E@SY-Bikes: Innovation in Bike Rental in the Palm of Your Hand

E@SY-Bikes: Inovação em Locação de Bicicletas na Palma da Mão
E@SY-Bikes: Innovación en el alquiler de bicicletas en la palma de tu mano

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Abstract: We present the development and evaluation of the E@sy-Bikes application, an innovation in bike rental aimed at providing a quality experience for users. The research focuses on creating a platform that integrates advanced real-time geolocation and sharing features, allowing user registration, generation of personalized profiles, and bike release through QR codes or tokens. It covers both web and mobile versions to offer greater accessibility and convenience to users. The focus is on the user experience with smooth navigation, an attractive layout, and functional features. In addition to promoting bike rental as an affordable, healthy, and sustainable option, the E@sy-Bikes application would be a profitable alternative to other means of transportation, contributing to pollution reduction and well-being. Security is also prioritized, with the use of technologies such as QR codes and specific rental points. For its development, comprehensive research of relevant sources was conducted, providing a solid theoretical foundation for demand analysis and flexibility in this process, market research, and agile management. The article highlights the E@sy-Bikes application as an innovative solution in bike rental, with an emphasis on user experience, convenience, and sustainability. The results obtained so far indicate its feasibility and effectiveness, as well as its potential to serve a wide user base through the integration of advanced technological features in a convenient and sustainable manner, contributing to a healthier lifestyle and environmental preservation.

Keywords: *Application; Bike Rental; User Experience; Technology.*

Resumo: Apresentamos o desenvolvimento e a avaliação da aplicação *E@sy-Bikes*, uma inovação em locação de bicicletas, que visa proporcionar uma experiência de qualidade aos usuários. A pesquisa se concentra na criação de uma plataforma que integra recursos avançados de geolocalização em tempo real e compartilhamento, permitindo o cadastro de usuários, geração de perfis personalizados e a liberação das bicicletas por meio de *QRCode* ou Token e abrange tanto as versões web e móvel, para oferecer maior acessibilidade e praticidade aos usuários. O foco principal está na experiência do usuário navegação fluída, layout atrativo e recursos funcionais. Além de promover a locação de bicicletas como uma opção acessível, saudável e sustentável, a aplicação *E@sy-Bikes* seria uma alternativa rentável a outros meios de

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transporte, pois contribui para a redução da poluição e bem-estar. A segurança também priorizada, com utilização de tecnologias como *QRCode* e pontos específicos de aluguel. Para o seu desenvolvimento, foi realizada uma pesquisa abrangente de fontes relevantes, fornecendo embasamento teórico sólido para a análise da demanda e flexibilidade neste processo, pesquisa de mercado e gestão ágil. O artigo destaca a aplicação *E@sy-Bikes* solução inovadora em locação de bicicletas, com ênfase na experiência do usuário, praticidade e sustentabilidade. Os resultados obtidos até o momento indicam sua viabilidade e eficácia, bem como o seu potencial para atender a uma ampla base de usuários através da integração de recursos tecnológicos avançados, de forma conveniente e sustentável, contribuindo para um estilo de vida mais saudável e para a preservação do meio ambiente.

Palavras-chave: Aplicação; Locação de Bicicletas; Experiência do Usuário; Tecnologia.

Resumen: *Presentamos el desarrollo y evaluación de la aplicación E@sy-Bikes, una innovación en alquiler de bicicletas, que tiene como objetivo brindar una experiencia de calidad a los usuarios. La investigación se centra en la creación de una plataforma que integre funciones avanzadas de geolocalización y compartición en tiempo real, permitiendo el registro de usuarios, la generación de perfiles personalizados y la liberación de bicicletas a través de QRCode o Token y abarca tanto la versión web como la móvil, para ofrecer una mayor accesibilidad y practicidad a los usuarios. La atención se centra principalmente en la experiencia del usuario, la navegación fluida, el diseño atractivo y las características funcionales. Además de promover el alquiler de bicicletas como una opción asequible, saludable y sostenible, la app E@sy-Bikes sería una alternativa rentable a otros medios de transporte, ya que contribuye a la reducción de la contaminación y al bienestar. También se prioriza la seguridad, con el uso de tecnologías como QRCode y puntos de alquiler específicos. Para su desarrollo se realizó una investigación exhaustiva de fuentes relevantes, aportando una sólida base teórica para el análisis de la demanda y flexibilidad en este proceso, la investigación de mercados y la gestión ágil. El artículo destaca la aplicación E@sy-Bikes como una solución innovadora en el alquiler de bicicletas, con énfasis en la experiencia del usuario, la practicidad y la sostenibilidad. Los resultados obtenidos hasta el momento indican su factibilidad y efectividad, así como su potencial para atender a una amplia base de usuarios a través de la integración de recursos tecnológicos avanzados, de manera conveniente y sostenible, contribuyendo a un estilo de vida más saludable y a la preservación del medio ambiente.*

Palabras clave: *Aplicación; Alquiler de bicicletas; Experiencia de usuario; Tecnología.*

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1. INTRODUCTION

In the face of a series of changes arising from modernity and mobility problems, the search for alternatives for transportation, as well as practicality and viability, is becoming increasingly necessary. In addition, issues such as sustainability and lifestyle, among others, are highly influential factors in this context. In this sense, bicycles have become famous for commuting in urban areas, providing a practical, healthy, and sustainable solution.

Bicycle rental applications have emerged to make users' lives more accessible and are offered by private companies through mobile applications. This flexible and convenient option has proven to be a financially accessible alternative, especially compared to other transportation forms, such as taxis or rental cars, as pointed out by Shaheen and Guzman (2019) and Shen, Zhu, and Jiang (2018). Furthermore, cycling as a form of physical exercise has proven benefits for cardiovascular health, stress reduction, and improved overall well-being. At the same time, bicycles do not emit pollutants, contributing to the reduction of air pollution in cities, according to publications by Celis-Morales et al. (2017) and Kienteka et al. (2016).

Considering the importance of safety when using bicycles, it is essential to use specific lanes whenever possible, pay attention to pedestrians and other cyclists, and follow traffic rules to avoid accidents.

In this context, the general objective of this study is to develop the E@sy-Bikes bicycle rental application to provide users with a pleasant and practical experience, ensuring accessibility and convenience in renting bicycles in urban areas.

To achieve this objective, this objective does not appear to be modifying the subject the following specific objectives are defined:

1. Analyze the needs and expectations of users regarding bicycle rental through mobile applications.
2. Design and develop the E@sy-Bikes app interface, aiming for intuitive navigation, efficient communication, and fluidity.
3. Implement a geolocation system and integration with payment services to facilitate the location of available bikes and streamline the rental process.
4. The E@sy-Bikes app should be tested and evaluated, user feedback collected, and improvements made based on their needs and suggestions.

In this way, E@sy-Bikes stands out as a comprehensive solution that meets the needs of users interested in bike rental, offering a pleasant experience, practicality, sustainability, and contributing to a healthier lifestyle.

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2. THEORETICAL BASIS

In addition to exploring the benefits of using bicycles as a sustainable and healthy means of transportation, we considered the challenges of urban mobility and the importance of efficient transportation alternatives.

Santos and Lima (2020) discuss the quality of use of an urban mobility support application in a study entitled "Libera a bike aí?! Avaliando a qualidade de usar de um aplicación de apoio à mobilidade urbana" (Free the bike there?! Evaluating the quality of use of an urban mobility support application). In which the study evaluated the usability, usefulness, and effectiveness of the application through user testing. The theoretical framework included concepts of urban mobility, bike sharing, and information and communication technology (ICT). The results showed satisfactory application performance but also pointed out some difficulties in the interface and clarity in the presentation of data. The article contributes to the understanding of the importance of urban mobility applications that are easy to use and effective in obtaining relevant information for users.

Silva Junior and Rempto (2019) present the Bike-UFF bicycle sharing system, implemented at the Fluminense Federal University (UFF), as a sustainable alternative for urban mobility. The study's theoretical framework discusses concepts of sustainable urban mobility, bicycle sharing, information and communication technology (ICT), and environmental sustainability. The results indicate that users have received the system well, reducing car use and promoting a more active and healthy lifestyle. The article contributes to understanding the importance of bicycle sharing and the use of ICT in promoting more sustainable and healthy urban mobility.

Bruno et al. (2019) present the Smart Bike platform, a solution for managing and monitoring urban transport based on electric bicycles and the Internet of Things (IoT). The study discusses the importance of using technologies to improve urban mobility and reduce the environmental impact of transport, with theoretical reference to concepts of IoT, monitoring systems, electric bicycles, and sustainable transport. The Smart Bike platform consists of sensors installed on the bikes, an app for users, a bike management system, and an open application programming interface (API) for developers. The results of the study indicate that the platform has the potential to improve the efficiency of urban transport, reduce car traffic, and improve air quality in cities, contributing to the understanding of the importance of using technologies to improve urban mobility and reduce the environmental impact of transport. The Smart Bike platform can be a reference for public managers and developers interested in implementing similar solutions.

Regarding health issues, the study by Celis-Morales et al. (2017) presents a systematic review of the scientific literature on the health benefits of cycling. The analysis includes studies that evaluated the relationship between cycling and improved physical fitness, cardiovascular function, and mental health.

Based on a review of 25 selected studies, the authors concluded that regular cycling brings several health benefits, such as improved cardiovascular capacity,

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reduced risk of cardiovascular disease, type 2 diabetes, obesity, and improved mental health, in addition to improved cognitive performance and immune function. These results may be helpful for health professionals and public managers promoting using bicycles for transportation and physical activity. The review of the scientific literature by the authors may be a valuable theoretical reference for future studies aimed at deepening knowledge about the health benefits of cycling. In addition to the health factor, the issue of sustainability, as addressed in the article by Kienteka et al. (2016), assessed the individual and environmental factors associated with using bicycles as a means of transport in a Brazilian city. The results indicated that the quality of cycling infrastructure and safety were the most critical factors in encouraging the use of bicycles as a means of transport. In addition, the authors highlighted that using bicycles as a means of transport can bring health benefits, such as improving physical fitness and reducing the risk of chronic diseases, contributing to urban sustainability, reducing pollutant emissions, and traffic congestion. These results are essential for promoting public policies that encourage using bicycles as a means of transport and promote urban health and sustainability. This study can be used as a theoretical framework for future research on the relationship between the characteristics of the urban environment, health and sustainability, and the use of bicycles as a means of transport. From an economic and financial perspective, a study published in 2019 by Shaheen and Guzman (2019) compared the costs of different modes of transportation in 10 cities in the United States, including the use of shared bikes. The results showed that, on average, shared bike use was cheaper than taking Uber, taxis, and public transportation in all cities studied. The study also highlighted that shared bikes are an economical and efficient option for short trips in dense urban areas.

Another article, from this point of view, compares the costs of using shared bikes and public transportation in different urban areas in Hangzhou, China. The results showed that the cost of using shared bikes was significantly lower than public transportation in all areas studied. In some areas, the cost of shared bikes was up to 10 times lower than that of public transportation. This indicates that using shared bikes may be a cheaper option for users than public transportation. The research highlights the importance of expanding bike-sharing systems to urban areas with high demand and few accessible and affordable transportation options by Shen, Zhu, and Jiang (2016).

3. METHOD

We used a comprehensive methodological approach, composed of stages, to conduct this research. We started by analyzing content from various sources, which provided us with a qualitative theoretical basis and helped to identify the needs of an application with a wide variety of functionalities and accessibility to the bike rental service. We also adopted agile methodologies, such as Scrum, for flexible and iterative project management, allowing greater adaptability to user demands and the market context.

In addition, we conducted quantitative market research through a carefully

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designed online questionnaire, which was answered by a diverse group of participants. The questionnaire collected demographic data, bike usage behaviors, functionality preferences, and user experience expectations.

With this blended approach, we gained comprehensive insights into user needs and preferences, effectively guiding project development to ensure a satisfying experience.

4. SEARCH RESULTS

Regarding the Demographic Profile, Most participants were male (60%), and the predominant age range was between 19 and 25 years old (50%). Regarding educational background, the majority had incomplete higher education (60%). Regarding occupation, there was a diversity of profiles, emphasizing the unemployed (25%) and developers (12.5%).
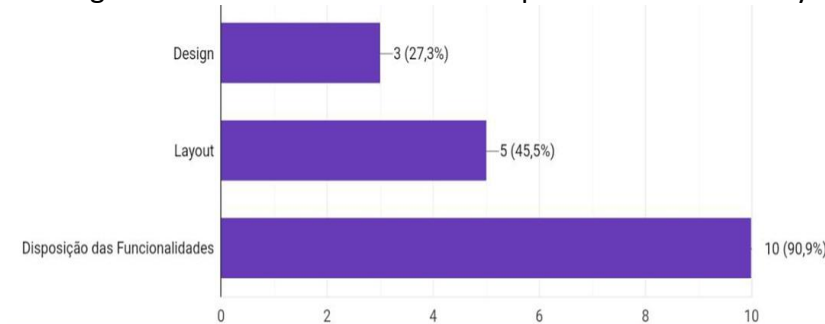
Regarding the Use of Bicycles as a Means of Transportation: The majority of participants (80%) do not use them, and of those who do, half do so only for leisure, while the other half use them occasionally when work is nearby.

Regarding Experience with Bicycle Rental Services: Only 30% of participants had ever used a bicycle rental service through an app, while 70% had never used this type of service.

Regarding the Importance of App Experience and Usability: Participants considered the layout of features to be the most critical aspect of the app experience (90.9%), followed by the layout (45.5%). Design was also valued, although to a lesser extent (27.3%).
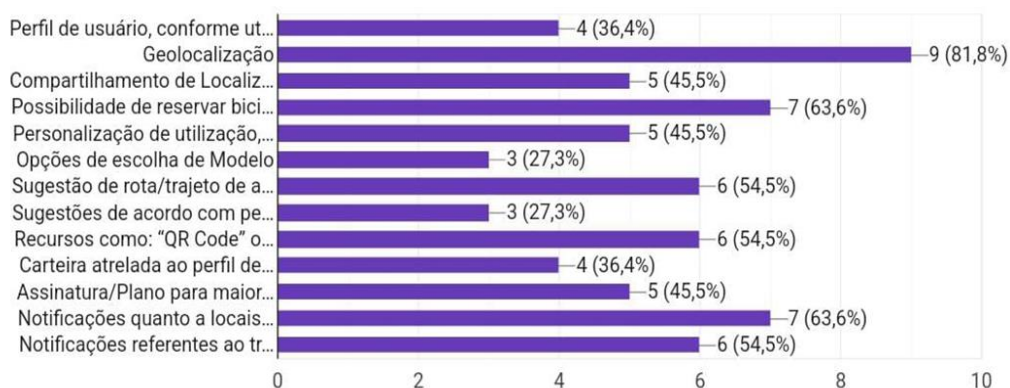
In terms of Important Features for the Bike Rental Service, the most relevant for users were geolocation (81.8%), the ability to reserve bikes (63.6%), and notifications related to rental locations, bike availability, and app news (63.6%). Suggestions of routes and paths based on the departure and destination location were also considered necessary (54.5%).

Figure 1 – Relevance in Terms of Experience and Usability

Source: Authors (2023)

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Figure 2 – Features by relevance

Source: Authors (2023)

Regarding the Presence of Totems: A significant percentage of participants considered it interesting to have totems with the same features as the app at the bike pick-up points.

In terms of Application Viability, regarding the interest in trying out bike rentals through the E@sy Bikes app: 45% of respondents were "Very interested" and 55% were "Interested". Regarding the importance of integration with other means of transportation, 36% considered this integration "Very important" and 64% considered it "Important".

Regarding additional benefits compared to other means of transportation, taking into account the wide availability, 55% believe in "Many additional benefits", 27% consider "Additional benefits" and only 18% consider it "indifferent". In addition, 64% of respondents were "Very interested" in using the service as an economical and sustainable option, and 55% believe that the app would bring "Many additional benefits" compared to other means of transportation.

Figure 3 - Measuring interest in the application

Source: Authors (2023)

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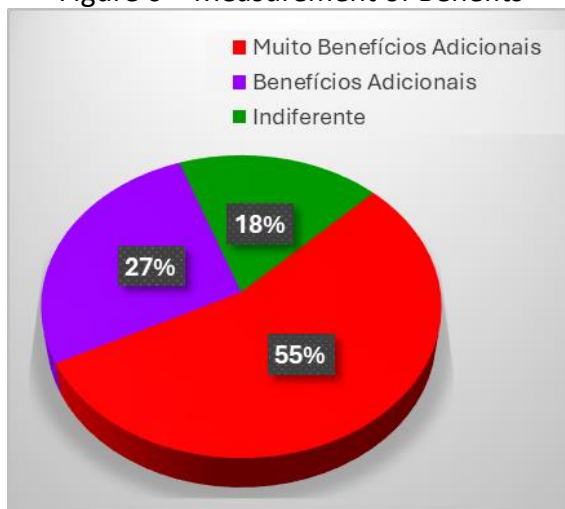Figure 4 - Integration with other forms of transport

Source: Authors (2023)

Figure 5 - Measurement in terms of Economy and Sustainability
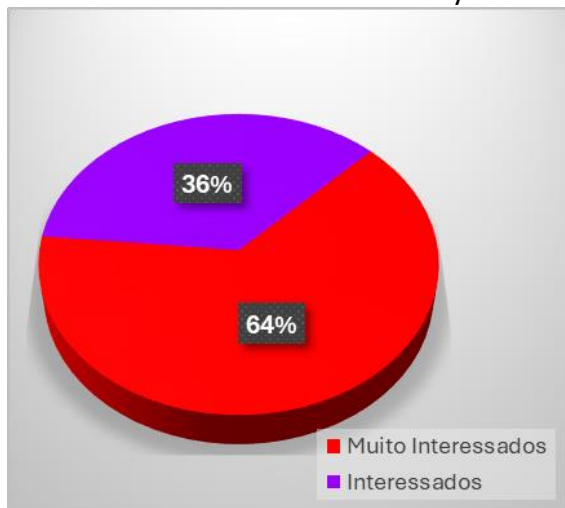
Source: Authors (2023)

Figure 6 – Measurement of Benefits

Fonte: Autores (2023)

5. DEVELOPMENT

During the meticulous development of the E@sy-Bikes application, a comprehensive approach was taken to ensure the platform's quality, usability, and effectiveness. This involved conducting thorough market research to understand the target audience and their needs. Based on the results, marketing strategies were defined to promote the application and attract users, highlighting the differentials and benefits offered, such as financial accessibility and healthy and sustainable aspects of using bicycles, among others.

In the development process, we made a strategic decision to use agile methodologies, such as Scrum or Kanban, to manage the project. This approach allowed us to adapt to changing requirements and market conditions, ensuring that the most important functionalities were prioritized. At each stage, user feedback was sought to make quick and continuous adjustments, ensuring value delivery over time.

For the development of the E@sy-Bikes application, we carefully selected the appropriate tools and languages, taking into account the application's usability, usefulness, and effectiveness. This included standard options such as HTML, CSS, and JavaScript for web development and mobile technologies such as Java or Kotlin for Android and Swift for iOS. We also implemented a system that allows users to scan a QR Code or enter a specific Token to unlock the reserved bike, integrated with a bike rental management system that controls the status of available bikes.

A key functionality implemented in the application is real-time geolocation, which allows users to locate the bikes closest to them. This was achieved through geolocation APIs, such as the Google Maps API, which provides capabilities to obtain the user's current location and display nearby bike rental points.

During development, attention was also paid to the accessibility of the application interface. Accessibility guidelines were taken into account, such as the use of contrasting colors, legible fonts, and support for assistive technologies. In addition, protective measures were implemented to ensure the safety of bikes and users, such as using QR Codes to unlock bikes and secure rental points.

A mobile version of the E@sy-Bikes application has been developed for Android and iOS devices. This version offers the same features as the web version. It has been adapted for smaller screens, providing an optimized experience for users accessing the platform via mobile devices.

The mobile version's interface was designed responsively, automatically adapting to the device's screen size, taking into account specific features such as tactile interactions. In addition, adjustments were made to the layout, arrangement of elements, and interactions, ensuring an intuitive, consistent, and high-quality experience.

By offering a mobile version, the E@sy-Bikes application increases its accessibility and convenience. Users can use the platform anywhere and at any time, book shared bicycles, and promote sustainable urban mobility.

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During the application's development, user tests were carried out to assess the quality of use and collect feedback. These tests identified possible difficulties in the interface and usability issues, enabling continuous improvements to the application.

The team responsible for developing the E@sy-Bikes app is multidisciplinary and includes developers, designers, UX/UI specialists, marketing professionals, and project managers. In addition, good software development practices are followed, and legal aspects such as user data protection are considered.

With all these efforts, the E@sy-Bikes app seeks to provide a quality bike rental experience, focusing on usability, practicality, accessibility, health, sustainability, and user safety.

5.1.   PROTOTYPE

During the initial research, the initial prototype of the E@sy-Bikes application was presented to the participants as a representation of the project's functionalities and feasibility. This prototype served as an initial idea of how the application could work, allowing feedback on the relevant functionalities and the concept's general acceptance.

Based on the responses and insights obtained from these initial surveys, it was possible to perceive the interest and receptiveness of the participants about the E@sy-Bikes application proposal.

This positive feedback encouraged the team to move forward with the project's development, improving the prototype and considering the application's visual identity.

Figure 7 - Home (Initial Design)

Source: Authors (2023)

Figure 8 – Geolocation (Initial Design)

Source: Authors (2023)

Figure 9 – Routes (Initial Design)

Source: Authors (2023)

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Figure 10 - Logo (Gif in sequence)

Source: Authors (2023)

The visual identity of the application, including the choice of blue and green colors, was carefully selected to convey specific messages to users. The use of blue and green colors refers to health, balance, tranquility, and sustainability, which are essential elements to promote the proposal of encouraging the use of bicycles as a sustainable means of transport.

Based on these elements, a distinctive prototype was created that reflects the visual identity of the E@sy-Bikes application. This new prototype incorporates the relevant functionalities identified in the initial research, offering users a practical, pleasant experience aligned with their values and expectations.

This approach of presenting an initial prototype, collecting feedback, and then developing a distinctive prototype based on the application's visual identity is a common strategy to ensure the project's acceptance and viability and provide a cohesive and attractive experience for users.

6. TESTING

6.1. VALIDATION OF THE E@SY_BIKES APPLICATION PROTOTYPE THROUGH APPLIED TESTS

Objectives of the prototype test: The test on the E@sy-Bikes application prototype aimed to evaluate usability, understanding of features, and visual appeal. Participants who fit the profile of the application's target audience, i.e., people interested in using bicycles as a means of transportation, were selected. The test script was structured with questions about the layout, usability, understanding of features, and overall satisfaction.

Data collection and analysis: Participants interacted with the application prototype and answered a questionnaire with multiple-choice questions about usability, design, and features. The data was collected, and the responses were compiled and organized into relevant categories, such as layout, design, and features. The data was then analyzed to identify patterns, trends, and areas for improvement.

Results obtained: The results of the validation tests demonstrated the following points:

1. Regarding usability, 82% of participants considered the application easy to use.
2. In the general usability rating, 64% of participants rated the application as easy.
3. Regarding design, 100% of participants considered the design modern and attractive.
4. Regarding the choice of colors and fonts, 82% of participants agreed they were appropriate.
5. In the general design rating, 91% of participants rated the application excellent.
6. Regarding features, 73% of participants considered bike reservations easy and intuitive.
7. Regarding the geolocation feature, 91% of participants rated it as efficient or very efficient.
8. Regarding the features meeting needs and expectations, 73% of participants agreed. 9. Regarding additional feedback, the most relevant and positive aspects mentioned were ease of use (71%), attractive design (82%), and valuable functionalities (100%).

These results highlight how validation tests reinforce the quality and effectiveness of the E@sy-Bikes application based on the participants' responses. The majority of participants expressed high satisfaction with the application's usability, design, and functionalities, which confirms the project's success in meeting the needs and expectations of the target audience.
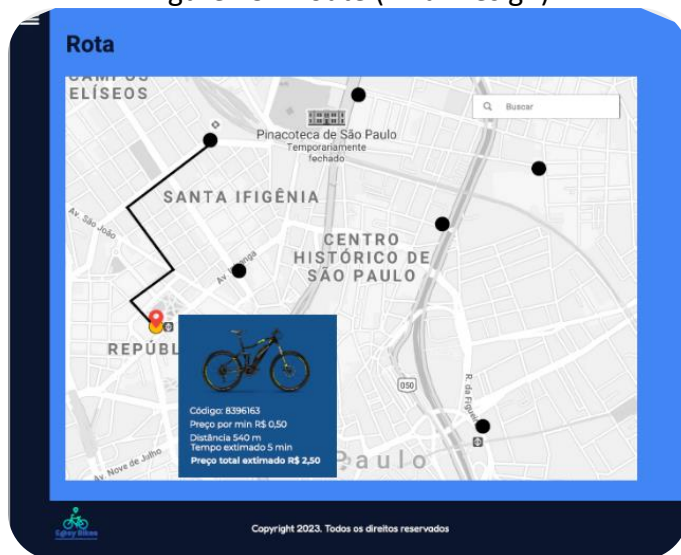
Figure 11 - Home (Final Design)
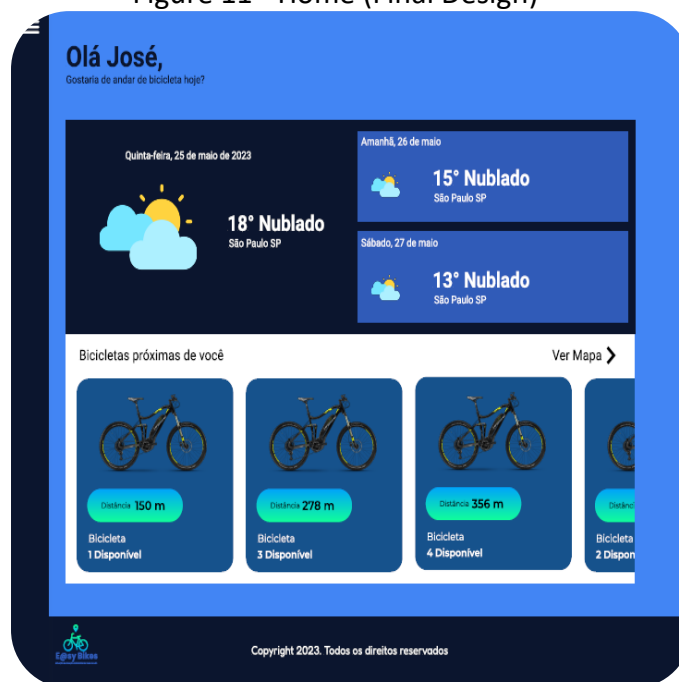
Source: Authors (2023)

Figure 12 - Geolocation (Final Design)
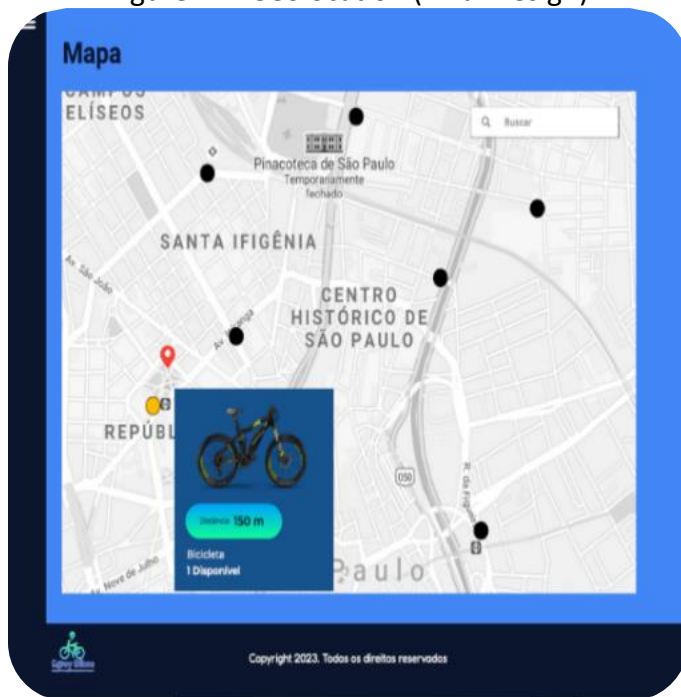
Source: Authors (2023)

Figure 13 - Route (Final Design)

Source: Authors (2023)

7. CONCLUSION

Based on the validation test results, we can conclude that the E@sy-Bikes application obtained a high satisfaction rate among participants. Usability was considered easy and intuitive, and the attractive design and user-friendly features were highlighted as strengths of the application. These results validate the proposal to provide users with a practical and pleasant experience, making bike rental more accessible and convenient.

The positive feedback reinforces the application's effectiveness in encouraging the use of bicycles as a sustainable means of transport, contributing to urban mobility, user health, and reducing pollution in cities. The mention of encouraging the use of bicycles as a sustainable means of transport is also very relevant, as it demonstrates that the application is aligned with the objectives of urban mobility, user health, and reducing pollution in cities.

The conclusion presented clearly and objectively demonstrates the main results of the validation tests of the E@sy-Bikes application. It highlights participants' satisfaction, evidencing high satisfaction with usability, attractive design, and user-friendly features. This indicates that the application met the expectations and needs of the target audience, providing a practical and enjoyable experience in the bike rental process.

Therefore, the conclusion is consistent and supports the quality and effectiveness of the E@sy-Bikes application. It provides a positive overview of the results obtained in the validation tests. These results reinforce the application's importance as a viable solution to promote sustainable mobility and improve the quality of life in cities.

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