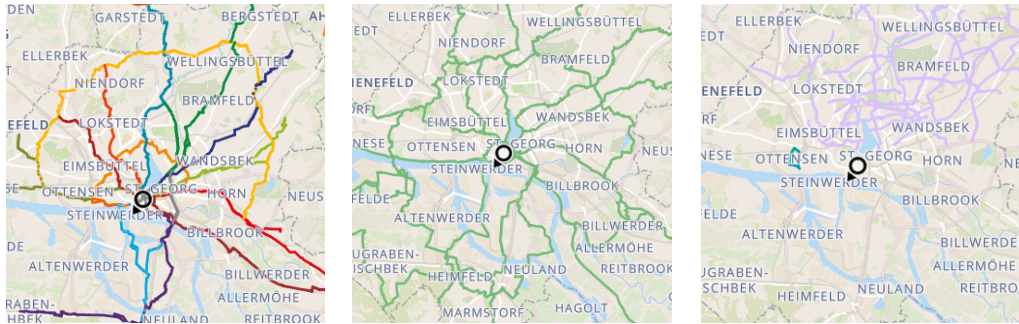


Figure 16. Hamburg cycling maps (from left to right): commuter routes, leisure routes, and district routes.



Figure 17. Hamburg's Cycle Highways Network and Surrounding Environment

Cycling Highways (Radrouten Plus) are high-quality, long-distance cycling routes designed for fast, safe, and convenient travel, especially for commuting. Key features include direct routes, separation from traffic, smooth surfaces, minimal stops, sufficient width, good lighting, and clear signage. They are meant to interconnect the metropolitan area.

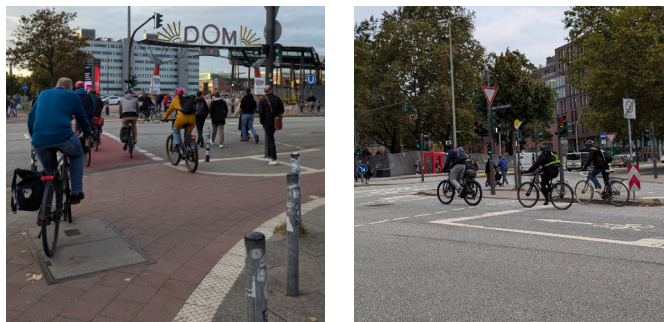


Figure 18. Typical Intersection Layout in Hamburg

Unclear Signage and Non-Separated Bike Lanes

Many bike routes lack clear signage, and the absence of separated bike lanes creates confusion and a sense of insecurity for cyclists.



Figure 19. Non-separated bike lanes force cyclists to share space with automobiles and pedestrians.

Inconsistent Bike Lane Standards

The quality of bike lanes varies significantly, with some lanes sharing the same surface as car roads and others made of uneven rock surfaces, resulting in uncomfortable vibrations during rides.

Frequent Disruptions

Cyclists often encounter disruptions due to traffic signs and bike lanes that abruptly end, further hindering the overall riding experience.



Figure 20. Multiple mobility hotspots under construction during the visit resulted in inconsistent bike lanes.

Insufficient Safe Parking Facilities

A lack of secure parking spaces at public transportation stations creates additional barriers for e-bike users, particularly for those integrating e-bikes with multimodal travel.



Figure 21. Insufficient safe parking led to disorganized parking.

Demographic Trends Among Kalkhoff Users

Observations indicate that most Kalkhoff e-bike riders are female and approximately 50 years old, highlighting a potential target demographic.

Challenges with Public Transportation Integration

Accessibility issues make it difficult to bring e-bikes onto public transportation. The lack of accessible facilities and overcrowding further complicate multimodal travel.



Figure 22. Lack of facilities for e-bikers to take their bikes on public transport.

4.3.3 Insights from Questionnaire

Among the 61 effective responses, participants were categorized as follows: 18 Everyday Commuters, 17 Greenovators, 12 Family Cruisers, 7 Silver Riders, 3 Sensation Seekers, 2 Global Nomads, and 2 Low-End Users.

1. Public Transportation as a Backbone

Hamburg residents heavily rely on the city's dense, affordable, and reliable public transportation system as their primary mode of daily mobility. It remains a highly preferred choice for social and recreational activities, emphasizing its cost-effectiveness and convenience.

2. E-Biking as Purpose-Driven Mobility

- Most participants expressed a preference for making public transportation their primary mode of daily mobility. Biking was viewed as an activity for specific purposes, such as leisure or recreation.
- Many participants showed a strong inclination toward e-biking with family and friends, emphasizing its social and purposeful appeal.

3. E-Biking for Health, Leisure, and Practicality

- Generally, e-bikes in Hamburg are used for specific purposes such as long-distance commuting, transporting children or groceries, and leisure activities rather than as a primary daily mobility mode.
- Older adults used e-bikes to stay active during retirement.
- Suburban respondents often used e-bikes to compensate for limited public transit options, especially with access to dedicated bike routes connecting them to the city centre.

4. Recreational Mobility

E-bikes are frequently used for outdoor group activities and hobbies among older adults. Family Cruisers occasionally use them for family trips. However, cars remain the dominant choice for recreational outings due to their convenience.

7. Motivations for E-Bike Use

Participants' motivations for e-bike adoption included:

- **Speed:** Faster access to destinations compared to other modes of transport.
- **Cargo Capacity:** Practicality for transporting children or goods.
- **Convenience:** Ease of parking and navigating urban locations compared to cars.

8. Challenges Discouraging E-Bike Use

Several barriers to e-bike adoption were identified:

- **Weather:** Unpredictable and cold conditions were a significant deterrent.
- **Infrastructure:** Issues included crowded city centres, inconsistent bike routes, and limited secure parking options.
- **Public Transport:** The convenience and reliability of Hamburg's public transit system made e-bikes less attractive for daily use.
- **E-Bike Weight:** Heavy batteries and accessories posed handling difficulties.
- **Cost:** High purchase and maintenance costs discouraged broader adoption.

5. Adoption in a Car-Free Scenario

In a hypothetical car-free city:

62% of daily e-bike users expressed willingness to use e-bikes to access the city center.

66% of daily car users indicated they would switch to e-bikes if car use was restricted.

6. Future Mobility Expectations

Gen Z: The majority of Gen Z respondents identified as "Greenovators," indicating a strong preference for environmentally friendly and shared transportation options.

Gen Y: Demonstrated diverse motivations, including convenience, exploration, and style. Gen Y exhibited the highest motivation to transition to e-bikes, driven largely by sustainability goals and the practicality of e-bikes for cargo transport.

Gen X: Mobility decisions were primarily driven by health benefits and leisure activities.

Conclusion

The insights gathered provide a comprehensive understanding of the mobility preferences and challenges in Hamburg. They emphasize the importance of addressing barriers such as infrastructure and affordability while leveraging motivations like sustainability, convenience, and health benefits to promote e-bike adoption across diverse user groups. These findings serve as a foundation for strategic e-bike design and urban mobility solutions tailored to Hamburg's unique context.

4.3.4 Conclusion

The insights from the research provide a brief response to the third research question:

What are the primary mobility needs and preferences of Hamburg residents in 2035?

The mobility preferences of Hamburg residents in 2035 are anticipated to revolve primarily around efficiency with sustainability and convenience. While environmental considerations are increasingly shaping mobility decisions, residents consistently prioritize practical and reliable solutions. Public transportation is expected to remain the cornerstone of urban mobility due to its affordability and dependability. However, e-bikes are projected to gain greater prominence as complementary options, particularly for suburban commuting, recreational activities, and mid-range travel. The insights can be concluded into these strategic implications for the stakeholders in the e-bike ecosystem:

Leverage Sustainability

Develop eco-friendly e-bike solutions that align with environmental priorities, especially for Gen Z and Gen Y users.

Promote Purpose-Specific Features

Focus on designs tailored for family use, cargo capacity, and leisure activities to cater to diverse user needs.

Expand Subscription Models

Offer flexible, cost-effective alternatives to ownership, appealing to urban residents who prioritize affordability and convenience.

Enhance Infrastructure

Invest in clear signage, consistent bike lane standards, and secure parking to address usability and safety concerns.

Integrate with Public Transport

Position e-bikes as an extension of Hamburg's multimodal ecosystem, enabling seamless first- and last-mile connectivity.

Customer Segmentation



Previous understanding of potential e-bike users developed Kalkhoff customer segmentation based on future mobility user profiles. This process aimed to identify key demographic groups and behavioural patterns that represent opportunities for growth. By gaining deeper insights into the unique needs and preferences of each customer group, Kalkhoff can design tailored solutions that address specific demands, fostering a competitive edge in the evolving e-bike market.

Using insights from the previous survey, including expert interview, Kalkhoff's customers were categorized into three distinct groups: core customers, emerging customers, and prospective customers. This segmentation enables the company to strategically align product development and marketing efforts with the varying expectations and priorities of these groups, ensuring a more targeted and effective approach to customer engagement and product innovation.

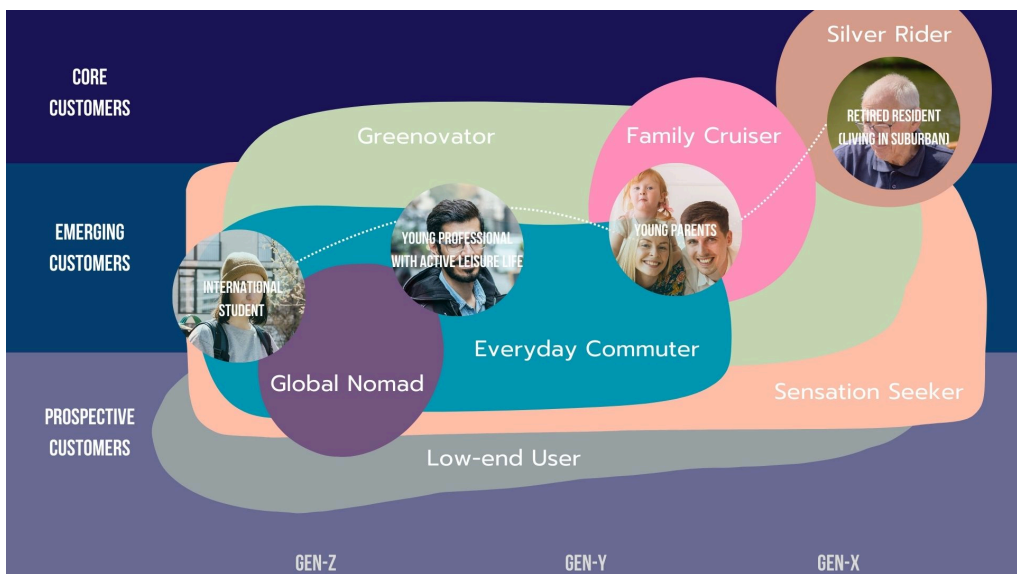


Figure 23. Customer Segmentation of Kalkhoff

4.4.1 Core Customers

Core customers are Kalkhoff's established and loyal user base.

Silver Rider

The core customer of Kalkhoff is generally a mature, high-income individual who values quality and reliability in an e-bike. As part of Silver Rider, these customers are typically older and tend to have a more conservative outlook, preferring trusted, well-established brands with a reputation for durability and performance. They prioritize high-quality features and are willing to invest in premium models that provide comfort, safety, and ease of use.

This demographic also includes a tendency toward female riders who are active and enjoy keeping a healthy lifestyle through regular cycling. They often look for lightweight, user-friendly options that are easy to manoeuvre and suitable for both daily commutes and leisure activities. Kalkhoff's reputation for powerful performance and dependability appeals to these customers, who are less interested in experimental or cutting-edge designs and more focused on tried-and-true functionality.

As an increasing number of older adults adopt e-bikes as their primary mode of transportation, Kalkhoff should focus on reducing the physical effort required and creating a seamless experience for users when they need to transfer their e-bikes onto other modes of transportation.

Awareness of Kalkhoff products within this group is largely driven by word-of-mouth, as they rely on recommendations from friends, family, trusted community members or local dealers when making purchasing decisions.

4.4.2 Emerging Customers

Emerging customers are a growing and dynamic segment of Kalkhoff's market. While some individuals in this group have already become early adopters and product pilots, there are still significant opportunities to explore and address their diverse needs.

Everyday Commuter

Everyday commuters are becoming an emerging customer segment for Kalkhoff due to growing health and environmental awareness, as well as improvements in urban biking infrastructure. As more people look for active and eco-friendly modes of transportation, e-bikes offer an appealing alternative to cars for daily commutes, aligning perfectly with Kalkhoff's focus on quality, comfort, and reliability. Everyday commuters are also a prime target for Kalkhoff's E-Trekking series, which is designed to deliver a high-quality, dependable, and enjoyable ride that meets the demands of daily use. However, the design appears to be too conservative for younger commuters.

Family Cruiser

The main generation of family cruisers—primarily Gen Y—are notably less inclined to drive and are postponing obtaining a driver's license. The strong cargo capacity in Kalkhoff's e-bike models means families can carry children, groceries, or other essentials effortlessly. This makes e-bikes particularly appealing for parents who look for a flexible, eco-friendly transportation choice that supports active lifestyles. On weekends, the whole family can use the e-bike for recreational rides, promoting quality time together while staying active and reducing their environmental impact.

Sensation Seeker

As outdoor hobbies and recreational activities grow in popularity, sensation seekers are increasingly drawn to e-bikes to explore nature while benefiting from a comfortable, high-speed ride. Kalkhoff's e-bikes cater to this need by combining power, stability, and a smooth riding experience, making them ideal for thrill-seekers who enjoy long rides through varied terrain. Rising car ownership costs also play a role, as sensation seekers look for cost-effective yet fulfilling ways to achieve mobility. For them, an e-bike is not only financial savings but also an expression of individuality and freedom.

4.4.3 Prospective Customers

Prospective customers are potential users who have yet to adopt e-bikes but may do so in the future due to evolving mobility preferences, increasing urbanization, or growing environmental awareness. Currently, there is limited research focusing on this segment, making it an untapped area of opportunity for Kalkhoff.

Gen-Z and Share E-bikes

Gen Z is a highly promising segment for shared vehicle services, as they are strong advocates for sustainable mobility and are motivated by eco-conscious choices. While e-bikes offer a convenient and environmentally friendly alternative to traditional vehicles, Gen Z generally prefers not to own expensive vehicles like e-bikes, especially when a pedal bike can often meet their needs. They value the flexibility of using shared or family-owned vehicles and enjoy other activities while travelling. A shared e-bike system, therefore, aligns with their lifestyle preferences, providing them with an accessible and sustainable mobility option without the long-term financial commitment of ownership.

Travel within Work

While e-bikes are often associated with commuting, they are also ideal for employees whose jobs require frequent movement within a localized area, such as delivery personnel and home healthcare workers. For these roles, e-bikes provide a cost-effective and efficient way to navigate urban or suburban areas, significantly improving work efficiency and reducing reliance on private cars. Offering solutions tailored to business needs, such as fleet services or maintenance packages, could position Kalkhoff as a key provider of mobility solutions within the B2B sector.

Individuals with Disabilities

E-bikes also present a valuable mobility option for individuals with disabilities, who, like elderly users, receive help from the added physical support and enhanced mobility that e-bikes provide. For many in this group, e-bikes are more than just a means of transportation—they are tools for independence, allowing them to move around actively and engage with their communities more freely. By expanding accessibility features and promoting e-bikes as an inclusive mobility solution, Kalkhoff can capture this market segment, supporting individuals with disabilities in leading more active and autonomous lives.



Figure 24. Off-road wheelchair constructed from two electric bikes by a YouTuber (JerryRigEverything, 2018).



4.5 Gen Y as Target User

Emerging customers should be prioritized as Kalkhoff's primary target users due to their clearly identified needs and challenges, as revealed through comprehensive research. This group presents significant potential for growth and aligns closely with the company's strategic objectives.

An Ansoff Matrix was used to evaluate the risks and opportunities associated with focusing on different customer segments. As shown in Figure 25, emerging customers represent opportunities for market or product development, enabling the maximization of product innovation while supporting the creation of a robust future product strategy.

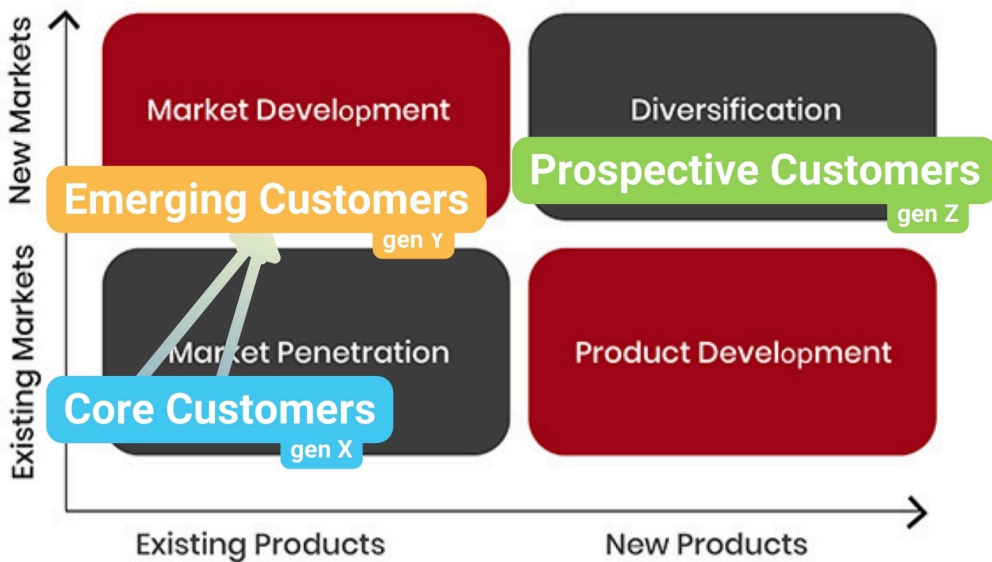


Figure 25 : Ansoff Matrix

A critical reason for prioritizing emerging customers is their demographic composition, which predominantly includes Commuters and Family Cruisers from Generation Y. This group is actively reducing car dependency and integrating bicycles into their daily mobility routines, as highlighted in Sections 4.1 and 4.3.3 In urban environments, where e-bikes offer an effective alternative to cars for short-distance commutes and errands, emerging customers represent a key opportunity to drive adoption and market growth. Additionally, their role in fostering a sustainable mobility culture has a multiplier effect, influencing the transportation choices of their families and communities

Looking ahead, as Generation Y ages, many are likely to transition into active elder e-bike users, extending the lifespan of e-bikes as their primary private vehicle. This demographic shift positions them as a crucial focus for both current and future market strategies, solidifying their importance in Kalkhoff's efforts to build a sustainable and resilient presence in the e-bike market.



Market Opportunity

According to Kalkhoff's product portfolio, the E-Trekking series addresses the needs of everyday commuters most effectively. However, there is currently no Kalkhoff bike specifically designed for family use. This presents a gap in the product line, as family users prioritize cargo capacity and durability—features that align well with Kalkhoff's expertise in reliability and quality.

Among the brands under Pon, Urban Arrow already specializes in cargo family e-bikes, creating potential overlap in product offerings and target markets. To avoid internal competition and market redundancy, Kalkhoff should strategically differentiate its product line by focusing on long-tail e-bikes designed for flexible and versatile use. This approach allows Kalkhoff to carve out a distinct niche, catering to users seeking multi-purpose solutions that combine practicality with adaptability, while complementing rather than competing with Urban Arrow's cargo-focused offerings.

Figure 26 highlights an opportunity for Kalkhoff to introduce a durable and user-friendly family e-bike to the market. But that also said, Kalkhoff will be entering this segment late, as many competitors have already developed a range of products catering to various family needs.

To stand out, Kalkhoff should focus on optimising the user experience to redefine the rules of the market, offering innovative solutions that go beyond the conventional features currently available.

Market Definition: based on product extension

Kalkhoff family (long-tail) e-bike is durable and user-friendly, designed to transport a lot and adapts flexibly to every family stage.

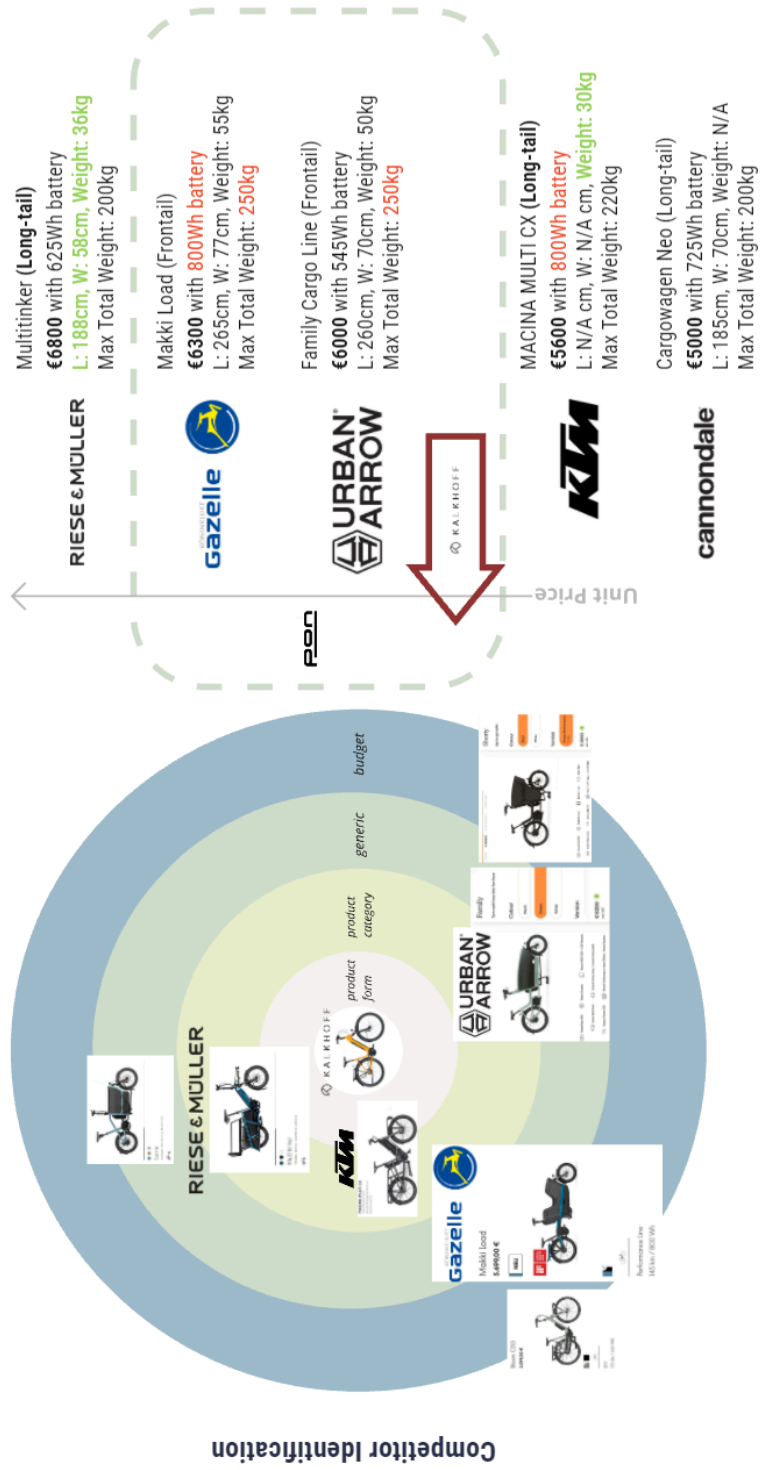


Figure 26. Market Definition



Insights from User Journey

Target User: Gen Y Parents (Ages 29–44) with Children (Under 10)

To gain a deeper understanding of user experiences with e-bikes, an online user journey study was conducted with four parents who actively use e-bikes. The study focused on their motivations, challenges, and needs, revealing critical insights into their experiences and expectations:

Diverse Demands Across Users and Family Phases

Parents rely on e-bikes for commuting, running errands, and transporting children in urban settings. However, their specific needs and feature preferences vary widely, reflecting the diverse lifestyles and family stages within this user group. These variations highlight the importance of creating versatile e-bike solutions adaptable to different family phases.

"When my kids were toddlers, a simple rear seat was fine. Now that they're older, I need something that can handle two of them ... plus their school bags ... I need different bike every few years!"

Accessory Adjustments and Expenses

As children grow, parents frequently need to replace or upgrade e-bike accessories, leading to increased costs and concerns about wastefulness. This points to a demand for adaptable, durable accessories that evolve with the needs of growing families, ensuring long-term value and sustainability.

"My kids start complaining after about 20 minutes on the bike ... they need distraction during long rides so I always have to stop for them or give them snacks."

Discomfort During Long Rides

Although parents are generally satisfied with the comfort of their own riding experience, long-duration trips often result in discomfort or fatigue for children as passengers. Cramped seating and inadequate support in narrow spaces were identified as significant pain points, limiting the overall enjoyment of e-bike rides with children.

Battery and Weight Challenges

The heavy weight of e-bike batteries and accessories emerged as a key challenge. Tasks such as shopping with children or navigating public transportation with an e-bike become cumbersome due to the bulky design, detracting from the convenience and flexibility parents seek.

"I don't like to carry the heavy battery up the stairs to charge it ... while also juggling kids and shopping bags, is a nightmare."

Balancing Cargo Functionality with Compactness

Parents expressed interest in the utility of cargo bikes for short-term needs but emphasized the importance of compact, easy-to-maneuver designs for daily use. Compactness is essential for maintaining a sense of independence and freedom while navigating crowded urban environments.

"My bulky cargo bike is convenient for delivering lots of things but it is not easy for me to navigate... I found it very difficult to park in the crowded city centre..."

Parking and Security Issues

The lack of secure, long-term parking options in urban areas was a common frustration. This limitation discourages parents from using e-bikes for extended outings or city exploration, significantly reducing the practicality and appeal of e-bikes in these scenarios.

"I'm always worried about leaving my e-bike locked up in the city. I can not find enough secure parking options, and I've heard too many stories about e-bikes getting stolen in busy areas."



Figure 26 : Bikes Used by Families.

User Journey: daily commute

Commute and transfer kids: going to drop off children at school in the city centre and go to office, speed: 18-23 km/h, 5-15 km.



Figure 27. User journey with brainstorming ideas

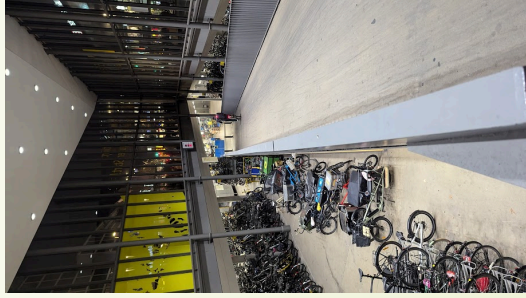
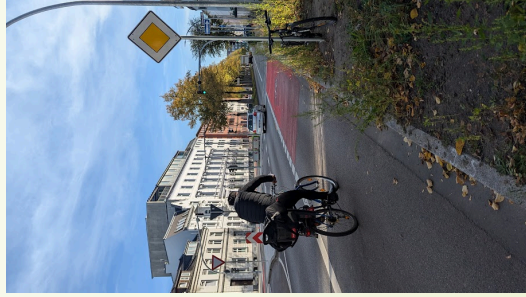
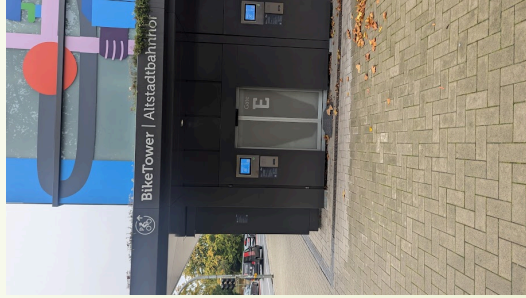
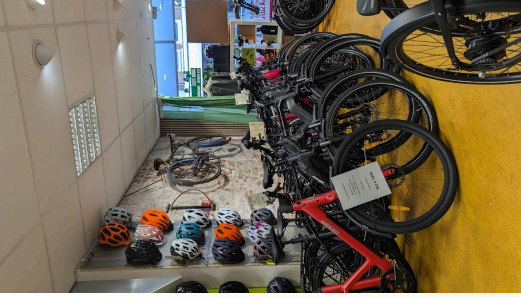
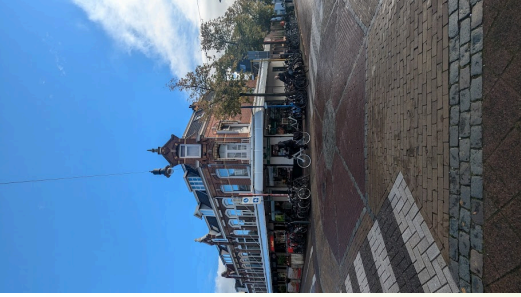
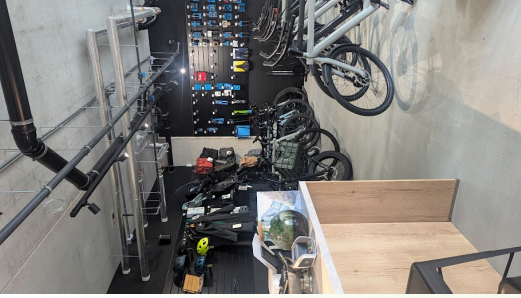


Figure 28. Images related to experts interviews (local dealers in the Netherlands) and field research in Hamburg

Design Brief

Ch. 5

5.1 Problem Statement

From previous research, we discovered that family mobility needs are highly diverse and dynamic. E-bikes are typically used for specific purposes, such as commuting, running errands, or transporting children, and they can serve as an efficient and convenient solution in urban for parents who often make multiple stops during a single trip. However, as children grow older and family mobility needs evolve, e-bikes often become secondary mobility options. This results in an increase in unused bikes within households, highlighting a mismatch between current product offerings and user needs.

This disconnect creates a feeling of limited utility, especially when users make a significant financial investment in an e-bike but find it suitable only for certain scenarios. Such feelings can diminish the overall appeal of e-bikes as practical and versatile mobility solutions.

Currently, Kalkhoff's product lineup stays general and does not adequately address the unique and evolving demands of family users. To effectively capture this market, which already includes strong competitors, Kalkhoff must maximise the adaptability of its e-bikes to different family stages. This strategy would enable the company to create solutions that enhance usability, flexibility, and long-term value for users.

5.2 Design Goal

Design a solution for a Gen Y working parent looking for a seamless and convenient e-bike riding experience with children, adaptable to evolving family stages.

The solution should address the diverse and dynamic mobility needs of families by enhancing usability and adaptability across various scenarios. It must prioritize flexibility, offering features that evolve with changing family requirements to maximize long-term value and user satisfaction. Additionally, the design should ensure that the e-bike remains a highly versatile and primary mobility option for different users, increasing the likelihood of adoption by other family members after the need for child transportation diminishes.

Ideation

Ch. 6

Ideation

The objective of the ideation phase is to generate and refine potential solutions that effectively address the established design goals in collaboration with stakeholders. This phase adopts an iterative methodology, allowing ideas and concepts to be continually developed and improved based on insights from user ideation sessions and expert feedback. The process begins with a divergent exploration of possible solutions to ensure a broad spectrum of ideas, which are subsequently analysed and synthesized into a cohesive and well-defined concept.



6.1

Design Principles

Four family bike users who commute and transport their children on e-bikes participated in the initial ideation session. To engage them in the design process, I outlined a typical user journey for family e-bike riders, highlighting the main pain points they encounter. Participants were then asked to select the issues that affect them most, discuss current solutions, and propose their expectations for an improved e-bike experience. Their insights were synthesized into the following design principles:

"My bike wouldn't require removing the battery every time I park."

"I would remove all luggage (including my child) and lock/unlock my bike in one step, just like using a car remote."

"My bike would carry my babies and stroller, and as they grow, it could transport my kids and their bikes!"

"Since I don't own a car, my bike should offer the same cargo flexibility as a car."

"I feel comfortable and relaxed when my kids feel relaxed and comfortable."

"The speed of the e-bike makes it essential to have a secure and well-designed kid seat for safety."

"My e-bike would take me further and have more adventures with my kids."

"I could easily carry my bike upstairs or onto public transportation like trains and buses."

Easy and Safe Parking

Frequent stops in urban settings pose challenges for family e-bike users, particularly in finding appropriate and secure parking. Users expressed a strong need for solutions that simplify the parking process while enhancing security.

Flexible Cargo Space

Family e-bike users require adaptable cargo solutions to accommodate various family needs as their children grow and their mobility requirements change. From transporting a stroller to carrying a child and their small bike, cargo space must evolve with family life.

Comfortable and Safe for Kids

With e-bikes often used for commuting and leisure, longer journeys can be challenging for children. Discomfort and difficulty in interaction can make trips less enjoyable, while high e-bike speeds raise safety concerns.

Lighter, Compact Urban Bike

Three out of four users preferred a compact e-bike for urban use. This preference stems from its ease of parking, better maneuverability compared to bulky cargo bikes, and compatibility with public transportation, enabling extended journeys and adventures.

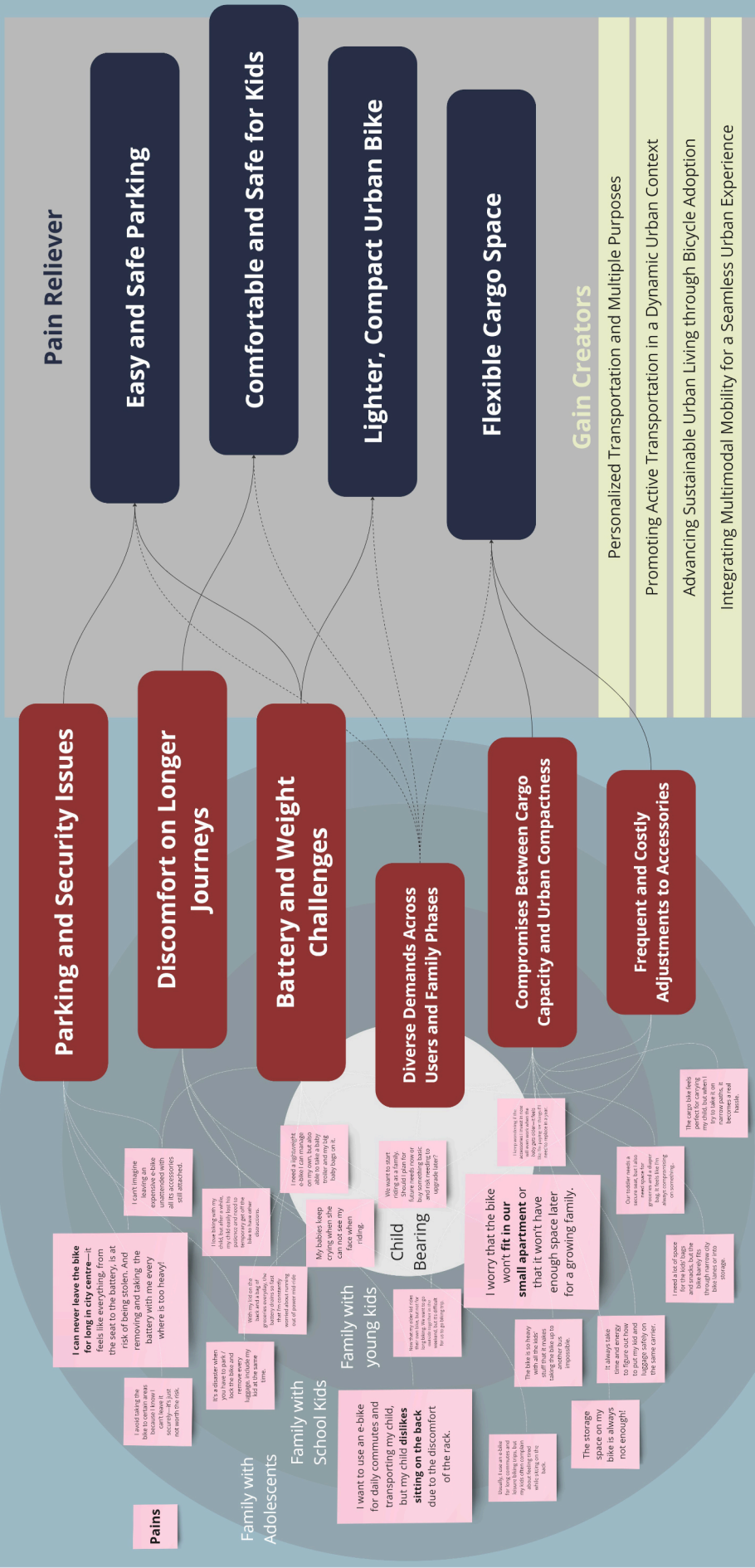


Figure 29. Value Proposition



6.2 Concept Iteration

These principles form the foundation for designing e-bikes tailored to the unique needs of family users, addressing their mobility challenges while enhancing functionality, safety, and adaptability.

Concept 1. Lift a Heavy Bike Up to a Higher Platform

This concept focuses on improving the experience of lifting and maneuvering an e-bike in challenging situations, such as entering a bus or climbing stairs at home. Parents who use e-bikes often carry children and groceries, making the bike heavy and difficult to lift during these scenarios. This pain point is a primary reason parents avoid using e-bikes with public transportation, as managing a heavily loaded e-bike in and out of a cabin can be inconvenient and frustrating. The solution aims to address these specific challenges, making it easier for parents to transport e-bikes across different platforms in urban settings.



Figure 30. Bike lift concept

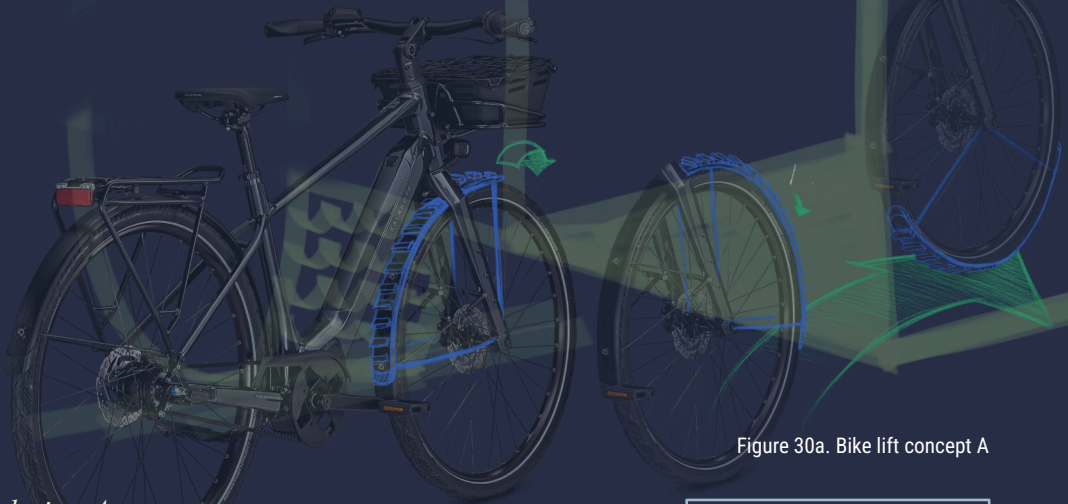


Figure 30a. Bike lift concept A

Solution A

The adjustable front wheel fender is designed to enhance mobility in challenging situations. Its position can be changed to rotate coordinated with the front wheel. When users need to guide the e-bike upstairs, the high-friction material on the fender engages with the stairs, using the principle of mechanical advantage to aid in lifting the bike.

Pros

- Does not require electricity.
- Adds minimal accessory weight.

Cons

- Requires the development of a new product and mechanical adjustments.
- Still relies on user effort to lift the bike.

Solution B

This feature uses the main motor to provide slow and stable support when climbing stairs. To activate it, the user first locks the front wheel to stabilize the bike's direction. Then, they hold the handles beneath the seat and press a button to enable the backward walking mode, which aids in pushing the bike up the stairs.



Pros

- Backward climbing offers easier control due to improved weight distribution.
- Does not require the development of a new motor.

Cons

- The activation process involves multiple steps and is not intuitive.

Figure 30b. Bike lift concept B

Pros

- Simple and easy to use.
- Does not require the development of a new motor.

Cons

Adds an extra motor to the front wheel, increasing the bike's weight and mechanical complexity.

Solution C

This feature incorporates a small motor into the front wheel to provide additional energy support when lifting the bike upstairs. To use it, users must lock the front wheel to keep balance, particularly on long staircases. By activating the walking mode and pressing the boost button, the motor provides extra aid for climbing.



Figure 30c. Bike lift concept C

Critical Feedback

While this concept directly addresses a real pain point, feedback from Kalkhoff highlighted its narrow scope and situational application. The use case is too niche to appeal to a broad audience, potentially limiting its market impact. Additionally, the concept's technical complexity requires extensive testing to ensure feasibility, further complicating its development.

Concept 2. Removable Carrier Bag

The removable carrier bag can transform into a seat, a cargo basket, or a shopping basket, offering enhanced utility for bikers. When configured as a seat, it includes a footrest for added comfort of passenger. Once parked, users can easily detach the carrier for further use. By folding the footrest, the carrier converts into a portable handle for convenient transport, making it a shopping basket. Additionally, the carrier features a retractable tarp to provide protection against adverse weather conditions.

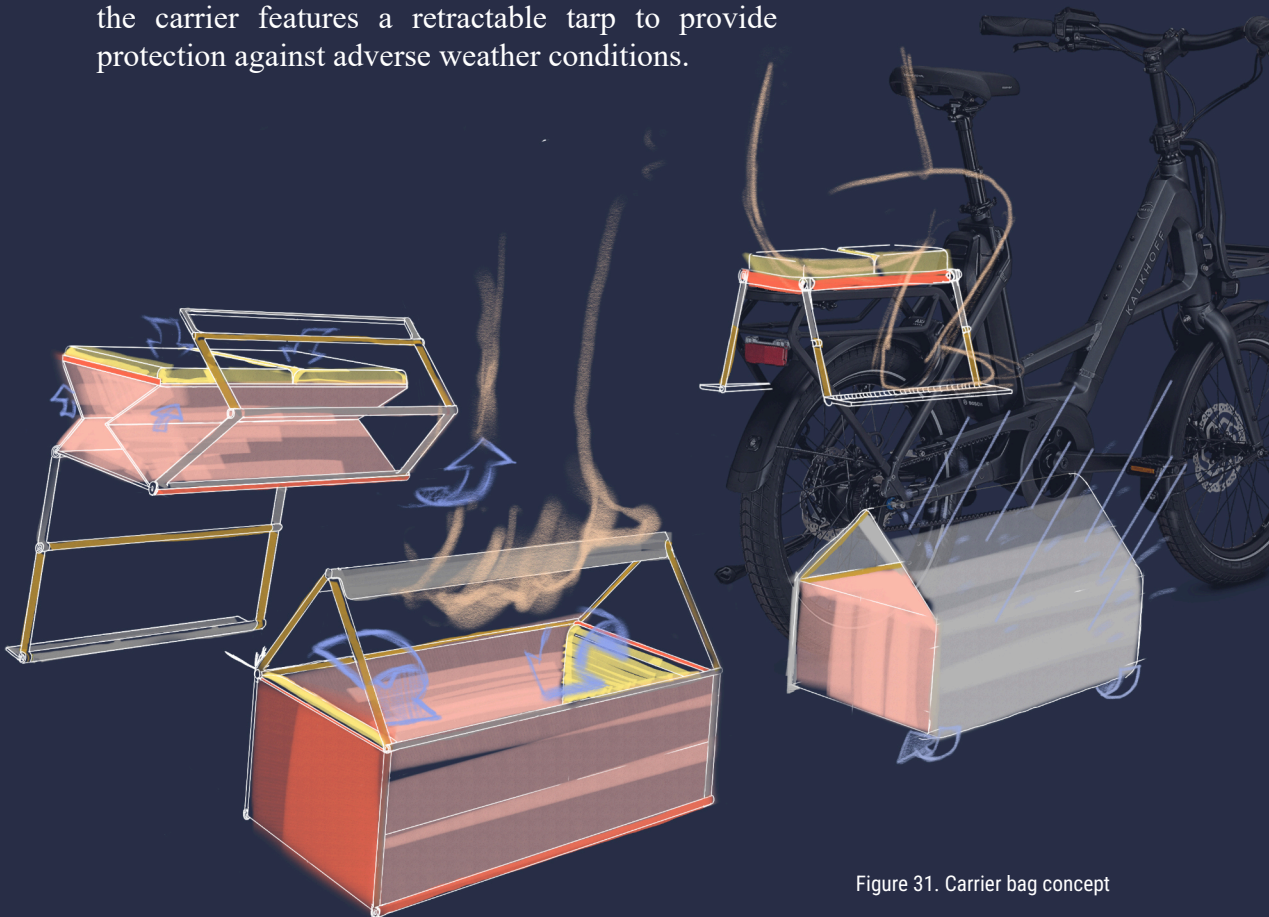


Figure 31. Carrier bag concept

Critical Feedback

While this concept demonstrates creativity and versatility, it does not address a common scenario where parents need to combine grocery shopping with picking up their children.

Concept 3. Family Subscription

Kalkhoff would offer a range of modular accessories that customers can rent and swap according to the subscription plan they choose. This approach provides families with adaptable mobility solutions tailored to their evolving needs, ensuring a seamless and effortless biking experience. The subscription would go beyond just the e-bike itself, incorporating features like complimentary access to alternative mobility services for days with unsuitable weather conditions. This positions the subscription as a comprehensive mobility product, enabling users to navigate various scenarios with ease.

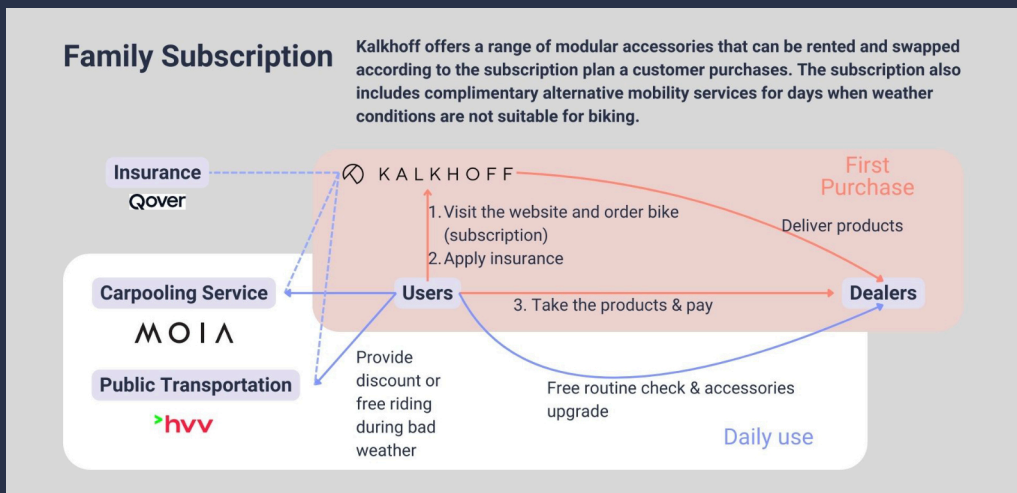


Figure 32. Family subscription

To enhance user convenience, the subscription could include additional services such as insurance, offering comprehensive coverage for both the e-bike and its accessories. Kalkhoff could also allow customers to buy accessories from other brands, emphasizing flexibility and freedom of choice. Personalization options, such as modular components that can be swapped to celebrate family milestones or special experiences, would add emotional value to the product. This personalized touch reinforces the brand's focus on family-oriented solutions and deepens user engagement.

Critical Feedback

Feedback from Kalkhoff highlighted the potential challenges of implementing such a subscription model. Managing a wide range of modular accessories on a rental basis introduces significant logistical and operational costs. Developing and coordinating this new service would require extensive investment and partnerships, making scalability a concern. Despite its innovative approach, the concept needs refinement to balance user appeal with business feasibility.

Concept 4. Modular Family Bike

The bike is divided into modular components, including the head, main frame, motor system, wheels, and accessories. Customers can personalize their e-bike by selecting specific parts based on their preferences and needs. This modular approach allows users to customize the components of their e-bike during the purchase process, offering the flexibility to upgrade or replace parts as their requirements change over time. After a period of use, customers can conveniently order new parts online and send their e-bike back for an upgrade, extending its usability and adaptability to different family stages.

Critical Feedback

Making the entire bike modular and customizable for customers will significantly increase design complexity and production costs. Modular designs must ensure the structural integrity of the e-bike, especially when components are swapped or upgraded, to keep safety and durability under varied usage conditions. Striking the right balance between durability and the flexibility of modularity stays a critical hurdle. In conclusion, with the exception of the fourth concept, all proposed concepts will undergo refinement and further development. Alternatively, they may be retained as feature references for potential incorporation in future projects.

Final Concepts

Ch. 7

Final Concepts

The final design integrates a set of innovative product and service solutions aimed at addressing the primary challenges identified in research phases. These solutions focus on enhancing security, convenience, and family-friendly functionality while promoting sustainable transportation.



P1

Rotatable Monkey Bar as an Easy Lock

The rotatable monkey bar, integrated with a ring lock, provides a dual-function security solution. When rotated to seat level, it synergizes with a worm gear mechanism to lock the bike while simultaneously protecting the battery from theft. The cover also increases the difficulty for theft to ride on the bike after stealing. This design not only protect kids or luggage on the carrier but also enhances e-bike security, allowing users to park confidently in urban areas and make short errands with ease.

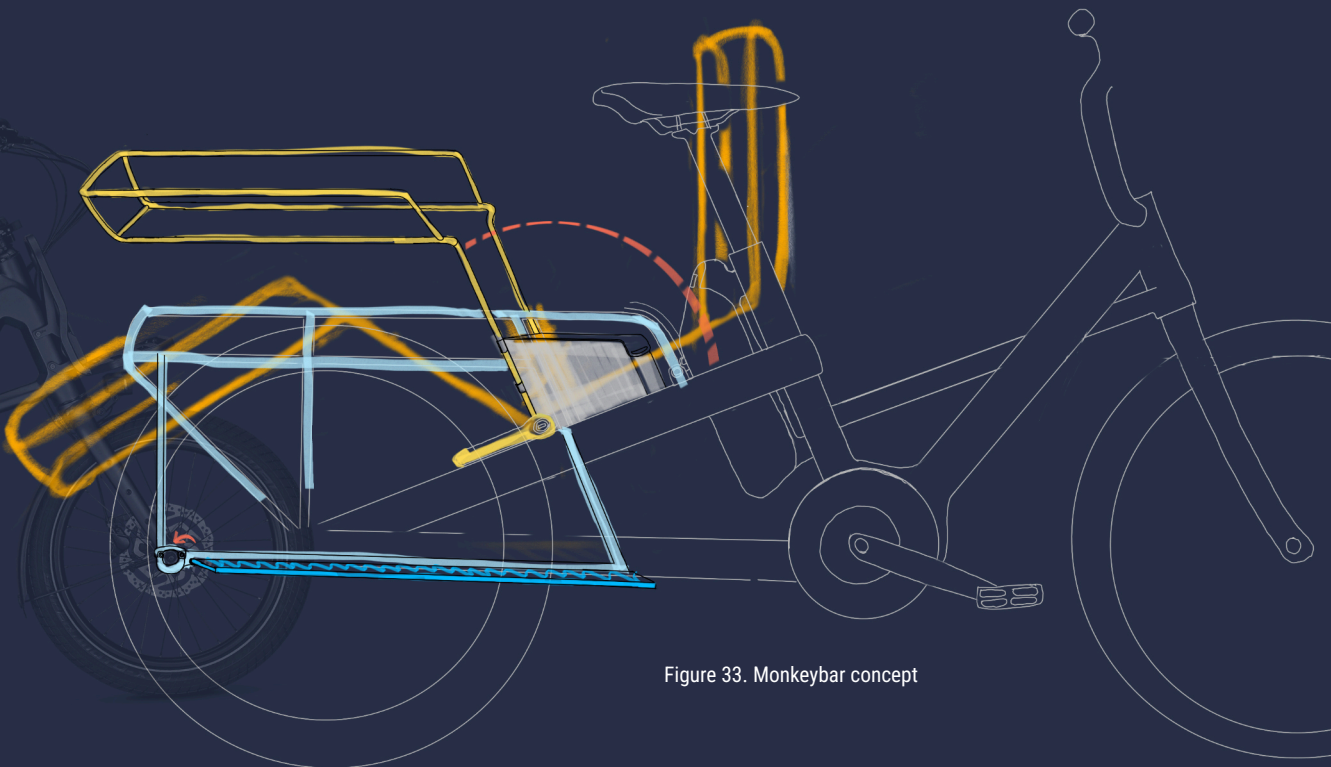
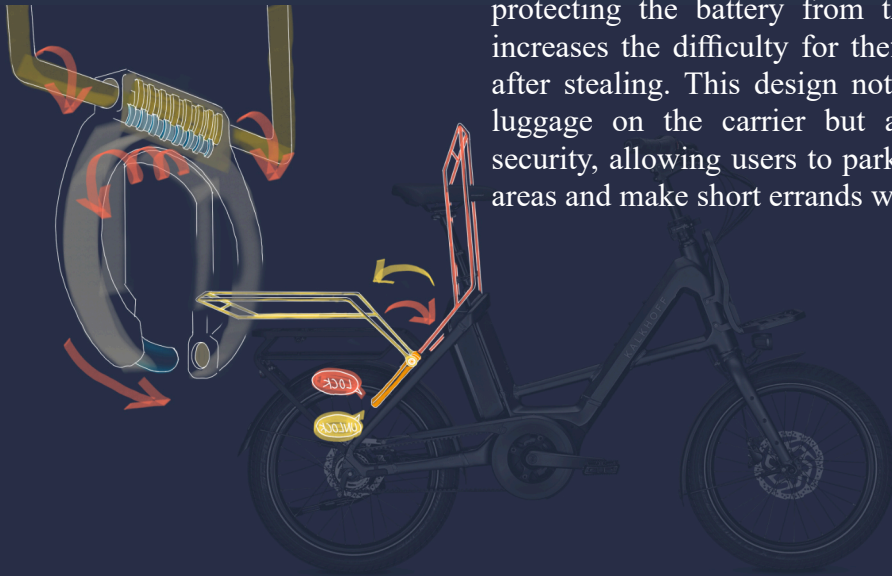


Figure 33. Monkeybar concept

Multifunctional Carrier Seat



Installed on the luggage rack, this versatile carrier features a soft, waterproof cushion and footrests to provide a comfortable seating solution for children. The cushion is removable, allowing for the attachment of additional child bike seats or for cargo transport. The grooves on the footrest can also secure and drag two children's bikes. This adaptability accommodates varying family needs, promoting cycling as a practical, family-friendly activity across different life stages.



Figure 34. Multifunctional Carrier Seat concept



P3

Spacious Handlebar Platform

A versatile space between the handlebars is designed to support the installation of various accessories with a simple one-step un/lock mechanism by modular mounting accessories. This allows users to easily and securely attach items such as a child seat or storage basket, catering to a variety of family scenarios. The space can also function as a cargo platform without any accessories, secured with a rope for added flexibility.

This design accommodates a baby bike seat and allows the seat to be adjusted so the child can face the parent during rides. This configuration provides children with a greater sense of safety and encourages more interaction between parents and children while riding.



Figure 35. Handlebar platform concept

Service 1. Short-Term Rentals at Key Locations

Recognizing the growing preference for shared and subscription-based transportation, Kalkhoff can leverage its parent company PON's existing "Lease A Bike" employer-based leasing service and expand it to key family-friendly destinations like parks, zoos, and recreational areas. These rentals allow families to use different e-bikes for short-term use and experience the benefits firsthand, potentially encouraging longer-term subscriptions or purchases. This combined approach promotes sustainable mobility while accommodating diverse family needs and offering a valuable trial for potential customers.



Service 2. E-Bike Charging Parking Lots

By offering free, secure e-bike charging stations at urban mobility hubs in Germany, Kalkhoff encourages the adoption of its e-bikes. These charging lots also serve as temporary storage solutions during inclement weather, allowing users to switch to public transportation seamlessly. This initiative, developed in collaboration with mobility departments, not only promotes e-bike usage but also boosts brand visibility in urban hotspots.



Figure 36. A folding bike brand's dedicated shared folding bike lockers at various mobility hubs (Brompton Hire, 2024).

Service 3. Public Transportation Pass

Addressing the unpredictability of weather, Kalkhoff could partner with local mobility departments (e.g. HVV) to offer free public transportation passes for e-bike users during adverse conditions. This collaboration mitigates a key barrier to daily e-bike usage, ensuring that families can continue their journeys comfortably and reliably, even in challenging weather.

Implementation

Ch. 8

Implementation

Design concept validation plays a critical role in the early stages of product development, ensuring alignment with customer needs, enhancing user satisfaction, and mitigating potential risks. For this validation process, a physical prototype and storyboards were employed to facilitate customer-design interaction and effectively communicate key design attributes.



8.1 Market Evaluation

To evaluate the viability and feasibility of these innovations, I adapted the Growth Share Matrix framework to align with user-centered evaluation and future business needs. Traditionally used for assessing the profitability of business units within a company, the framework was modified by replacing the traditional axes:

Market Share Index → Relevance

Relevance measures the alignment of the innovation with Kalkhoff's core competencies and market positioning as an e-bike producer. It evaluates whether the innovation is closely related to Kalkhoff's expertise and whether it would be straightforward for the company to develop and implement.

Market Growth → Influence on User

Influence on User assesses the degree to which the innovation impacts user behavior and addresses critical user pain points. It considers whether the solution has the potential to transform user experiences or resolve significant challenges faced by e-bike users.

8.1.1 Evaluation Framework

The innovations are evaluated based on their positioning within the modified matrix:

High Relevance, High Influence

Strategic priorities—innovations in this quadrant should be prioritized for immediate development and rollout as they align closely with Kalkhoff's strengths and have significant user impact.

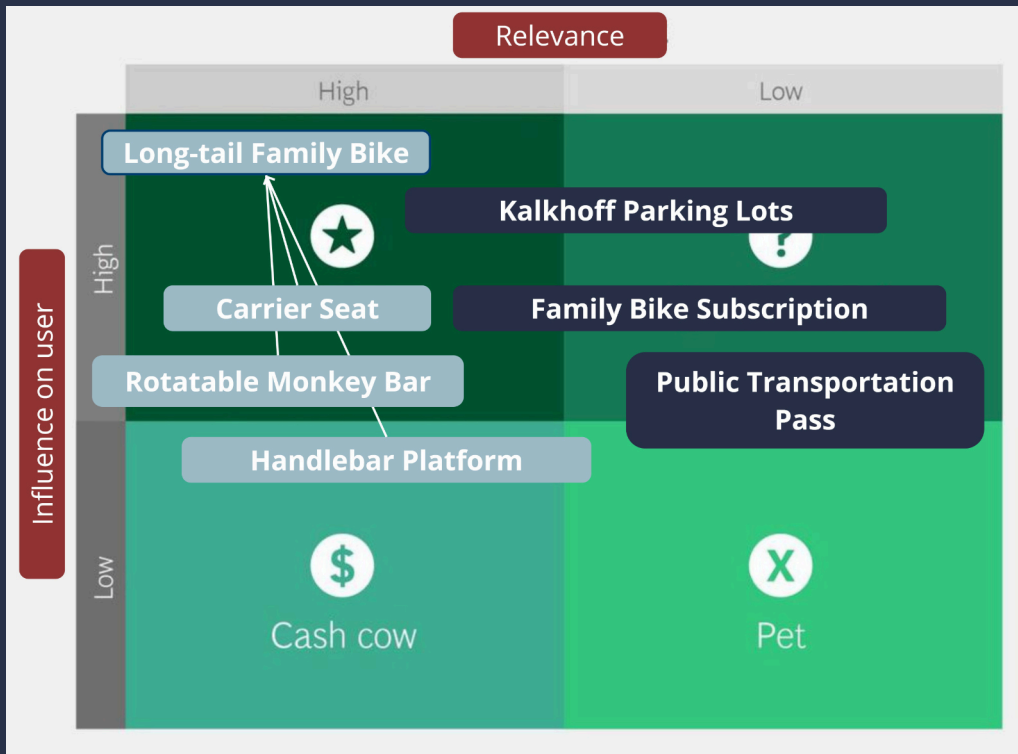


Figure 37. Market Evaluation based on Growth Share Matrix

High Relevance, Low Influence

Incremental improvements—innovations here are easy to develop and align with Kalkhoff’s positioning but may not substantially impact user behaviour. They can be secondary priorities or bundled with other solutions.

Low Relevance, High Influence

Strategic opportunities—innovations in this quadrant may have strong user impact but are less aligned with Kalkhoff’s expertise. These could be explored as partnerships or future development opportunities.

Low Relevance, Low Influence

Non-priorities—innovations in this category may lack both alignment with Kalkhoff’s strategy and significant user impact, making them unsuitable for immediate development.

Referring to the SWOT analysis (3.6) in research phase, each proposed innovation can be effectively positioned within the modified Growth Share Matrix to evaluate its strategic significance.

8.1.2 Product Innovations

All product innovations align directly with Kalkhoff's core positioning as a provider of reliable and comfortable e-bikes. According to market opportunity and to ensure a cohesive and premium family biking experience, Kalkhoff should consider designing a long-tail bike. This extended-frame bicycle would serve as a platform to seamlessly integrate all the proposed product innovations, creating a bundled solution that caters specifically to families.

8.1.3 Service Innovations

Service innovations, while having a high impact on users, extend beyond Kalkhoff's immediate resources and capabilities. Their successful implementation would require a well-structured collaboration plan with key stakeholders, such as mobility departments, public transportation providers, and corporate partners. These services represent strategic opportunities within the framework, as they significantly address user pain points but necessitate partnerships for execution.

8.1.4 Roadmap

The first version of roadmap for this concept is on the next page. The roadmap describes in detail the steps and processes to take to achieve the desired result.

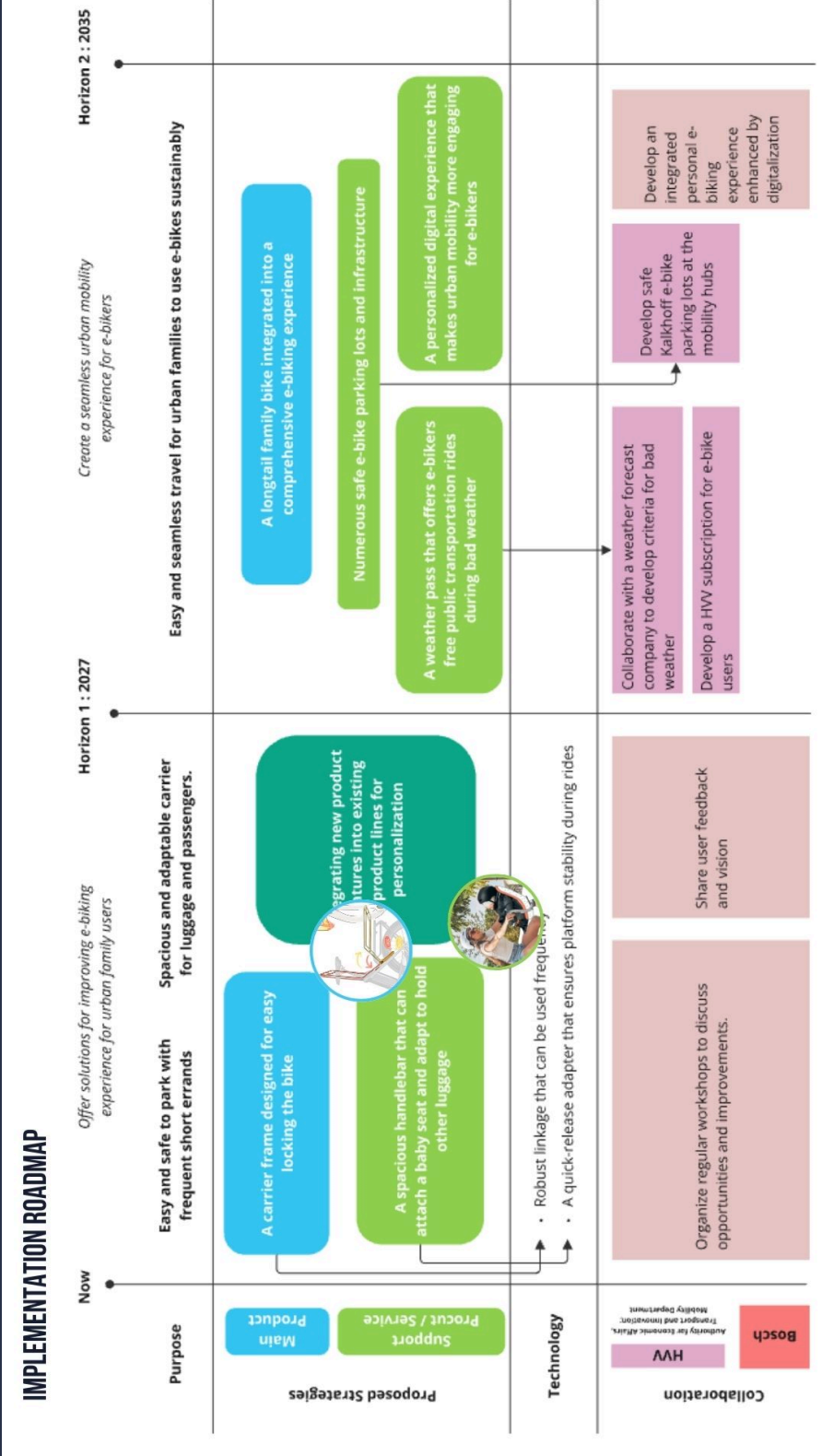


Figure 38. Roadmap V1

Validation

Ch. 9

Validation

Design concept validation plays a critical role in the early stages of product development, ensuring alignment with customer needs, enhancing user satisfaction, and mitigating potential risks. For this validation process, a physical prototype and roadmap discussion were employed to facilitate practical implementation and effectively communicate key design attributes.



9.1

Evaluating with Young Innovators

To develop an actionable future vision for these final concepts, it is important to solicit diverse perspectives from stakeholders with varying risk tolerances. This study sought to gather insightful feedback by inviting five young design students from TU Delft to evaluate the proposed roadmap. Participants were provided with a brief overview of the project context and roadmap itself. They were then asked to critically assess each step and plan according to four key properties of compelling visions: clarity, value drivers, artifact, and magnetism (Simonse, 2024). The following feedback was received:

1. The roadmap lacks clear delineation of responsibilities, failing to specify which experts are accountable for each step. This omission limits participants' understanding of the team's capabilities and available expertise.

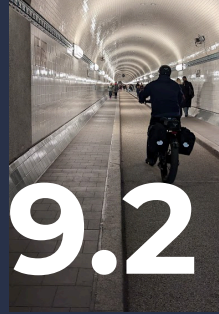
2. Incorporating information about Kalkhoff's internal resources, including those accessible through its parent company, would enhance the roadmap's comprehensiveness.

3. While the value drivers are clearly articulated from a user perspective, enhancing the roadmap's magnetism requires demonstrating the value streams for all stakeholders, including the cooperating organizations. This would provide a more holistic view of the potential benefits and interdependencies.



This feedback informed revisions to the final roadmap.

MVP Prototyping 9.2



For the minimum viable product (MVP), the rotatable monkey bar, a functional prototype was produced to assess usability and gather feedback from target users. The prototype was 3D printed using PLA and installed on a Kalkhoff Tier C+ (Compact) frame to provide a realistic testing environment.

Three parents who regularly transport their children and commute by bicycle were invited to participate. They were asked to bring their typical daily luggage and perform the following tasks:

1. *Attach the luggage and unlock the bicycle.*
2. *Detach the luggage and lock the bicycle.*

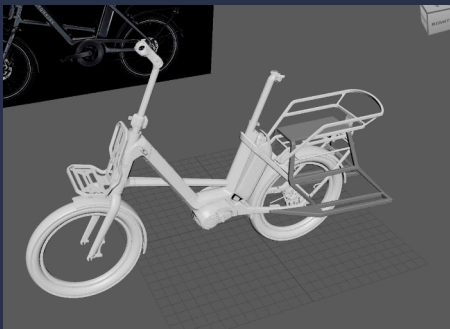


Figure 39. Prototypes based on the C+ Advance frame

The primary feedback received focused on the need for a more robust and stable structural design. This feedback highlighted the importance of ensuring safety, particularly given the potential for children to climb on the structure. Consequently, design revisions will prioritize increased structural integrity. Participants also suggested consolidating all keyholes into a single locking mechanism, which will also be considered.

Final Delivery

Ch. 10

Final Delivery

This project delivers three product concepts, a functional prototype (rotatable monkey bar), and a strategic roadmap, providing Kalkhoff with a clear product vision for sustainable mobility. The prototype embodies the most promising concept, focusing on usability and security. Critically, user feedback from validation testing has informed key design improvements, including adding bar support and adjusting the footstep position.



Rotatable Monkey Bar



Multifunctional Carrier Seat



Figure 40. Final Concept

10.1

Rotatable Monkey Bar

The rotatable monkey bar, integrated with a ring lock, offers a dual-function security solution. When rotated to seat level, it engages a worm gear mechanism, simultaneously locking the bike and protecting the battery from theft. The cover also further deters theft by hindering the bike's rideability after a potential theft attempt. This design not only protects children or luggage on the carrier but also enhances e-bike security, allowing users to park confidently in urban areas and run short errands with ease.

Given that the Kalkhoff Tier C+ meets urban usage scenarios with its lightweight design and compact form factor, the final product design is implemented and showcased on the Image C+ Advance as a minimum viable product to illustrate a future mobility scenario for family users.



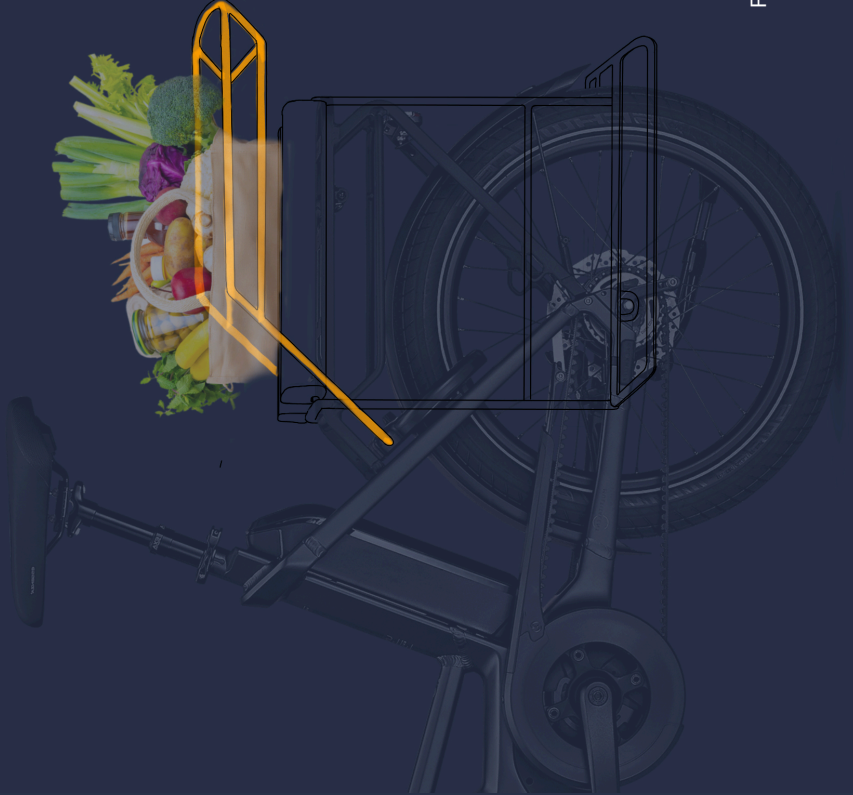
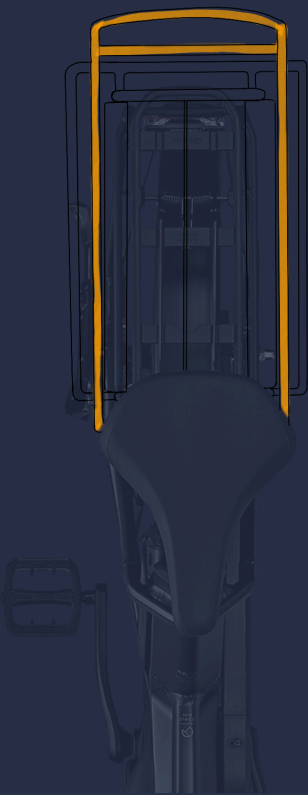
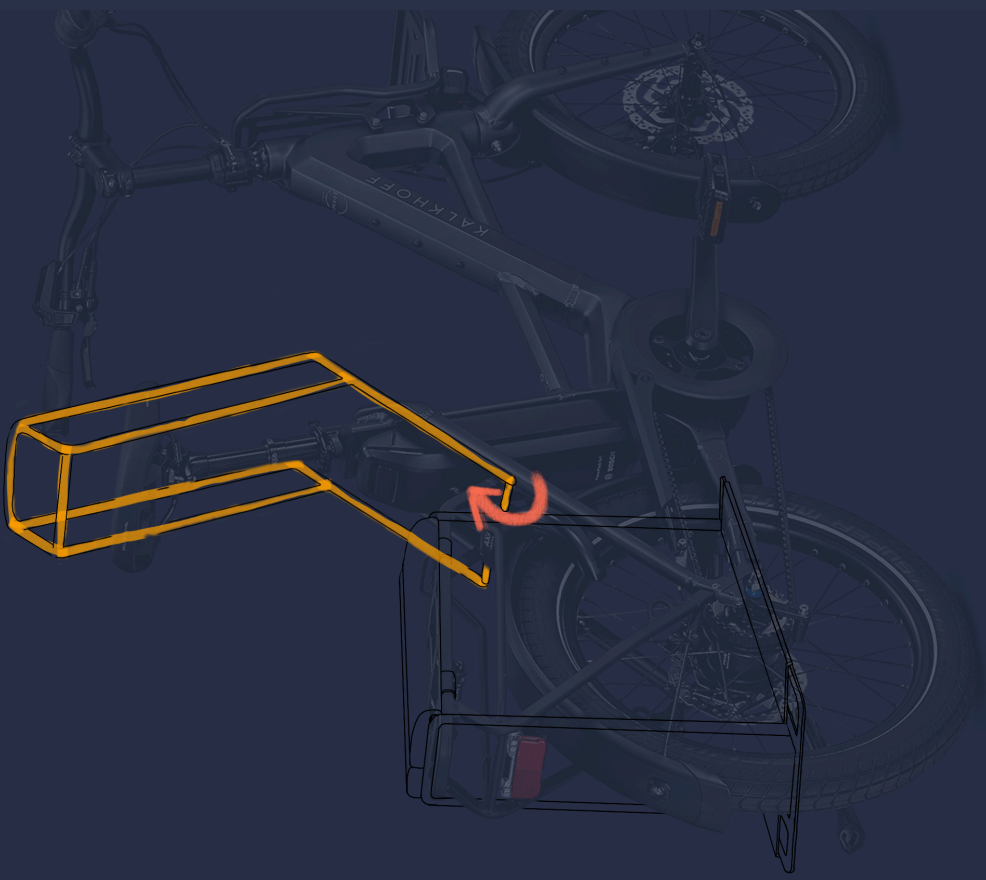


Figure 41a. Monkey bar in use

Rotating downwards to unlock



Rotating upwards to lock

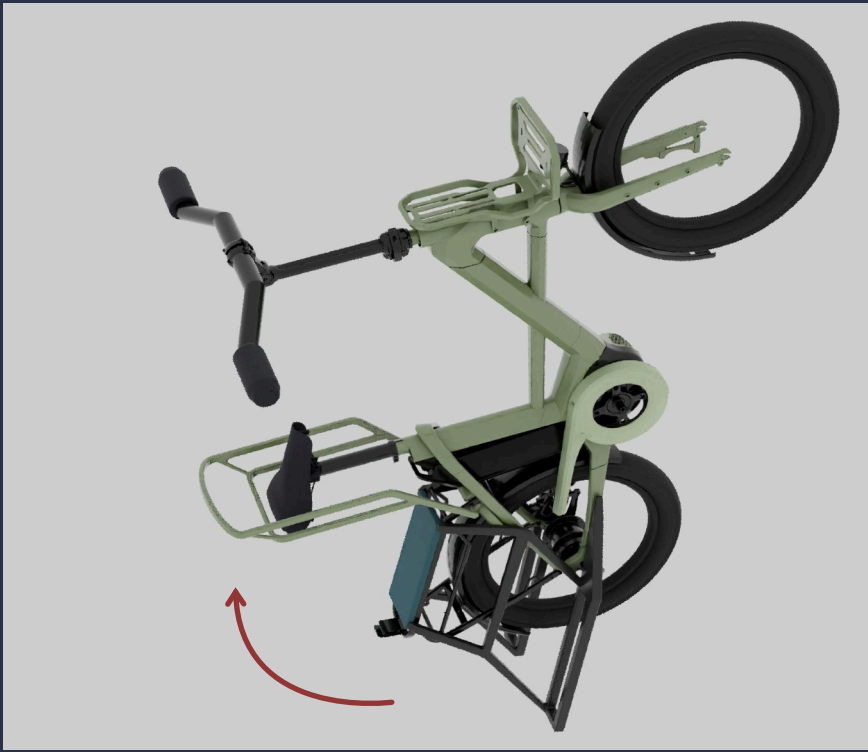


Figure 41b. Monkey bar in use

10.2

Multifunctional Carrier Seat

Installed on the luggage rack, this versatile carrier features a soft, waterproof cushion and footrests, providing a comfortable seating solution for children. The removable cushion allows for the attachment of additional child bike seats or for cargo transport. Grooves on the footrest can also secure and tow two children's bicycles. This adaptability accommodates varying family needs, promoting cycling as a practical, family-friendly activity across different life stages.

The multifunctional carrier seat is further refined by extending the length of the footrest, enabling the towing of a child's bicycle and adapting to the evolving riding needs of families.

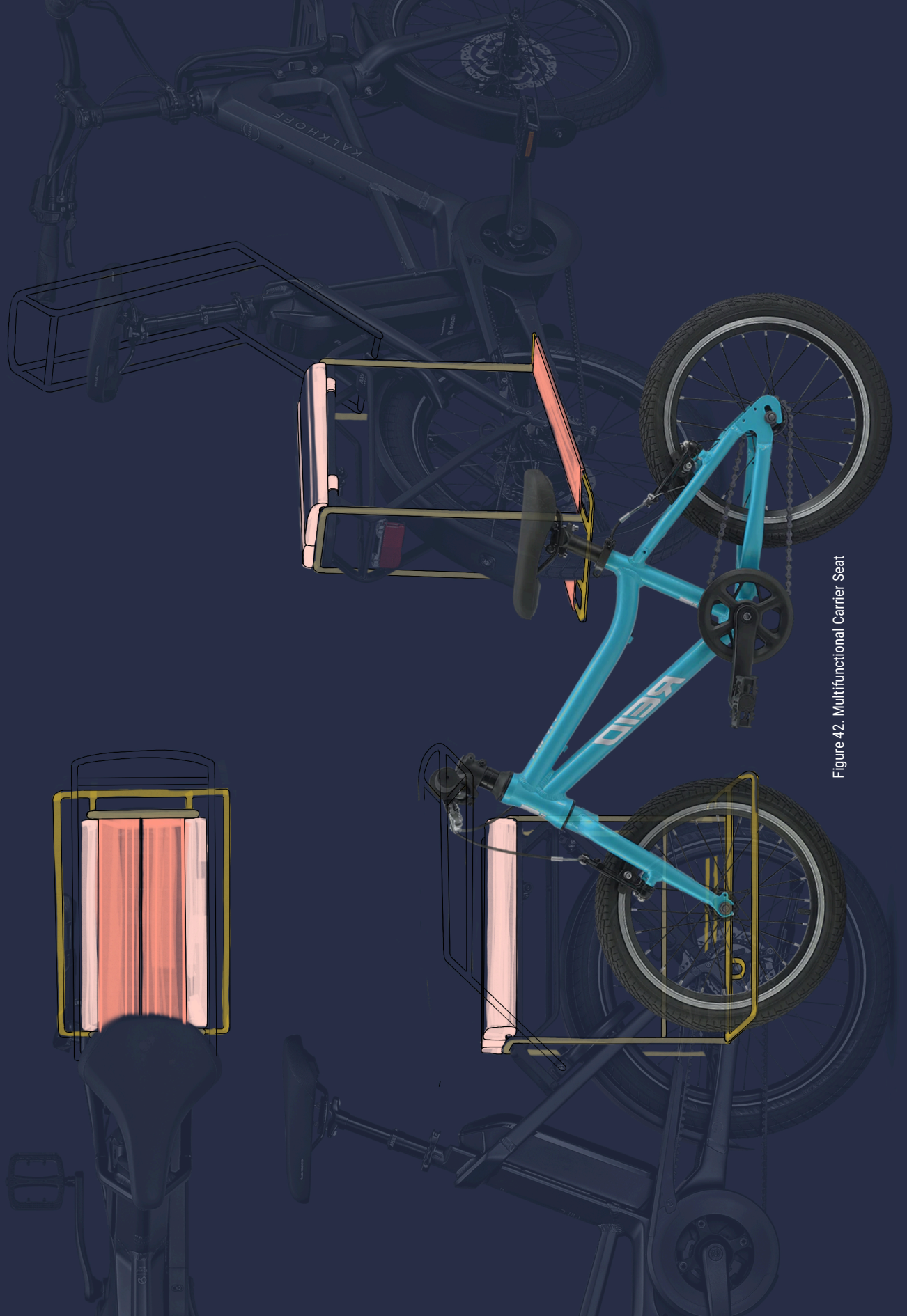


Figure 42. Multifunctional Carrier Seat

Measurement
based on Kalkhoff Image C+ Advance



Figure 43. Monkey bar and Multifunctional Carrier Seat dimensions



Figure 44. Render of the new bike accessories in Germany

Future Development

Installed on the luggage rack, this versatile carrier features a soft, waterproof cushion and footrests, providing a comfortable seating solution for children. The removable cushion allows for the attachment of additional child bike seats or for cargo transport. Grooves on the footrest can also secure and tow two children's bicycles. This adaptability accommodates varying family needs, promoting cycling as a practical, family-friendly activity across different life stages.

The multifunctional carrier seat is further refined by extending the length of the footrest, enabling the towing of a child's bicycle and adapting to the evolving riding needs of families.





Figure 45a(left), 45b(top), 45c(bottom). Renders of the new bike accessories



Roadmap

Now

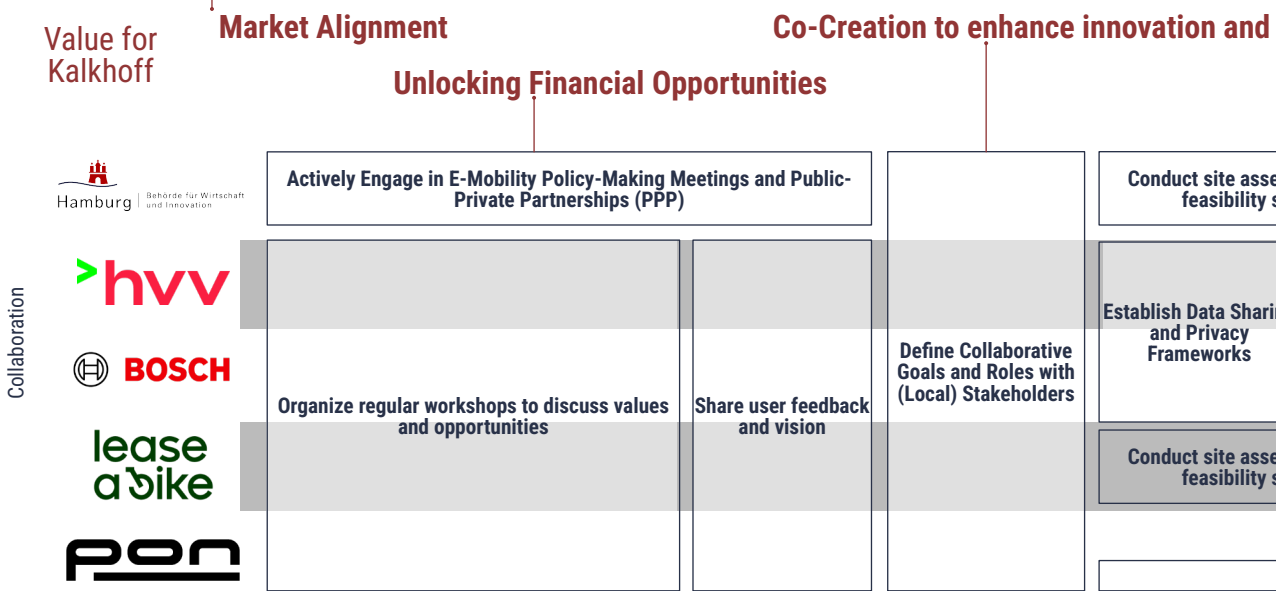
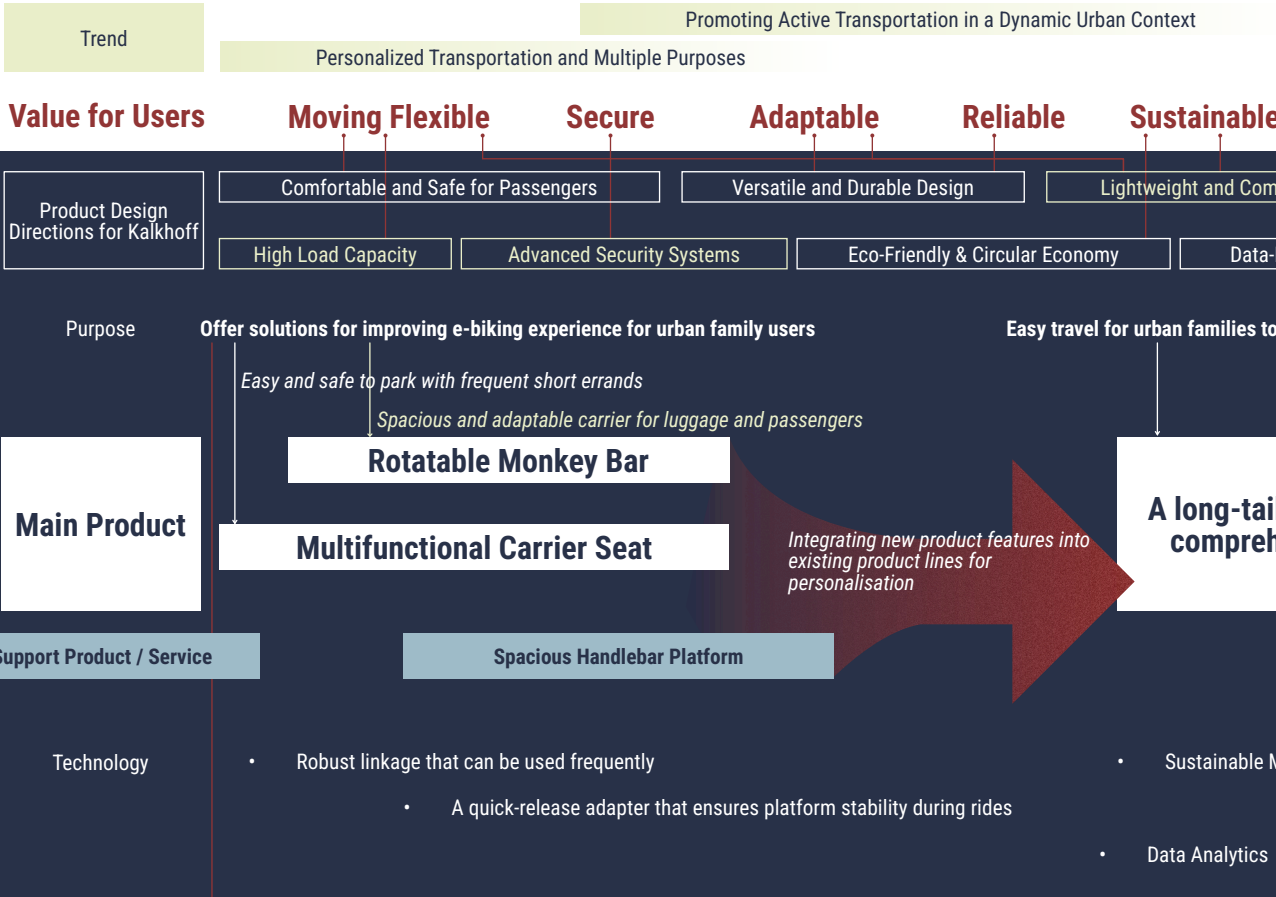


Figure 46. Final Roadmap

Horizon 1 : 2027

Horizon 2 : 2035

Integrating Multimodal Mobility for a Seamless Urban Experience

Advancing Sustainable Urban Living through Bicycle Adoption

Empowered

Autonomous

Efficient

Impact Designs

Customization for Urban Lifestyles

Integration with MaaS Platforms

Driven Performance Insights

Smart Tech Integration

Connectivity to Public Infrastructure

use e-bikes sustainably

Create a seamless urban mobility experience for e-bikers

Kalkhoff get people moving everywhere.

Vision

Personalised E-bike Experience with Seamless Mobility Integration

Family Bike Short-Term Rentals

Kalkhoff E-Bike Charging Parking Lots

Public Transportation Pass

Materials - production

• Mobile Apps

• Mobility-as-a-Service (MaaS)

• Internet of Things (IoT)

• AI and Machine Learning

• E-Charging Infrastructure

• Vehicle-to-vehicle (V2V) and Vehicle-to-infrastructure (V2I)

differentiation

Driving Infrastructure Improvements

Expanding Market Reach

essments and studies

Develop Service Ecosystem and business model for parking lots

Plan for Scalability

Develop a HVV subscription for e-bike users

Test Initial Solutions

ng

Develop a data-shared platform to analyse product usage

Collaborate with a weather forecast company to develop criteria

Develop a Digital Ecosystem for E-Biking

essments and studies

Develop Service Ecosystem and business model for short-term rentals

Test Initial Solutions

Cross-Promotion

Supply Chain Optimization

Discussion

Ch. 11

Limitations

Firstly, the research did not directly engage with existing Kalkhoff customers. While the focus on future user needs and broader mobility trends provided valuable context, the absence of direct feedback from current users limits the understanding of brand loyalty, current product satisfaction, and potential adoption rates of proposed features. This lack of user feedback could impact the accuracy of predicting market acceptance of the concepts.

Secondly, while the project focused on addressing user pain points related to family e-bike use, it did not fully incorporate a comprehensive strategic analysis of Kalkhoff's parent company, PON Holdings. This oversight means the proposed product concepts might not be perfectly aligned with PON's overall business strategy, resource allocation, or existing portfolio of mobility services. The competitive landscape, while acknowledged, could have been analyzed more deeply considering PON's broader market positioning. The presence of existing family-oriented e-bikes in the market necessitates a more thorough competitive analysis to ensure product differentiation and market viability.

Future Research

Based on the limitations, several avenues for future research emerge:

Engage Current Kalkhoff Users

Future studies should prioritize direct engagement with existing Kalkhoff customers. This could involve surveys, interviews, and focus groups to gain insights into their experiences with current products, their unmet needs, and their receptiveness to the proposed concepts. This feedback would provide crucial validation and refinement of the product vision.

Expand Stakeholder Engagement

Expanding the scope of stakeholder engagement beyond the current participants is crucial. Future research should include a wider range of stakeholders, such as industry experts in e-bike technology and urban planning, policymakers involved in sustainable transportation initiatives, and community representatives from diverse demographics. This expanded engagement would ensure a more holistic understanding of the challenges and opportunities in the evolving mobility landscape.

Conduct In-Company Validation and Strategic Alignment

Further research should focus on rigorous validation within Kalkhoff and alignment with Pon Holdings' overall strategy. This includes a detailed resource assessment to evaluate the feasibility of implementing the proposed concepts, and a thorough analysis of how these concepts fit within Pon's existing portfolio and long-term business objectives. Identifying the specific departments within Kalkhoff

and Pon responsible for executing various aspects of the product development process is crucial for successful implementation.

Explore Specific Technological Advancements and Market Adoption

Future research should delve deeper into specific technological advancements relevant to e-bike development, such as advancements in battery technology (e.g., increased range, faster charging), connectivity features (e.g., smart features, integration with other devices), and sustainable materials science (e.g., lightweight and recyclable materials). Furthermore, research should explicitly map the proposed concepts onto the technology adoption lifecycle. This analysis would help refine the target market, inform appropriate marketing strategies, and predict potential adoption rates over time. This would also provide a more robust business case for Kalkhoff.

Conclusion

Ch. 12

The comprehensive exploration of urban mobility trends, market dynamics, and user-centered design has led to the development of strategic solutions tailored to Kalkhoff's mission of fostering sustainable and practical e-bike experiences. Through rigorous research and iterative design processes, the project identifies a clear opportunity to position Kalkhoff as a key player in the future of urban mobility by addressing diverse family needs and embracing sustainability.

The integration of innovative product concepts, such as the rotatable monkey bar and multifunctional carrier seat, demonstrates Kalkhoff's potential to enhance usability, safety, and versatility in its e-bike offerings. Coupled with proposed service innovations like e-bike parking hubs and short-term rental, the roadmap establishes a framework for bridging user needs with scalable business strategies.

While the solutions address identified challenges, including infrastructure gaps and shifting mobility behaviors, the study also highlights the importance of collaboration with stakeholders to overcome logistical and regulatory hurdles. Future research should validate these concepts across the brand's users and refine their alignment with Kalkhoff's operational capacities.

This project emphasizes the transformative potential of strategic design in shaping sustainable urban mobility solutions. By aligning Kalkhoff's product offerings with emerging trends and diverse user needs, the proposed innovations not only address immediate market demands but also position the brand to thrive within the evolving mobility ecosystem of 2035. The findings provide a robust framework for Kalkhoff to drive meaningful change, enhancing its role as a leader in sustainable mobility and contributing to a healthier, more inclusive urban environment.

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Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME

Complete all fields and indicate which master(s) you are in

Family name	<input type="text" value="Kao"/>	IDE master(s)	IPD <input type="checkbox"/>	Dfi <input type="checkbox"/>	SPD <input checked="" type="checkbox"/>
Initials	<input type="text" value="K. F. Kao"/>	2 nd non-IDE master	<input type="text"/>		
Given name	<input type="text"/>	Individual programme (date of approval)	<input type="text"/>		
Student number	<input type="text"/>	Medisign	<input type="checkbox"/>		
		HPM	<input type="checkbox"/>		

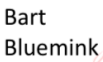
SUPERVISORY TEAM

Fill in the required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	<input type="text" value="B Bluemink"/>	dept./section	<input type="text" value="DOS / MOC"/>	<p>! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.</p> <p>! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.</p> <p>! 2nd mentor only applies when a client is involved.</p>
mentor	<input type="text" value="S Santema"/>	dept./section	<input type="text" value="DOS / MCR"/>	
2 nd mentor	<input type="text" value="R Maes"/>			
client:	<input type="text" value="Kalkhoff Werke GmbH"/>			
city:	<input type="text" value="Cloppenburg / Emstek / Hamburg"/>	country:	<input type="text" value="Germany"/>	
optional comments	<input type="text"/>			

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)



Digitaal ondertekend door Bart Bluemink
Datum: 2024.09.06 14:51:26 +02'00'

Name Date Signature

CHECK ON STUDY PROGRESS

To be filled in by SSC E&SA (Shared Service Centre, Education & Student Affairs), after approval of the project brief by the chair. The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total _____ EC Of which, taking conditional requirements into account, can be part of the exam programme _____ EC	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">★</td> <td style="text-align: center;">YES</td> <td style="background-color: #333; color: white;">all 1st year master courses passed</td> </tr> <tr> <td></td> <td style="text-align: center;">NO</td> <td style="background-color: #333; color: white;">missing 1st year courses</td> </tr> </table>	★	YES	all 1 st year master courses passed		NO	missing 1 st year courses
★	YES	all 1 st year master courses passed					
	NO	missing 1 st year courses					
Comments: <input style="width: 100%;" type="text"/>							

Sign for approval (SSC E&SA)

Robin den
Braber

Digitaal ondertekend
door Robin den Braber
Datum: 2024.09.27
10:35:21 +02'00'

Name Robin den Braber

Date 27-09-2024

Signature _____

APPROVAL OF BOARD OF EXAMINERS IDE on SUPERVISORY TEAM -> to be checked and filled in by IDE's Board of Examiners

Does the composition of the Supervisory Team
comply with regulations?

YES	★	Supervisory Team approved
NO		Supervisory Team not approved

Comments: _____

Based on study progress, students is ...

★	ALLOWED to start the graduation project
	NOT allowed to start the graduation project

Comments: _____

Sign for approval (BoEx)

Monique
von Morgen

Digitally signed by
Monique von Morgen
Date: 2024.10.01
09:34:09 +02'00'

Name Monique von Morgen

Date 1/10/2024

Signature _____



TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Keng [redacted] Kao

Student number [redacted]

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT

Complete all fields, keep information clear, specific and concise

Project title Design a future urban sustainable mobility scenario in Germany for Kalkhoff

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

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Context and Background

By 2030, the EU aims for 100 cities to be climate-neutral, with a focus on reducing car usage and reallocating public space for sustainable mobility (European Commission, 2021). This trend is driving demand in Germany's bicycle market, particularly for electric bikes, with a projected annual growth rate of 0.21% and a market volume of \$7.69 billion by 2029 (Statista, 2024). In this context, Kalkhoff faces significant opportunities to strategically position itself within these evolving scenarios to enhance its business prospects.

Objective

The primary objective of this project is to map and present the most probable future scenarios for bike mobility for the German bicycle manufacturer Kalkhoff. The focus will be on the future of sustainable mobility in Hamburg, known for its large market representing the population distribution in Germany (Statistisches Bundesamt (Destatis), 2023) and its ambitious bike-transformation policies and infrastructure. This comprehensive product strategy will highlight market opportunities for Kalkhoff, enabling the company to align its product vision with the future of urban mobility.

(continue on next page)

→ space available for images / figures on next page

introduction (continued): space for images

Stakeholders and Opportunities

1. Kalkhoff:

Kalkhoff is a German manufacturer owned by Pon Holdings BV. It positions itself as a premium, sportier brand in Germany's fragmented market (Nieuwsfiets.nu, 2023). This project will help Kalkhoff understand the opportunities and challenges of aligning with the sustainable mobility trend in Hamburg.

2. Customers / Product Users / Residents of Hamburg:

Germany being a key market for Kalkhoff, Hamburg is chosen for user research due to its ambitious mobility targets and significant investment in cycling infrastructure (€49 per capita annually) (European Cyclists' Federation, 2023). This project will focus on understanding future urban mobility scenarios, enabling the development of products that meet customers' needs while promoting sustainable behaviours.

3. Policymakers / Municipality of Hamburg:

Hamburg aims for 80% of trips to be made by walking, cycling, or public transport by 2030, expanding its cycling infrastructure to meet this goal (European Cyclists' Federation, 2023). While the municipality won't directly participate in this project, the findings could inform their public-private partnership strategies in sustainable mobility.

Academic Opportunities

TU Delft will gain valuable insights from this project on integrating technology into product strategies for sustainable urban mobility and understanding the challenges companies face in developing future mobility scenarios.

image / figure 1

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image / figure 1

Limitations(Challenges) of the Research

1. Market Dynamics: The fast-evolving sustainable mobility market may render some scenarios outdated, limiting their long-term relevance for Kalkhoff.
2. Technological Constraints: The MVP or prototype development depends on the technology and manufacturing that Kalkhoff currently uses.
3. Scope Limitation: The research is focused on Hamburg, which may restrict the applicability of findings to other cities with different mobility challenges.
4. Stakeholder Involvement: The lack of direct involvement from Hamburg's municipality may limit insights into public sector collaboration and policy implementation.
5. Data Availability: The project's success relies on accurate and comprehensive data on current mobility trends, infrastructure, and user behaviours; any data gaps could impact scenario reliability.

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image / figure 2

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

In the context of sustainable mobility, a significant challenge for mobility providers like Kalkhoff is the development of a practical product strategy that aligns with future-oriented trends. While the emphasis on sustainable mobility presents numerous opportunities, creating a concrete product vision based solely on speculative future scenarios is inherently difficult. This project aims to bridge this gap by developing a clear and actionable product vision for Kalkhoff, enabling the company to better understand and navigate the opportunities and challenges presented by the shift towards sustainable mobility. By creating a boundary object—such as a strategic roadmap or prototype—this project will provide Kalkhoff with a solid starting point for refining its product strategy and guiding iterative product design, ultimately adding value to the company's long-term objectives within the sustainable mobility landscape. As the main client for this research project, Kalkhoff will provide essential brand positioning insights, technology scouting insights and prototype manufacturing guidance.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence)
As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a future mobility scenario for German urban areas to inspire the innovation strategy of Kalkhoff

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The project will be structured according to the double diamond design process, divided into two main phases. In the first phase, the focus will be on context analysis and problem framing, centred around understanding user needs. This will involve an extensive literature review, trend analysis, and brand-product research to gain a comprehensive understanding of the domain and potential stakeholders. I will conduct user research in Hamburg and employ context mapping techniques to identify the values and goals of potential users. The insights gathered will be used to create a detailed future scenario, utilizing user journeys and customer segmentation to guide the design directions.
In the design phase (second phase), I will develop concepts using Vision in Design, value proposition design, and co-creation with stakeholders. These concepts will be developed into MVPs and a strategic product plan, presenting workable prototypes to test and evaluate the concepts.

Project planning and key moments

To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time

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Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting 4/9/2024

Mid-term evaluation 10/18/2024

Green light meeting 12/13/2024

Graduation ceremony 1/10/2025

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	<input type="checkbox"/>
For how many project weeks	
Number of project days per week	

Comments:

Christmas and New Year vacations are considered working weeks for aiming to graduate before February.

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.

(200 words max)

As a SPD student with three years of experience as a product designer specializing in manufacturing, my professional background includes collaborating with large firms to develop product-service solutions that align with business objectives and maximize value for both the company and its users. This experience has underscored the profound impact that a well-developed product strategy, grounded in a future vision, can have on both a company's success and user satisfaction.

This project offers a unique and valuable opportunity for me to apply my skills in a real-world context, closely aligning with my passion for sustainable future mobility. As someone who enjoys exploring cities at a leisurely pace, I am particularly drawn to understanding the opportunities and challenges of transforming urban mobility. This project will enable me to gain a deep understanding of how cities and companies can transition toward sustainable mobility, while also providing insights into effective collaboration between municipalities and mobility providers.

My academic journey in Strategic Product Design has equipped me with the expertise to conduct comprehensive contextual research, engage in co-creation with stakeholders, design implementation roadmaps, and validate future-oriented designs. The prospect of experimenting with innovative design tools and methodologies in a practical setting is particularly exciting. Additionally, exploring the intersection of business strategy and design within the realm of sustainable mobility presents a compelling challenge.

For personal growth, I am eager to enhance my individual project management skills and leadership abilities in group discussions, particularly as this is my first major project in a non-native language and cultural context.

