PROMOB-e

Impacts of electric bicycles and kick-scooters sharing systems:

Recommendations

Product prepared by:
PROMOB-e
German Cooperation for Sustainable Development
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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CONTENT

This report takes up previous studies[1] with the preliminary identification of the environmental and social impacts of electric bicycles and kick-scooters sharing systems in the Brazilian market. It presents recommendations in order to avoid, mitigate and/or compensate for the environmental and social impacts of vehicle components, mainly related to lithium batteries. It can be used as an advisory guide and can support policy makers and agents involved in the implementation of urban micro-mobility products and services.

The execution of this report was possible with the support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, executing agency for the German Cooperation for Sustainable Development, as well as institutional partners, such as the Ministry of Economy of Brazil. In addition, we would like to thank the operator Tembici, who supported the project, and professionals from the electric mobility market interviewed, listed in the Appendix.

1. RIELLI, L. SANTOS, C., CHAPMAN, S., NOVAES, L. (2019). Impacts of electric bicycles and kick-scooters sharing systems: challenge characterization. GIZ. Brasília, 2019. | RIELLI, L. SANTOS, C., NOVAES, L. (2019). Impacts of bycicle and electric kick-scooter sharing systems: identification of socio-environmental aspects GIZ. Brasilia, 2019.

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1. INTRODUCTION

The widespread use of individual combustion transport vehicles has contributed to negative environmental impacts with consequences on a global scale. Climate change, for example, is associated with greenhouse gas emissions. The contribution of the Brazilian transport sector will be 135.2 million tonnes/CO2e in 2020, 52% above the results of 2010[2]. Of this total, 64%, or 86.5 million tonnes/ CO2e, will come from burning of fuels by automobiles and motorcycles. According to estimates by the Energy Research Company (EPE), there will be 52 million passenger cars in 2026[3], a number 26% higher than the fleet in 2018[4], increasing the adverse effects. Thus, alternative technological solutions, such as electric mobility, take prominence and priority.

New passengers transport modals must generate positive outcomes on socio-environmental aspects. It is a premise and requirement for technological development and business models. While the new solutions can bring real benefits to cities and people's lives, they can generate negative consequences hitherto unknown or of little relevance.

Introduced at the end of 2017, agents involved in electric kick-scooters sharing systems have little explored the direct, indirect and induced impacts of their activities along the value chain and the life cycle of their materials and components. In general terms, the same can be seen in the electric bicycles sharing systems, which are beginning to gain relevance as an urban modal around the world.

In addition to technological developments, the institution of regulatory legislation and the encouragement of public programs, may further accelerate the transformation process. In mature markets, such as France and Germany, these changes are already a reality. Two cases with the participation of public agents are presented as a reference.

This study presents routes of solutions and recommendations with the objective of avoiding, mitigating and/or compensating socioenvironmental impacts of electric bicycles and kick-scooters sharing systems in the Brazilian market. It is the sequence of two previous studies, which subsidize with technical information the possibilities of action by different audiences involved. The first study, to characterize the challenge, presents the following content: identifies concepts and definitions; presents the global and Brazilian market outlook for electric bicycles and kick-scooters; introduces the current context of the lithium battery energy storage market; and synthesizes the legal framework, in the light of the Urban Mobility Policy and the National Solid Waste Policy[5]. The second document defines Life Cycle Assessment, identifies environmental aspect and the damage caused by components of electric vehicles, especially batteries, and presents a legal assessment on civil and environmental responsibility in the post-use of lithium batteries.

The provision of information on the magnitude and scope of the negative effects of new modes of transport allows for the correct identification of risk and responsibility assessments. From the perspective of public policy makers, it must support the planning of initiatives that avoid imbalances and market failures. As for the operators, it allows them to adapt their business risk models and understand the implications and responsibilities. Thus, it allows to evaluate and plan preparatory, compensatory and engagement initiatives, avoiding adverse effects.

2. Böhler-Baedeker, S. Kost, C. Merfortth, M. Kumar, K. (2013). Planos de Mobilidade Urbana: Abordagem Nacionais e Práticas Locais. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Germany. Available at: < http://itdpbrasil.org.br/wp-content/uploads/2015/03/td13_urbanmobilityplans_pt.pdf> Accessed 4/17/2019.

3. BRASIL (2017). Plano Decenal de Energia 2026. Ministério de Minas e Energia. Empresa de Pesquisa Energética. Brasília. Available at: www.mme.gov. br/documents/10584/0/PDE2026.pdf/474c63d5-a6ae-451c-8155-ce2938fbf896. Accessed 4/17/2019.

4. IBPT (2018). Available at: https://ibpt.com.br/noticia/2640/REAL-FROTA-CIRCULANTE-NO-BRASIL-E-DE-65-8-MILHOES-DE-VEICULOS-INDICA-ESTUDO. Accessed 4/17/2019.

5. Idem, item 1

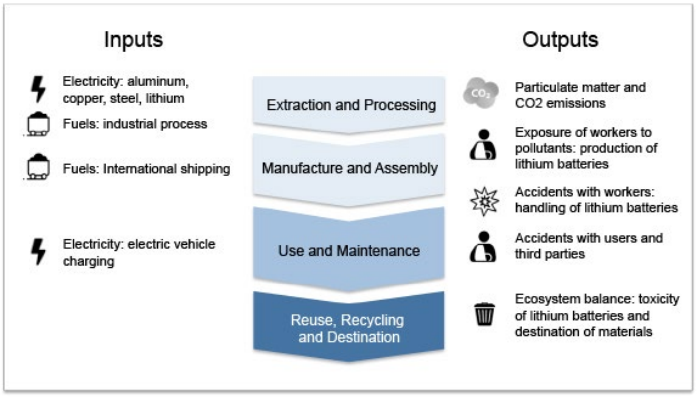
It is, therefore, an opportunity for the system to mature, benefiting from learning from selected examples. Moreover, a broader comprehension of socio-environmental impacts should provide new opportunities. Differentiation in institutional and market positioning, as a low-impact transport alternative, can be reinforced, being a fundamental element in strengthening the reputation of operators and the satisfaction of users.

The following recommendations are restricted to initiatives with the potential to address the negative social and environmental effects caused by the implementation of electric bicycles and kick-scooters sharing systems. Thus, it does not address other elements relevant to the success and longevity of the new modes, for example, aspects related to the business model, the operational model and integration into the existing urban mobility system. The following propositions are, therefore, not exhaustive, and may benefit from constructive debates and future interactions with industry agents.

2. ROUTES OF SOLUTIONS

During the study to identify socio-environmental aspects in the electric bicycles and kick-scooters value chain, impacts and damage factors of greater relevance to the attention of those involved in the implementation of sharing systems were listed. To a large extent, they are aspects common to operators, considering that they are inserted in a value chain of profile and global scale. Figure 1, illustrates the socio-environmental aspects and impacts during the stages of pre-use, use and post-use.

Figure 1 | SOCIO-ENVIRONMENTAL IMPACTS ON THE VALUE CHAIN



Note: Prepared by NOVí. Credits: Iconfinder[6]

Once the key aspects are identified, it is necessary to evaluate paths, approaches and examples that can address the challenges arising from the technological transition process. Thus, the following sections present two routes of solutions: the mobilization of private organizations, in the search for solutions based on market conditions; and solutions induced by public policies or regulatory frameworks that reorganize players and market conditions. It is, therefore, about presenting alternative and complementary paths that should be considered by the Brazilian market to achieve the objective of avoiding, mitigating and/or compensating for negative socio-environmental impacts.

2.1. MARKET SOLUTIONS

2.1.1. SECTORAL COLLABORATION

In March 2019, eleven American companies initiated the Streets for All Coalition, It is a voluntary movement for the engagement of agents from the micro-mobility sector for coordinated action on common and pre-competitive issues. The launch was supported and co-founded by environmental organizations, advocacy for alternative transport and sharing system operators. So far, there is no participation of public agents.

The coalition's mission is to reinforce common public policy positions needed by the sector. The main motivation is to anticipate and proactively demand the engagement of legislators and formulators of public policies, especially for the issue of user security and access equity, which would enable the expansion of the solution in regions with lower purchasing power.

The coalition's charter of principles consolidates seven positions: 1) ensuring support from public policies for sustainable modes; 2) adopt security measures, sharing the responsibility for security among all those involved and asking the public authorities for clear requirements from operators; 3) equity in access, enabling new modes for consumers with less purchasing power; 4) protection of sidewalks; 5) quality of the service provided. 6) protection of individual data; and 7) equality of law enforcement measures with bicycles. Although not explained, the climate change topic is reinforced as the main environmental attribute to be defended by those involved in the initiative.

Although recent, the movement demonstrates the viability of organizations of different profiles and positions to build common understandings and minimum conditions for the evolution of the sector. The environmental aspects identified in the previous studies (Figure 1) would certainly have the attention and benefit from collaborative forums such as the Street for All Coalition.

6. Free icons. Available at: www.iconfinder.com/search/?q=co2&price=free

2.2. SOLUTIONS INDUCED BY PUBLIC POLICIES

Although the private sector can proactively and voluntarily address a series of challenges common to the agents involved in the sector, the complexity and scale of the necessary transformation requires the participation of public agents. A clear regulatory environment makes it easier to understand the "game rules", including social and environmental accountability. On the other hand, public policies must induce, encourage and organize the development of the new market and guarantee urban planning. The following examples illustrate the beneficial and lead role of the State in the new model of mobility.

2.2.1. MOBILITY IN BERLIN

Traditionally, Germany is part of the automotive market of technologies manufacturers and providers. Unlike other urban centers, the Berlin-Brandenburg region is not the birthplace of large traditional industries in the sector, representing less influence, and has a population with a cosmopolitan profile, innovative and open to new global trends such as sustainability[7]. In this context, the region established the vision of being a globally relevant player in the electric mobility value chain, including: research and development; component design and production; production and storage of "green energies"; and models for implementing new mobility solutions[8].

In 2011, the Berlin local government created an agency to promote electric mobility in the region. eMO, the Electric Mobility Agency in Berlin, operates under the physical and legal framework of the Office of Partnerships for Business and Technology, in the Department of Economy, Energy and Public Affairs. Due to its multidisciplinary nature, it holds strong attachments with the Department of Transports and Environment. The main source of resources come from the municipality of Berlin, the government of Brandenburg and private partnerships, such as institutions and companies from the mobility sector. The revenue distribution in 2018 reached approximately 70% of public resources, being the rest from private funds.

eMO's mission is to promote and coordinate electric mobility activities in the region and the ambition to design Berlin as an internationally recognized model for electric mobility management. The agency currently offers support on development, execution and introduction to market of electric mobility innovation projects. The action is focused on CASES (connected, automatic, shared, electric and sustainable) solutions. The thematic areas are new mobility, including Mobility as a Service[9], micro-mobility and automation; city logistics, with electrification platforms, shared micro-hubs from the delivery sector, and last mile efficiency; and intelligent infrastructure, with the development of charging points and incentives for the use and expansion of different types of electric vehicles[10].

Since its establishment, eMO has been a significant innovation hub to promote new solutions on urban electric mobility. More than 30 projects have been developed in a network of universities, public agencies, big companies and start-ups. It is therefore a reference in the development and application of solutions for the urban environment.

Benefiting from the activities of eMO, Berlin has a growing ecosystem of agents involved in electric mobility. Considering the start-up ecosystem, there are 50 companies in operation, 160 support services and 110 other agents. In relation to light vehicles, there are 150,000 electric bicycles, 600 of which in sharing systems (Lime, JUMP, Lidl and NextBike), 2,300 shared electric kick-scooters (Emmy and Coup) and the expectation of 2,000 to 3,000 electric kick-scooters with initial activities scheduled for 2019, obtaining interest from 9 operators.

eMO does not have an agenda specifically aimed at reducing socio-environmental impacts, however, aspects are a requirement and criterion for project development. In this sense, it has operated in charging systems for electric vehicles using solar energy and the inclusion of the lithium battery recycler chain in the solutions, among others.

7. eMO (2014). Berlin is Going Electric: Action Plan for Eletromobility 2020. Berlin Agency for Electromobility eMO. Available at: < www.berlin-partner. de/fileadmin/user_upload/01_chefredaktion/02_pdf/publikationen/eMO%20Aktionsprogramm%20%28english%29.pdf>. Accessed 4/17/2019.

8. Idem, item 7.

9. Mobility as a Service (MaaS) is the integration of different ways of transport in only one mobility service on demand. MaaS is structured in a digital platform that centralizes mobility options in the same payment channel, management of trips, among other functionalities.

10. More information at: https://maas-alliance.eu/

2.2.2. MOBILITY IN FRANCE

The mobility guidance bill is under discussion in France (Projet de Loi d'Orientation des Mobilités - LOM)[11]. It aims to deeply change public policies on mobility and reach population all over the country[12]. For this purpose, four goals were listed:

I) to reduce territorial inequalities, improving mobility and accessibility;

II) to improve the quality and safety of road, rail and river networks;

III) to accelerate the energy transition, the reduction of greenhouse gas emissions and the fight against pollution and road congestion, promoting a modal rebalancing;

IV) To improve efficiency on cargo transportation to reinforce competition in territories.

For such objectives, five investment programs were designed:

a) To perform maintenance and modernization of existing road networks;

b) To double the supply of railways to correct the saturation of big junctions in urban centers;

c) To connect medium-sized cities and rural areas;

d) To develop the use of less polluting and shared mobility;

e) To support an ambitious freight transport policy.

For the implementation of its policy, French law provides for a strong investment system, which intends, by 2025, to allocate 350 million euros to boost active means of transport, such as bicycles and hiking. Each year the government must submit to parliament a report on investments to be discussed between the executive and the legislature.

One of the examples provided for in the law is the link imposed on the road manager (except motorways and expressways) both in the construction and in the revitalization of long-distance roads to the viability of implementing cycle paths. The maturity and diversity of the French transport system allows the law to structure an effectively integrated network, in which bicycle stands and similar structures are located next to railway stations, for example.

But the public authorities maintain a strong control over the policy, forcing the installation of bicycle parking spaces in safety, even if it is necessary to remove spaces from car parking spaces, as well as imposing that the bikes be accepted in trains and, gradually, in bus (a maximum of five). The policy also goes beyond the limits of the streets, with mandatory teaching of the practice of bicycle use starting in 2022 for all primary school students.

The bill is based on the assumption that mobility is in transformation because of collective awareness of the environmental impacts of the current model, starting to value collaborative behaviors. It also focuses on directing investments to densely populated areas, using active modes as a mechanism to control traffic jams. In this case, the government is responsible for selecting projects that encourage active mobility and following up its implementation, which means the State is the inducer of policy changes.

In Brazil, the definition and submission of investment values would come into conflict against the competence of the executive branch to manage its budget. In addition, there are differences between the degree of development of mobility systems. Besides the recent formation, Brazil shows infrastructures with deep needs of investment. Thus, it is not a matter, like in France, of improving a well-structured system and adapting it to an eco-friendly modal or energy transition

In the Brazilian case, there are deficiencies that lead to a simultaneous discussion of topics, with the necessity of investments in less contaminant technologies, while communities have issues to access means of transportation. Moreover, the similarities that the French legal system has with the Brazilian allow the bill to serve, in the future, to inspire Brazilian public policies with examples of success.

11. The motion was approved by the Senate in April 2 of 2019 and will be discussed in the National Assembly. Available at: < https://www.nouvelobs.com/politique/20190402.AFP3951/le-senat-adopte-le-projet-de-loi-d-orientation-des-mobilites.html>. Accessed 4/17/2019.

12. https://www.gouvernement.fr/conseil-des-ministres/2019-02-20/lettre-rectificative-au-projet-de-loi-d-orientation-des-mobi

3. RECOMMENDATIONS

The continuous and fast expansion on electric mobility sharing systems all around the world may benefit of learning inside and outside the sector, which might avoid and mitigate undesirable environmental impacts. Chart 1 consolidates and summarizes 19 recommendations by thematic areas. Despite the grouping used for this analysis to bring together related topics, facilitating the identification of the potential interest by agents involved in the implementation of electric bicycles and kick-scooters sharing systems, they clearly comprise a unique and systemic approach that will contribute to the development of the sector. The following sections expand and explore the recommendations, with implementation examples.

Chart 1 | SUMMARY OF RECOMMENDATIONS

Identification and analysis of socio-environmental impacts	Material and components of vehicles
1. Conduct technical study of Life Cycle Assessment 2. Structure primary database on socio-environmental aspects 3. Mobilize agents in the sector and define governance to assess socio-environmental impacts	4. Prioritize energy management and the use of renewable sources 5. Reduce the transport distance of materials and components 6. Develop vehicles suitable for use 7. Develop eco-efficient vehicles 8. Achieve value and reduce risks from lithium battery post-use
Sharing systems operating model	**Legislation, public policies, and sectoral relations**
9. Stand for sustainable solutions 10. Stimulate safe behavior on users 11. Implement low-impact vehicle charging system 12. Act proactively in the relation with communities 13. Adopt a sustainable management system	14. Promote urban electric mobility 15. Promote pre-competitive sectorial initiatives 16. Develop the post-consumption chain of lithium batteries 17. Tighten local relations 18. Set technical standards for vehicles components 19. Promote harmonization of legislation

Note: Prepared by NOVí.

3.1. DENTIFICATION AND ANALYSIS OF SOCIO-ENVIRONMENTAL IMPACTS

As explained during the second study of this project, information specific to the Brazilian context is necessary for conclusive analysis. Thus, the following actions are required to a technical development of the socio-environmental analysis:

- **Conduct a technical study of Life Cycle Assessment (LCA) for the Brazilian context:** after defining the specific geographical and temporal boundaries, it will be possible to conduct an inventory of socio-environmental impacts and damages for specific conditions found in Brazil. Considering the relevance of the processes involved in the sharing systems operating model, it is recommended to evaluate not only the vehicles, but also the material and energy flows involved in the activity.

- **Structuring a primary database on socio-environmental aspects:** most of the LCA work relies on public databases with standardized and secure information on socio-environmental aspects. For instance, GHG emissions on transport activities in the United States may be assessed from Greet Model[13], linked to the Department of Energy of the American government. The existence of an open, dynamic and accessible database for operators would enable ex ante analysis of socio-environmental impacts in the implementation in new cities or regions.

- **Stimulate stakeholders and define governance to assess socio-environmental impacts:** the definition of premises, analysis scope and result assessment must be done not only by the technical team, but also with stakeholders. The cooperative and pre-competitive participation can be beneficial to everyone involved, making the results more practical and useful. As an example, the cement industry, with high environmental impacts, launched the global sectoral initiative Getting the numbers right[14] more than a decade ago, voluntarily consolidating data on energy consumption and CO_2 emissions.

Performing the LCA will provide technical support for the discussion of the introduction of new technologies in Brazil. For public policy makers, it will contribute with aspects related to industrial policy, import substitution of critical components and destination models in post-use. The model of responsibility and prioritization in the light of the National Solid Waste Policy may be better framed, considering the destination of batteries to manufacturers in the countries of origin or other alternatives, such as remanufacturing and second life[15]. Thus, there will be more clarity a legal safety to stakeholders, reducing potential risks, contributing to the acceleration of the installation of electric mobility in the Brazilian market.

3.2. MATERIAL AND COMPONENTS OF VEHICLES

The identification of socio-environmental aspects reinforced the relevance of the energy matrix in the origin of the components and in the manufacture of vehicles. Additionally, she highlights that the current "disposable" nature of electric scooters significantly reduces the benefits obtained in socio-environmental terms during their use. Thus, the following measures will contribute to the global sustainability of solutions:

- **Prioritize energy management and the use of renewable sources at all stages of the value chain:** as identified, the greatest energy consumption is in the production of lithium batteries and aluminum, steel and copper alloys used in bicycles and electric kick-scooters. In the processing of lithium in rotary kilns, for example, the thermal substitution by biomass or the co-processing of high calorific waste will bring a significant reduction in the use of fossil fuels. During the production of components, using renewable sources of low impact (for example: solar and wind power generation) and automation systems for energy efficiency will bring even more significant benefits. Local clean energy production, in distributed generation, is a cost-effective and low socio-environmental impact alternative to be considered. Finally, traceability, transparency and certification systems such as the Carbon Disclosure Project (CDP) or Renewable Energy Certificates (REC) can offer standardized, comparable and reliable information to those involved in the following links in the production chain.

13. Greet Model - The Greenhouse gases, Regulated Emissions, and Energy use in Transportation Model. Available at: <https://greet.es.anl.gov/>. Accessed 4/17/2019.

14. WBCSD, Getting the numbers right Project. (2016). Available at: <https://www.wbcsdcement.org/GNR-2016/>. Accessed 4/17/2019.

15. Idem, item 2.

- **Reduce transport distances of material and components:** Optimize logistic flows brings direct benefits to structure costs of operators and reduces socio-environmental impacts during transport of components. With the evolution and maturity gain of the sharing market, the selection and development of local suppliers will contribute to mitigate impacts.

- **Develop vehicles suitable for an specific application:** electric kick-scooters available in the Brazilian market were made for personal use, with low intensity and abrasion. During previous stages of the project, we recurrently found the need among operators of reducing theft and vandalism, to ensure economic viability and sustainability of the business model. In this way, pioneering companies such as Skip, Bird and Lime[16] are developing their own vehicles, with exclusive parts, reducing resale value. In addition, they are more robust equipment, with less components exposed to vandalism such as tires, fenders, levers and screws. Among the changes announced is the development of self-maintenance and telemetry systems, allowing vehicles to make self-diagnoses of non-conformities, anticipating and accelerating the maintenance process. Finally, the climatic, topographic and road conditions of Brazilian cities require adapted vehicles, able to be exposed to bad weather, for example, rain and high temperatures in a safe manner and according to technical specifications.

- **Develop eco-efficient vehicles:** vehicle design and selection of materials used must consider the effects on socio-environmental impacts. Lithium batteries, for instance, have inferior service life from other components in electric bicycles[17]. Choosing batteries with compatible service life to the rest of the components reduces total impacts. Another route for product development is the replacement of aluminum and steel alloys with alternative materials. Muzziclycles, for example, is a Brazilian company that developed a model of urban bicycle with a frame produced with recycled plastic materials. According to the manufacturer, the production process reduces water consumption to less than 1% and less than 2% of electricity when compared to a traditional aluminum frame, in addition to removing materials with potential environmental impact[18].

- **Increase value and reduce risks on post-consumption of lithium batteries:** lithium batteries may retain 70% to 80% of its capacity after their service life[19]. Thus, before evaluating remanufacturing, there is the possibility of seeking a second use, after fulfilling the primary function. One of the technological development routes is to use it as a stationary source of electricity (for example: UPS, emergency lights, alarms, among others). In Germany, Bosch, BMW and Vattenfall are testing the use of electric vehicle lithium cells for residential stationary use. In the Brazilian market, this solution can be offered as energy storage for peak consumption (energy storage), in isolated systems or in locations with low reliability of the supply of electricity through the network. To do so, the private sector will have to engage in reverse logistic systems and in the development of business models as a whole.

3.3. SHARING SYSTEMS OPERATING MODEL

- **Stand for sustainable solutions:** reducing local pollutants, with the result of fewer cars on the streets, is an important attribute of entry of electric bicycles and kick-scooters into new markets. In this sense, strengthening the sustainability value proposal generated by sharing systems can induce user loyalty and strengthen local relationships. A clear "zero impact" positioning throughout the operation process would contribute to the vision of avoiding and mitigating negative effects during the sharing process and across the value chain. Carbono Zero, a Brazilian fast delivery company, has committed to zero its carbon emissions by adopting a fleet of electric utility vehicles for long and medium distance trips to transfer hubs, using conventional and electric cargo bikes for delivery to the final recipient[20]. In addition, unavoided CO2 emissions can be offset by market mechanisms such as investing in initiatives with a positive effect or purchasing voluntary carbon credits (VCS - Voluntary Carbon Standard). Lime has chosen this option to reduce negative impacts[21].

16. Lekach, S. E-scooters can be hacked, here's what companies are doing about it. (2018). Mashable. Available at: <https://mashable.com/article/e- scooter-hacks-bird-lime/>. Accessed 4/11/2019. | Constine, J. Boosted Boards founders launch heavy-duty scooter renter Skip. (2018). Techcrunch. Available at: <https://techcrunch.com/2018/05/17/skip-scooters/>. Accessed 4/17/2019.

17. Idem, item 1.

18. Muzzicycles. Available at: <http://www.muzzicycles.com.br/>.

19. Omar, N. Second life batteries - Opportunities or challenges. (2018). MOBI - Mobility, Logistics and Automotive Technology Research Centre. Available at: <https://eurobat.org/images/3_Eurobat_N_Omar.pdf>. Accessed 4/17/2019.

20. Carbono Zero Courier. Available at: <https://carbonozerocourier.com.br/site/>.

21. Lime Green. Available at: <www.li.me/lime-green>.

- **Stimulate safe behavior on users:** security of users and traffic behavior are the main issues in the process of adopting new mobility technologies. An interviewed operator told that the perception is that many users associate the experience with leisure or as a toy, in the case of electric kick-scooters, dropping the associated risk assessment. In California, when registering a new user, operators request a photo of the driver's license, in order to have greater control and authorize only those over 16 years of age[22]. In the same market, Lime launched the Respect the Ride program, investing USD 3 million on educational, civil, environmental and road initiatives. Operators in France are advised to offer helmets[23]. Clearly, operators in the Brazilian market may act proactively offering reward programs (for example: Programa Trânsito Legal, by the insurance company Porto Seguro), education and training for beginners (for example: Projeto Bike Anjo), among other activities. Finally, vehicles can easily embark collision or crash alert systems (man down alerts), which would allow greater responsiveness in terms of supporting users, guaranteeing the operation and registering occurrences.

- **Implement a low-impact vehicle charging system:** optimizing the vehicle loading flow is essential to reduce environmental impacts. In addition to an electric propulsion fleet, as previously mentioned, fleet and displacement management can benefit from the use of connected with traffic applications. In addition, the operation model with defined physical, virtual or hub-centric[24] stations facilitates the collection of vehicles, reducing logistical needs. Finally, just as it has advanced in electric scooters, the battery swap model at the place of use (swap and go model) can be studied by Brazilian operators[25]. The use of renewable solar and wind energy, especially those originating from distributed generation, will contribute to reducing the impacts related to power generation. In relation to this last possibility, the Brazilian electric sector, through the Research and Development Program of the National Electric Energy Agency (ANEEL), has been developing electric mobility initiatives, and there may be synergies and mutual interests in the development of new solutions. The Strategic R&D "Desenvolvimento de soluções em mobilidade elétrica eficiente"[26] is an important opportunity in this regard, with projects underway until 2023.

- **Act proactively in the relationship with communities:** "It is easier to be forgiven than ask permission" as an introductive strategy, certainly has adverse consequences that must be reversed. Among them, there is a low utility perception from the public on new vehicles in communities[27]. Additionally, in relation to theft and vandalism, operators have data to identify high-risk areas, in terms of vehicle misuse, and to act proactively. Creating means of accessibility, communication channels and brand recognition contribute on reducing costs and impacts from vandalism.

- **Adopt a sustainability management system:** except for a few cases (for example: Lime and Bird), the market for sharing bicycles and electric kick-scooters presents little public information on socio-environmental aspects. Thus, offering more transparency on actions, through a sustainability report, can facilitate the understanding of sustainability management by agents involved in the market. The use of reporting standards such as the Global Reporting Initiative (GRI) favors comparability of information. Similarly, to contribute to the uniformity and standardization of internal procedures, the ISO 14001 environmental management and ISO 55001 asset management standards can be management tools recognized by the market.

3.4. LEGISLATION, PUBLIC POLICIES AND SECTORAL RELATIONS

Following the global trend, local governments look for alternatives to cars as personal transport. There surely is a tendency of accepting new modal of electric transportation due to the reduction of contaminants and traffic. On the other hand, the speed and evolution of the business model requires speed, flexibility and iteration by public agents and legislators,

22. Walker, A. Chandler, J. Kids love e-scooters - Why aren't they allowed to ride them?. (2018). Curbed - LA. Available at: <https://la.curbed.com/2018/9/27/17898356/scooters-bird-lime-age-requirement-license>. Accessed 4/17/2019.

23. How to avoid falling foul of Paris' new rules on electric scooters. (2019). THE LOCAL fr. Available at: <www.thelocal.fr/20190327/how-to-avoid-being- hit-with-fines-when-using-an-electric-scooter-in-paris>. Accessed 4/17/2019.

24. Idem, item 1.

25. Standard Swappable Batteries: The Future for Electric Scooters?. (2018). InsideEVs. Available at: <https://insideevs.com/standard-swappable-batteries-electric-scooter/>. Accessed 4/17/2019.

26. ANEEL, (2019). Available at: www.aneel.gov.br/sala-de-imprensa-exibicao-2/-/asset_publisher/zXQREz8EVlZ6/content/agencia-abre-chamada-de- p-d-estrategico-sobre-mobilidade-eletrica-eficiente/656877?inheritRedirect=false. Accessed 4/30/2019.

27. Holley, P. (2018). Electric scooter companies conquer with a simple strategy: Act first, answer questions later. Available at: www.washingtonpost.com/news/innovations/wp/2018/06/22/electric-scooter-companies-conquer-with-a-simple-strategy-act-first-answer-questions-later/. Accessed 4/17/2019.

offering legal certainty to agents involved in the electric mobility market. The following actions will contribute to the implementation of sharing models in the Brazilian market:

- **Promote urban electric mobility:** although the transfer of subsidies from public resources from traditional modes of combustion to new electric vehicles may be considered fair, this was not the approach demanded by the operators interviewed during stages 1 and 2 of this project. The government can encourage the use of electric bicycles and scooters by offering specific road infrastructures, integrating them with the existing modes and means of payment, among other actions. In France and Sweden, for example, the government offers subsidies for the purchase of individual electric bicycles[28]. In Germany, as presented in the previous chapter, the city of Berlin, through the Berlin Electromobility Agency (eMO), offered vouchers for experimenting with different electric modes, seeking to break with not always rational habits of using an individual car. Thus, an agency that promotes electrifying the economy both municipally or at a state level, can leverage new opportunities from electric mobility.

- **Promote pre-competitive sectorial initiatives:** in a growing market, many definitions might be boosted in sectorial approaches with the agreement of stakeholders. Streets for All in California[29] has been developing common initiatives on security, accessibility, monitoring and service quality. Local authorities in Bordeaux, France, signed an agreement with operators, where they commit to produce a common and voluntary charter of good practices[30]. Finally, studies and information from market intelligence, such as user profiles and socio-environmental aspects, might also be done collaboratively.

- **Develop post-consumption chains of lithium batteries:** The same way arrangements were foreseen in the PNRS, a sectorial agreement for the destination of lithium batteries may be produced. Currently, most of those involved guarantee to give the correct destination to the materials, but with little traceability and guarantee of adequate final destination.

- **Tighten local relations:** "It is easier to be forgiven than ask permission" as an introductive strategy might generate negative outcomes[31]. The disruption to urban planning and the daily life of public managers and citizens can create difficulties in future adjustments, not to mention that it increases the responsibility of those who work without legal support. Thus, greater involvement of local players in launching into new cities is needed. On the other hand, public agents and public policy makers must offer guidelines and conditions for good implementation, without restricting technological advances and innovations in the model. The city of Berlin, for example, did not authorize the start of activities for sharing of electric scooters before the approval of legislation at national and local level[32]. In Brazil, the urban mobility plan is the appropriate instrument for setting the minimum requirements for planning and managing the system.

- **Define technical standards for vehicle components:** standards are effective tools to ensure quality, market acceptance and user confidence, especially in relation to the safety of new urban mobility vehicles. In the United States, UL, an independent company for security certification, publish the norm UL 2272, Safety of Electrical System for Scooters, assessing electric, mechanic aspects and safety of lithium batteries in case of fire[33]. Regarding the exposure to foreign substances (like dust), and to water, the available equipment shows different levels, from IP53(splashes of water) to IP54 (water jets)[34]. Similarly, Brazilian standards and control bodies, such as the Brazilian National Standards Organization (ABNT) and the National Institute of Metrology, Quality and Technology (INMETRO), can issue standards and certificates that guarantee safety and life of the processes, products and services of electric bicycles and kick-scooters sharing market.

28. Idem, item 1.

29. Streets for All Coalition. Available at: <www.streetsforallcoalition.org/>.

30. Loi Mobilitités: des solutions pour tous, dans tous les territoires. (2019). Ecologique-Solidaire. Available at: <www.ecologique-solidaire.gouv.fr/loi-mobilites-des-solutions-tous-dans-tous-territoires>. Accessed 4/17/2019.

31. Holley, P. (2018). Electric scooter companies conquer with a simple strategy: Act first, answer questions later. Available at: www.washingtonpost.com/news/innovations/wp/2018/06/22/electric-scooter-companies-conquer-with-a-simple-strategy-act-first-answer-questions-later/. Accessed 4/17/2019.

32. Electric scooters awarded official traffic permit in Germany. (2018). Xinhua Net. Available at: <www.xinhuanet.com/english/2018-10/26/c_137561024.htm>. Accessed 4/17/2019.

33. UL (2019). What we do – Page. UL Certification. Available at: <www.ul.com/aboutul/what-we-do/>. Accessed 4/17/2019.

34. Classe de proteção IP. Eicos Sensores de Nível e Sensores de Fluxo para Líquidos. Available at: <www.eicos.com.br/folhetos-tecnicos/classes-de-protecao-ip/>.

- **Promote harmonization on legislation:** challenges are abundant when structuring a mobility model in Brazil. The fragmentation of the federative system makes it possible, in practice, to speak of 5,570 different mobility plans, since, as stated in study 1, it is the responsibility of the municipality to establish it. At first glance, such differences could render business models unfeasible in practice, since they would require multiple adaptations. Nevertheless, it is worth remembering that despite the need for adjustments, large international platforms have been successful in penetrating the Brazilian market, such as Uber and Airbnb. The next chapter deepens into opportunities for harmonization and guiding principles.

4. LEGAL PROGNOSIS

Legislation, as it is known, is not capable of following the speed of social changes, not even foreseen them. Excepting the guiding role of public policies, embodied in the National Policy of Urban Mobility (PNMU), the foremost function of the law in those cases turns out to be reactive, considering anomalous scenarios. Thus, with electric bicycles and kick scooters, a certain period of time will be needed so that societies adjust to the new modal. From this interaction, there will be raised concerns to be regulated, such as the interaction between electric kick-scooters and pedestrians. While general guidelines must be fixed by law and, in many cases, are the exclusive responsibility of the Union (e.g. traffic and taxes), eminently local issues can be delegated to more flexible instruments, such as urban mobility plans themselves. Another example is the Terms of Commitment, voluntary instruments that in a negotiated manner bring more clarity to the responsibilities established in the legislation.

While larger municipalities naturally end up taking the lead in the process, the smaller ones suffer from a lack of structure regarding technical capacity. Considering that this lack is not restricted to the topic of mobility, many municipalities are part of regional consortia or their own representations, such as ANAMMA - National Association of Municipal Environmental Bodies, most often organized according to common realities. This favors less fragmented dialogue and the possibility of establishing regional and homogeneous policies. In some cases, as in the state of São Paulo, certain sectors of economic activity include environmental chambers, of a technical and consulting nature, constituted with the purpose of contributing to the improvement of standards and guidelines. This interaction between public authorities, civil society and other entities is not only possible but also desirable in view of sustainable development.

In addition, about the post-use of batteries, as stated, the legislation, especially the National Solid Waste Policy, establishes the responsibility of all those who are part of its life cycle. Thus, the definition of the duties of each entity in reverse logistics can prevent all responsibility from falling, for example, on those who provide the electric bicycles and kick-scooters sharing service. In this case, the main dialogue should be carried out at the federal level, with the Ministry of the Environment, depending on the scope of the use of batteries. Nothing prevents, however, that negotiations are initiated at the state level, with the licensing agency, particularly if the batteries are to be manufactured in Brazil.

Thus, although the environmental challenges of this new modal are many, in terms of impacts, what most worries is undoubtedly post-use. Based on the time spent in other agreements, it is necessary to start discussions either at the federal level, through the instruments mentioned in the PNRS, or at the state level, before the large-scale impacts caused by these residues become a reality.

In the case of batteries, therefore, we are talking about a risk that is no longer accepted by society. In other words, in the absence of a "zero risk", it is better to avoid possible damage than to repair it. Therefore, an eminently preventive responsibility applies, based on the concept of precaution so that the possible environmental damage is not materialized.

Otherwise stated, the precautionary principle expresses a value judgment that concerns not what man is still able to do, but the more nature will still be able to endure[35]. In summary, it recommends:

> "When there is a threat of serious or irreversible damage, the absence of absolute scientific certainty will not be used as a reason for postponing economically viable measures to prevent environmental degradation."[36]

35. JONAS, H. (2006). O princípio responsabilidade: Ensaio de uma ética para a civilização tecnológica. Translation from the original in German by Marijane Lisboa, Luiz Barros Montez Rio de Janeiro: Contraponto, Ed. PUC-RJ, 2006.

36. ORGANIZAÇÃO DAS NAÇÕES UNIDAS SOBRE MEIO AMBIENTE E DESENVOLVIMENTO (1992). Declaração do Rio sobre Meio Ambiente e Desenvolvimento. Rio de Janeiro, 3 a 14 de junho de 1992. Available at: <http://www.onu.org.br/rio20/img/2012/01/rio92.pdf>. Accessed 4/18/2019.

Currently, precaution is one of the most relevant principles of environmental law, and is found in several laws, such as the National Solid Waste Policy, of which it is expressed principle (art. 6, I). Also, in criminal law, precaution was expressly provided for in the Environmental Crimes Law (Law No. 9.605/98):

> Art. 54. Cause pollution of any kind at levels that result or may result in damage to human health, or that cause the death of animals or the significant destruction of flora:
>
> [...]
>
> § 3º incurs in the same penalties from the previous paragraph anyone who fails to adopt, when required by a competent authority, precautionary measures in case of risk of serious or irreversible environmental damage.

As seen, the principle of precaution is one of the directives to define proactive conduct of providers of the new system of electric bicycles and kick-scooters, and it intends to anticipate environmental damage.

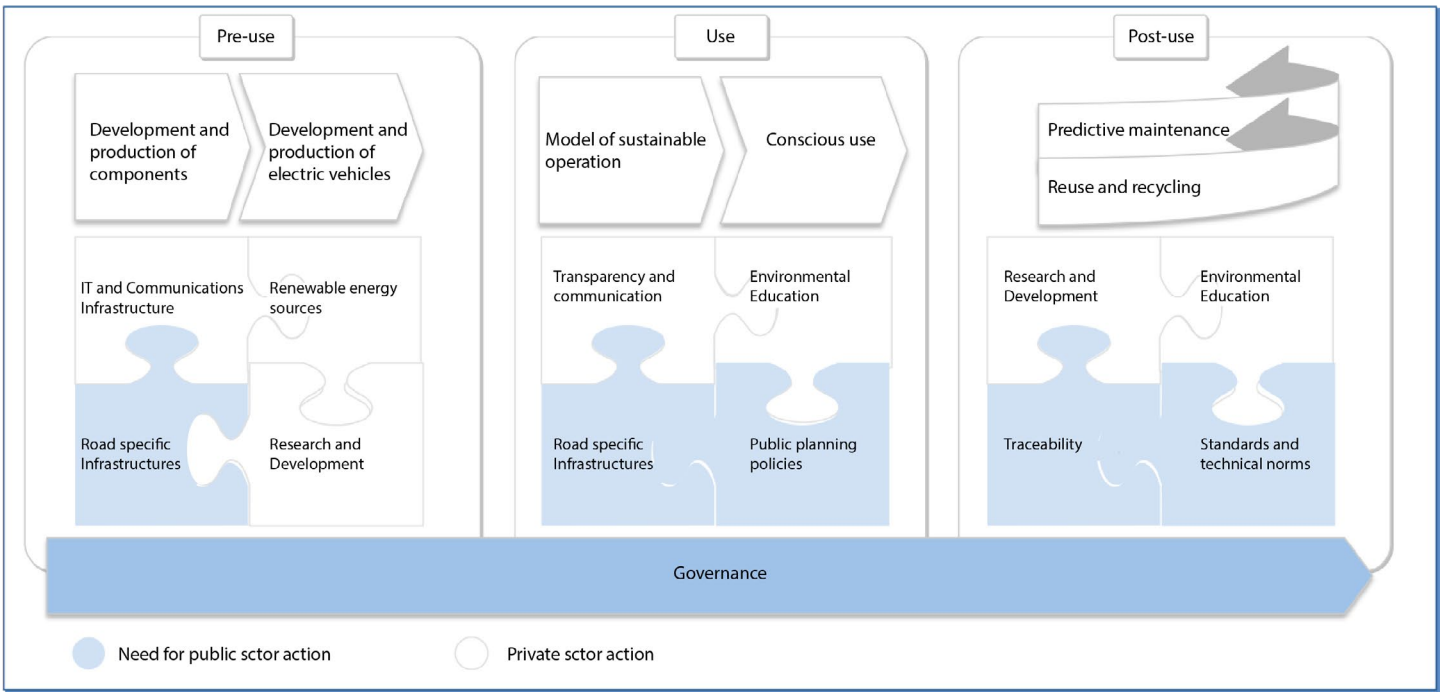
5. ANALYSIS

The recommendations and examples presented in the previous chapter summarize the main results obtained during the execution of stages 1 and 2 of this project. From the bibliographic review, interviews with operators and research in markets and reference agents, it was possible to list the most relevant measures, considering the current context of the electric bicycles and kick-scooters Brazilian sharing market.

When going through all the items presented, it becomes evident the complexity and multiple approaches necessary to introduce a systemic transformation in society. The promotion of electric mobility with low socio-environmental impact should offer ways to integrate economic, political, legal, behavioral, operational, technical, methodological aspects, among others. Figure 2 summarizes and interconnects elements needed to avoid and mitigate negative effects during the whole value chain. These are concatenated measures that, in the medium term, can bring results on the risks identified in stage 2 of this project, considering the potential growth of the challenge.

At each stage of the value chain, it will be necessary to develop specific solutions for the sector's needs. Operators must establish partnerships for the development of suppliers that meet the needs of the Brazilian market. In this sense, the proximity to research and innovation centers can facilitate and boost the structuring of the value chain and the search for solutions that contribute to sustainability.

Figure 2 | SYSTEMIC APPROACH OF ACTION ON THE VALUE CHAIN



Note: Prepared by NOVí.

Despite the relevant inducing role of public agents and public policies, private agents involved in the sector can play a leading role. The public sector is exclusively responsible for guaranteeing legal certainty, public interests and market conditions for the activity. In addition, operators can adopt a proactive stance, advancing market consolidation and maturity, through engagement and transparent communication with the different audiences involved.

Among the transversal actions, along the value chain, the need for cooperation and integration between the agents involved, in a governance system, stands out.

This role can be encouraged by a specifically designated public agent, through the formation of a joint council, class entity, voluntary sectoral initiative, among others. Regardless of the format, it is essential to formalize the space for dialogue to mediate dilemmas regarding the implementation of new modes, in a sustainable and perennial way.

It is up to those involved in the Brazilian electric mobility market to create action plans, with clear objectives, goals and responsibilities and make them public and easily accessible. In this way, we seek to contribute with the necessary actions to make the new modes of electric mobility even more attractive.

6. CONCLUSIONS

After going through the three studies on the impact of electric bicycles and kick-scooters sharing systems, the potential of the new and vibrant market is evident. There is growing evidence that light electric vehicles can be viable and relevant alternatives as a solution to the challenge of urban mobility. They are low capital invested and highly efficient equipment, when compared to the traditional model anchored in the individual use of automobiles.

On the other hand, the negative effects generated along the new global value chain are little known. Among them are the impacts, the process and the responsibility for the destination of vehicles and their components at the end of their service lives. These situations were nonexistent or of low relevance not more than two years ago. Understanding, measuring and prioritizing impacts and damages caused to the environment and people is essential to carry out management, define responsibilities and address the implications.

From the public sector, it is a challenge to ensure celerity and flexibility towards demands from the legal process. In any case, there must be an emphasis on determining minimum requirements, especially in relation to road safety and urban planning and guidelines for operators to act under harmonized conditions. The formation of collaborative and cooperative spaces should facilitate the process of formulating public policies and enable greater effectiveness to actions.

Despite the public sector's relevance, many actions listed can advance through private agents, responding to demands and taking advantage of new opportunities to capture value. From the perspective of the operators, it is important to define a model of socio-environmental risks, considering current challenges and future perspectives. The dynamics of the market, with rapid changes in the business model, will require strategic priorities to be defined. It is not possible to imagine, for example, the sustainability of the sector with equipment with a short service life, or even considered "disposable". Energy management, with improvements in the efficiency of vehicles, processes and the use of renewable sources, as well as the recycling of materials should be among the topics of rapid action.

As can be seen from international cases, the adoption of electric mobility will not be achieved with few actions. It is a systemic transformation, a transition to a new economic arrangement, with low use of fossil fuels and sharing of goods.

It is clear, however, that it is too early to establish conclusive assessments. Novos estudos técnicos devem avançar na avaliação de materiais, alternativas de uso e escopo de análise em termos de serviços prestados. Despite divergent opinions identified during the research, it is not a question of preventing or barring the adoption of new technologies, but raising questions, expanding the scope of analysis and, mainly, adopting a precautionary attitude in acting under strong uncertainty about the consequences of the actions.

7. APPENDIXES

7.1. INTERVIEWED PROFESSIONALS

NOVí and GIZ would like to thank the professionals in the electric mobility market interviewed between January and February 2019.

Table 1 | INTERVIEWED PROFESSIONALS

Name	Occupation area	Organization
Marco Gibram	Corporate Sales	Emove
Artur Bauab	Founder and CEO	Mymobility
Brenda Holz	Development - Kick-scooters	Tembici
Nicole Barbieri	Development - Kick-scooters	Tembici
Pedro Scaramuzza	Business development	Tembici
Rafael Alves	Industrial Director	Tembici
Danilo Lamy	Founder and CEO	Bikxi
Rodrigo Carvalho	Engineering department	Yellow
Gustavo Jorge	Purchase department	Yellow
Robert Loacker	Opportunities & Sales Management Director	Bosch
Stênio Freitas	Application engineer	Bosch
Marcos Palasio	Gasoline Systems Senior Manager	Bosch
Kathrim Hoffman	Communication and Public Relations	eMO – Berlin Agency for Electromobility
Tim Reinshagen	Sales and Service	Scooter Helden
Julia Boss	CEO	Wind Mobility
Julia Groeth	Communication and Public Relations	COUP

Note: Prepared by NOVí.

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