

Article

Sharing Lisboa: A Digital Social Market to Promote Sustainable and Energy Efficient Behaviours

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Abstract: Several solutions and city planning policies have emerged to promote climate change and sustainable cities. The Sharing Cities program has the ambition of contributing to climate change mitigation by improving urban mobility, energy efficiency in buildings and reducing carbon emissions by successfully engaging citizens and fostering local-level innovation. A Digital Social Market (DSM), named Sharing Lisboa, was developed in Lisbon, Portugal, supported by an application (APP), enabling the exchange of goods and services bringing citizens together to support a common cause: three schools competing during one academic year (2018/2019) to win a final prize with the engagement of school community and surrounding community. Sharing Lisboa aimed to promote behaviour change and the adoption of energy-saving behaviours such as cycling and walking with the support of local businesses. Participants earned points that reverted to the cause (school) they supported. A total of 1260 users was registered in the APP, collecting more than 850,000 points through approximately 17,000 transactions. This paper explores how the DSM has the potential to become a new city service promoting its sustainable development. Furthermore, it is crucial for this concept to reach economic viability through a business model that is both profitable and useful for the city, businesses and citizens, since investment will be required for infrastructure and management of such a market.

Keywords: energy efficiency; sustainable mobility; behaviours; sustainable community



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1. Introduction

Nowadays, cities are growing in size and population, leading to challenges related to demographics, climate change, energy consumption, transportation, among others, jeopardizing the resilience of urban systems and social wellbeing. The Lisbon Metropolitan area has seen a population increase of 5.7% from 2001 to 2017 [1]. Several solutions and city planning strategies have emerged to overturn these challenges and promote the sustainable development of cities, focusing on changing behaviour towards energy efficiency improvements, achieving the targets imposed by the 2030 climate and energy framework to decrease greenhouse gas emissions by at least 40% compared to 1990 levels; introduce a renewable energy share of at least 27%; and promote an improvement in energy efficiency of at least 27% [2].

Over the last years, the city of Lisbon promoted the implementation of several sustainable urban mobility and building energy efficiency services in order to reach the targets proposed. These services include: the introduction in 2017 of a bike-sharing service with electric bikes; the deployment of electric vehicles charging stations; adoption of alternative vehicle technologies by the municipal fleet with 39% of municipal fleet composed by electric vehicles, compared to a 36% increase in electric vehicle sales in Portugal from 2017 to 2018 [3]; introduction of smart meters for energy monitoring at a residential level;

installation of PVs, among others. As a result, Lisbon was ranked in the 14th position in a smart and sustainable ranking of 28 European capital cities [4].

With the growth of such solutions and services, the levels of digitalization and the amount of urban data have also been increasing, leaving city leaders and operators, including public and private organizations and companies, with the challenge of deciding how these data will be collected, stored used and shared [5]. The added value that the amount of data collected can be applied by different types of users (e.g., public entities, private companies, academics, citizens) and for several purposes (e.g., new software, new services, policy-making). Consequently, smart city planning must involve new stakeholder groups which will add complexity to the process and, therefore, a new type of governance in smart city planning is required. With the number of stakeholders involved, it is essential to: have clarity when outlining the plan and identify each stakeholder responsibility and role [6]; promoting a culture of data sharing and transparency, reflected on potential data products and services; and consider data ownership, governance and policy factors [7]. Cities and the lives of their citizens are, therefore, changing and evolving with impacts mainly related with governance, policies, culture and, consequently, start training and reskilling workers and test new technologies, enabling a complex process of digital transition [7,8].

Information and communication technologies (ICT) are an essential tool to enable the sustainable transformation of smart cities, presenting innovative approaches to address urban challenges [9]. However, ICT are frequently selected before understanding if they will address the underlying needs of citizens [10]. As such, smart cities' degrees of success vary significantly and their full potential is not reached due to a lack of citizens' involvement [11].

Consequently, the topic of citizen engagement in urban processes starts to be tackled, since it becomes of crucial importance to involve the citizens in this transformation process promoting the adoption of sustainable behaviours improving quality of life and leading to the transformation of urban contexts [12]. While the assessment of city approaches and their impact outcomes provide insights on smart city evaluation, they do not take into account the inputs from citizens even though they recognize their crucial role in the design of measures [13].

The growth of digitalization levels within cities has enabled the practice of democratic governance through e-participation. However, engagement in such activities is difficult to acquire since its effect are most of the time invisible to the participants or take a long time to appear. Participation through gamification has revealed increases in engagement, motivation, civic learning and enjoyment [14]. As such, gamification can be a crucial tool to adopt when designing services to promote behaviour change and the adoption of more sustainable behaviours, since it has the potential to interest and motivate the community to participate in city life [15]. Environmental sustainability is among the domains in which gamification has demonstrated positive impacts when applied to promote socially beneficial behaviours, applied to promote energy savings and sustainable buildings [16] and sustainable mobility [17]. Within the scope of the STREETLIFE EU project, the Rovereto Play&Go game aimed to assess the impact of gamification techniques and incentives on mobility behaviour with results indicating that the game had induced a change in the participants' mobility habits [17]. A game network involving schools in 19 European member states promoting sustainable mobility modes achieved a 15% shift in trips made by car to more sustainable modes such as walking and cycling, among others [18]. In Switzerland, the Bellidea smartphone APP deployed in the city of Bellinzona to promote sustainable mobility reached 600 users of which 180 used the APP functions on a daily basis [19]. The enCOMPASS project developed an APP to motivate behavioural changes combining team competition, virtual rewards and life simulation with the goal of achieving energy savings in households and public buildings. Preliminary results indicated energy consumption reductions between 10 to 12% in residential consumers [20]. The GAIA project [21] developed a platform installed in schools with the goal of increasing sustainability awareness and energy efficiency through gamification. With the participation of over 3000 students and 200 educators, energy savings between 15 and 20% were reached.

The ChArGED project [22] aimed to promote energy efficiency and reduction of wasted energy in public buildings through an APP that provided users with real-time recommendations and in-game challenges. Users self-reported an improvement of 9.61% of energy savings. Furthermore, users also were very satisfied with the game APP. A summary of these projects is presented in Table 1.

Table 1. Summary of projects on user engagement.

Project (Year)	Where	Type	Who	How	Results
Mobility					
STREETLIFE EU (2013–2016) [17]	Germany, Finland, Italy	Service-based gamification framework	Citizens	<ul style="list-style-type: none"> Incentivize voluntary behavioural changes towards sustainable mobility solutions 	<ul style="list-style-type: none"> Gamification incentivized players to use their private cars less Potential of gamification to promote sustainable urban mobility policies
Traffic Snake Game Network (TSG NETWORK) (2014–2017) [18]	19 European Member States	Game	Children (6–12) and parents	<ul style="list-style-type: none"> Shifting journeys undertaken by car to more sustainable modes such as walking, cycling, public transport, park and walk and car sharing 	<ul style="list-style-type: none"> 177,587 pupils in 1192 schools played the game. EU-wide savings in this period reached 2,458,853 kilometres of car trips and 397 tonnes of CO₂. Sustainable trips went from 63% before the campaign to 78% during the campaign.
Bellidea (2017–2018) [19]	Switzerland	APP	Citizens	<ul style="list-style-type: none"> Track users' routes and give feedback on how and how much they move Provide points, depending on how users move and which means of transport they use. Points can be redeemed for real-life prizes 	<ul style="list-style-type: none"> 600 citizens registered on the app Around 180 of them regularly used it for at least 6 weeks each.

Table 1. Cont.

Project (Year)	Where	Type	Who	How	Results
Energy efficiency in buildings					
Charged (2016–2019) [22]	Luxembourg, Spain, Greece	APP	Public buildings	<ul style="list-style-type: none"> Personalized real-time recommendations to each individual end-user 12 different in-game challenges were designed, all linked to different user actions that reduce or time-shift energy consumption 	<ul style="list-style-type: none"> Users self-reported 2.44% improvement for turning their PC off after work and 3.46% improvement for turning off the lights after work. Self-reported energy-saving behaviour at work improved by 9.61%. The intention to save energy improved by 2.82% Users ChArGED game app satisfaction was 5.68/7 and 4.69/7 enjoyment in both pilot sites
ENCOMPASS (2016–2019) [20]	Germany, Greece, Switzerland	APP	Residential, Public building, School	<ul style="list-style-type: none"> Motivate behavioural changes combining team competition, virtual rewards and life simulation 	<ul style="list-style-type: none"> First results: 10 to 12% consumption reduction for the residential consumers
FEEdBACk (2017–2021) [23]	Portugal, Spain, Germany, Holland, Switzerland and Denmark.	APP	Public, services, residential buildings	<ul style="list-style-type: none"> Informative videos and episodes on lighting, heating or appliances Surveys on day-to-day decision-making regarding energy-efficient behaviours 	<ul style="list-style-type: none"> Ongoing

Table 1. Cont.

Project (Year)	Where	Type	Who	How	Results
Sustainability awareness					
GAIA (2016–2019) [21]	Greece, Italy, Sweden	Platform	Schools	<ul style="list-style-type: none"> Real-time data from sensors in the buildings and participatory sensing help to visualise the real-life impact of students' behaviour and enable competitive gamification 	<ul style="list-style-type: none"> Over 3000 students and 200 educators participated 75% of the students responded that GAIA had a positive influence on them Energy savings between 15–20% were obtained in several schools.

Given the importance of user engagement on the successful deployment of several ICT towards improving cities sustainability and environmental impacts, it is, therefore, crucial to evaluate the role of behavior and culture in their success but also to take a bottom-up approach [24] by engaging citizens in the decision making and tasks design. However, changing their behaviors can be a slow process and technology can play an important role in developing new urban services that generate high-impact behavior change. Changing behavior can be achieved through learning; however, it is essential to provide people with the necessary tools to enable the practice of new strategies until these become definitive [25]. Positive feedback and reinforcement are probably the most powerful educational elements in driving behavior change. When people have access to the results of their actions, it has been shown that they are more likely to change their behavior over time [26].

This work explores the concept that citizens must be engaged by being part of the decision-making process, through an integrated approach where they participate in co-design sessions of innovative solutions, shared learning initiatives and, consequently, become generators of data and information that can be applied for the development of new policies and new technologies. Including people in the design process, planning and management of these solutions has been shown to improve acceptability and increase their use [13].

2. Sharing Cities Program

The H2020 Sharing Cities lighthouse program [27] aims to achieve wide-scale deployment of smart cities solutions, shifting the thinking to decarbonized and local renewables and making the active engagement of citizens a reality, demonstrating and assessing how the innovative use of technologies and new products can improve city life and the lives of its inhabitants, creating safer, cleaner, smarter and more social cities. Sharing Cities aims to adopt a more agile and collaborative smart cities market, improving the speed and scale at which new solutions and services are implemented. Sharing Cities has three demonstration districts in Lisbon, London and Milan in which replicable urban digital solutions and collaborative models have been deployed such as building retrofit, the introduction of shared electric mobility services, implementation of energy management systems, city sensors and smart lamp posts and an urban sharing platform through engaging with citizens. "Fellow" cities Bordeaux, Burgas and Warsaw will co-develop, validate, or implement the above solutions. The Lisbon partners include the Lisbon Municipality, Lisboa E-Nova, Universidade de Lisboa—Instituto Superior Técnico, EDP-D, EMEL, Reabilita, CEiiA and Altice Labs.

As previously mentioned, Sharing Cities aims at improving urban mobility, energy efficiency in buildings and carbon emissions by successfully engaging citizens in the transformation of their living context and fostering local-level innovation. As such, one of the actions promoted within the program was to develop a shared service model, enabling the creation of new urban services and incentivizing behaviour change by valuing and rewarding positive behaviours and choices related to energy efficiency, mobility, building retrofit, combining physical and digital environments—Digital Social Market (DSM). This innovative approach benefits citizens and brings communities together, fostering closer relationships among all members: citizens, retailers, community.

3. Digital Social Market—Sharing Lisboa

The DSM was named Sharing Lisboa. It was developed taking into account the local context and urban challenges identified by citizens, placing their needs and perceptions first. It works as an exchange of goods and services, encouraging citizen engagement through the creation and availability of new services and business models potentially leading to meaningful behaviour change incorporating smart city initiatives. Sharing Lisboa is supported by a mobile application allowing the digital and physical interactions between users, services and service providers. The concept of DSM was developed in several steps in a co-creation environment which enabled developing its different components, leading to a set of services that aim to strengthen the relationship between citizen and city. Within the DSM, the citizen can voluntarily engage in the marketplace taking advantage of its services and making choices based on common causes, incentives and/or reward mechanisms (Figure 1).

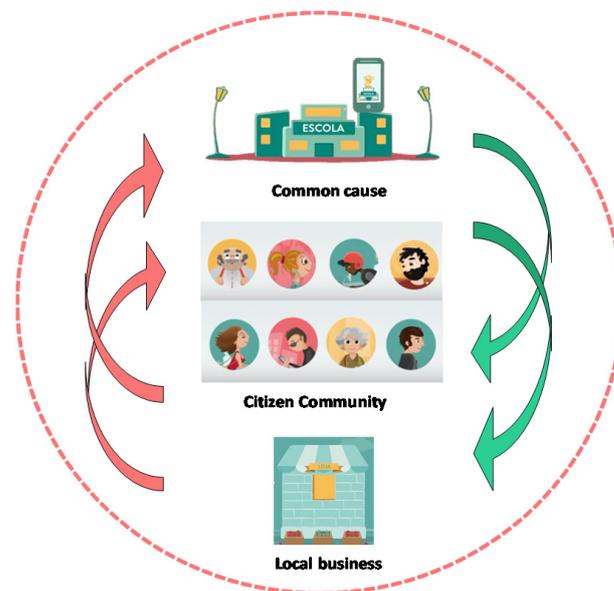


Figure 1. Digital Social Market structure.

DSM Development

Sharing Lisboa was developed with the guidance of Sharing Cities partner Future Cities Catapult and with the participation of Lisbon partners, over the course of two years, based in several stages considering a user research framework and design workshops involving city representatives, program partners and citizens. The User Research approach applies several methods based on observation, task analysis, among others [11], allowing to assess citizen's perceptions on the project's measures and if they respond adequately to their needs. These different stages included:

Step 1—Citizens needs identification

Step 2—Identification of features and motivations for engagement in the service

- Step 3—Co-creation sessions for DSM development
- Step 4—Final DSM concept and operational features definition and implementation process
- Step 5—Sharing Lisbon mobile application development
- Step 6—Sharing Lisboa Pilot Launch
- Step 7—Sharing Lisboa assessment
- Step 1. Citizens' needs identification

In this stage, an initial questionnaire was used to recruit citizens to participate in the development of the concept. The selection of participants took into account a profile matrix that considered the type of transport used (private car, public, active and multimodal), energy awareness (high, medium and low), community involvement (high, medium and low) and digital use (super, high, medium, low). Both extreme and representative profiles were recruited. Of the 33 questionnaire survey responses, 11 participants (5 female and 6 male) were selected. Following this selection, the citizens were invited to volunteer in the construction of a Diary Study. This enabled the 11 participants to share in a blog their everyday behaviours, preferences and perspectives through the submission of photos, quotes, etc., related to four themes: daily routines, transportation, energy consumption and community life. An example of one blog entry is presented in Figure 2.



Figure 2. Example of diary study entry.

Step 2. Identification of features and motivations for engagement in the service

After the Diary Study period, 10 of the participants were then invited to participate in individual in-context interviews, to deepen and clarify their diary study contributions and to gain further knowledge on their routines, patterns, ideas, and willingness to accept future smart solutions implemented in the city and how they would respond to different incentives promoting the adoption of those solutions. Eight additional participants were recruited for the interviews covering missing profiles. A total of 18 interviews were conducted (11 female and 7 male) with an average duration of approximately 2 hours. The results allowed the creation of citizen profiles and categorization of data in several themes (as presented in Figure 3).

The next step was to promote meetings with city representatives and workshops with project partners in order to align the findings previously identified with the strategic priorities of the city of Lisbon and how to best build the DSM as a tool to achieve them. Besides city representatives and project partners, several stakeholders from the mobility and energy areas were also invited to participate. The final Lisbon goals identified can be seen in Figure 4.

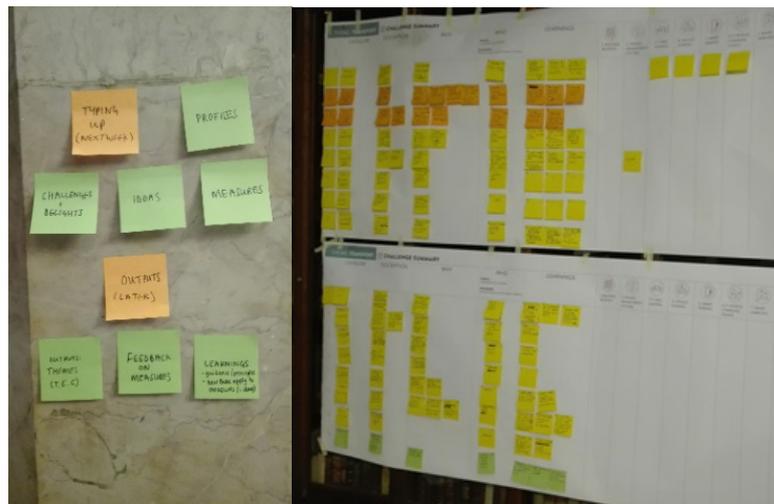


Figure 3. Organization of main findings from diary studies and interviews.

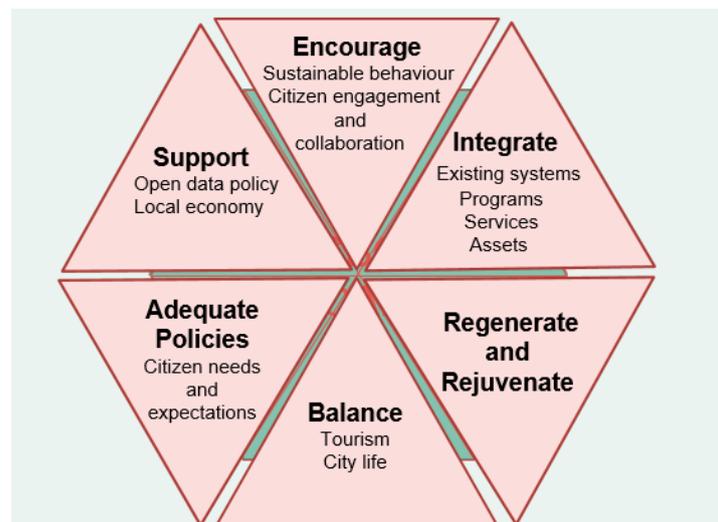


Figure 4. Identification of Lisbon goals.

Step 3. Co-creation sessions for DSM development

This stage contemplated workshops with Sharing Cities partners, in which the design and functioning of the DSM, and how it could be adapted to the Lisbon reality and available resources, were discussed. The main outputs of this workshop led to the first design of the DSM concept and user journey adapted to the Lisbon concept and how it could potentially work in the city.

With an initial DSM design and user journey created, the following activity required, once more, the participation of citizens in order to assess their willingness to adopt and use such a service, their perceptions towards the concept, challenges and expectations regarding DSM implementation in the city of Lisbon. For this, a total of three focus group sessions were conducted with a total of 14 citizens. Each session took between one and a half hours to two hours. Participants were recruited bearing in mind that they should reflect the demographics of the demonstration area (e.g., gender, age, employment status, etc.) but divided into heterogeneous groups to ensure a good mix of ideas and perspectives. Based on the information collected, it was possible to organize it into several categories: Dissemination and acceptance of DSM; DSM characteristics; Benefits for participants; and Common causes. Overall, the citizens had a positive acceptance of the DSM; however, it stood out that it was essential to show citizens its usefulness and the educational process

to promote behaviour change and decision-making towards sustainability. A transversal theme that was raised in the focus groups was the citizens' desire to contribute to a cause through such a system and that schools could be the place to start implementing these types of services.

Step 4. Final DSM concept and operational features definition and implementation process

The steps following the Focus Group sessions were to, among the partners, develop the final concept, design and outline the implementation process. Within this stage, all the elements of the DSM were refined such as: main end-users, how to build and engage the community, how to incentive participation and promote behaviour change.

The final concept of Sharing Lisboa is translated into a platform that works as an exchange of goods and services, which will bring citizens together to support a common cause. Based on previous sessions conducted with citizens, a common cause was selected for which citizens could contribute through their participation and engagement. The common cause identified was the educational context with the participation of three schools that competed for the course of one academic year (2018/2019) to win a final prize of EUR 20,000 to spend on energy-efficient measures to improve the school, the other two schools would win a participation prize of EUR 5000 each. Even though the DSM was mainly promoted in the competing schools, not only the school community was involved in it, but also the surrounding community, citizens and local business shops were incentivized to participate.

Three schools were selected taking into account Sharing cities demonstrating area (downtown Lisbon), schools that had no recent building improvements, students ages (8th grade was considered as a target group due to energy efficiency and sustainability concepts being part of the curriculum) and schools located in three different parishes. As such the schools selected were: Escola Nuno Gonçalves, Penha de França; Escola Engenheiro Duarte Pacheco EB2+3, Olaias; and Escola Manuel da Maia, Campo de Ourique. Considering the three schools, a population of approximately 4500 students and 130,000 people from the three neighborhoods could be reached to participate in Sharing Lisboa. The selection of the schools took into consideration several aspects. The first one was that the schools were included in the demonstration area of the project, but in different parishes. Additionally, another aspect to take into consideration was to select schools that did not have any retrofit improvements that could improve the energy consumption of the school and, therefore, not allow a fair comparison of the schools' results. Elementary schools were excluded mainly due to the fact that, since DSM would mainly work through an APP, students would be required to use a smartphone to participate, and the team considered that students under the age of 10 do not own smartphones so the participation through the APP would only be targeted to adults, excluding the children. So the team then considered that secondary schools were the best group of students, aged between 10 and 15 years, to promote the DSM, particularly students from the 8th grade (13–14 years old) whose educational curriculum starts to address themes such as climate change, energy efficiency, etc."

Sharing Lisboa aimed to create a sustainable community, promoting behaviour change and the adoption of more sustainable and efficient behaviours, such as: energy-saving behaviours, cycling, walking. Through the adoption of these behaviours, participants earn points that reverted to the cause (school) they supported. Participants could earn points from: walking; cycling; reducing energy consumption; charging an EV; checking-in at local shops; and filling thematic quizzes. Schools earned points by reducing energy consumption. Even though the points won by the participants reverted to the school they supported, after every 200 points won the participants would win a bonus. The bonus to the participants included discounts in the local business network that participated in the DSM. Participants received a voucher through the APP that they could redeem for a discount in one of the shops. They could choose in which shop to use the voucher.

Figure 5 presents the calculations considered for points attribution for each of the behaviours and services from which participants could benefit from.

Sustainable Behaviours	App Welcome	Energy Consumption	Biking	Walking	EV Charging	Quizz	Shops
Schools		Winning school: % Savings/ N° Students => + 10% points Each school: If 1% Saving => 5 points					
Citizens	10 points	10 points / 1% Saving	10 points / km (min 300m)	10 points / km (min 300m)	(12kwh =>100km) 10 points / 2km => 0,24 kwh	50 points + 5 points / answer Mini quiz 5 points/ answer	10 points / check-in

Figure 5. Sharing Lisboa rewards attribution.

Since the DSM was implemented in schools, in which several activities and awareness campaigns were promoted among students, teachers, workers and parents, there was a DSM agent totally dedicated to Sharing Lisboa during the development and implementation stages in order to motivate and engage participants. The Sharing Lisboa agent was responsible for promoting and organising meetings with schools' communities to launch the Sharing Lisboa pilot. A video presenting Sharing Lisboa and explaining how it worked was also made and showed in the schools to motivate participation. Furthermore, several Sharing Lisboa merchandise was produced, such as pencils, umbrellas, headphones, among other to offer the students, teachers and school staff to promote the DSM. Additionally, the agent not only developed activities and regular sessions focused on sustainability, energy efficiency and mobility; but was also periodically present in the three schools with the aim of supporting the community by assessing their perceptions towards the Sharing Lisboa, challenges with APP usage, new ideas proposals, changes needed, etc.

Furthermore, some activities were promoted within the APP throughout the year, like gaining double the points on a specific activity in a specific period (e.g., one week). Regarding users from outside the school community, such as the people living in the neighbourhood and local business stores, the video was used to promote the DSM and leaflets were distributed within the three neighbourhoods.

Furthermore, community interaction activities also took place, aiming for the creation of a local shops network with which the school and neighbourhood communities could interact. Participants were also motivated to propose the inclusion of new businesses.

Regarding users from outside the school community, such as the people living in the neighbourhood and local business stores, the video was used to promote the DSM and leaflets were distributed within the three neighbourhoods.

Step 5. Sharing Lisbon mobile application development

The Sharing Lisboa APP was also developed in the context of co-design using a design-thinking methodology. Within the Lisbon' consortium, tacking in account all the feedbacks obtained by the involved community, AlticeLabs lead several sessions to collect all the uses cases and define the contents of the app. Beta-tester provided continuous feedback on the APP and its content and Lisbon team met regularly with the technical team to further discuss the app and suggest changes and improvements. Figure 6 presents how the Sharing Lisboa APP worked. An Android version of the APP was the first to be developed and was launched in November 2018. The IOS version was launched in the first trimester of 2019.

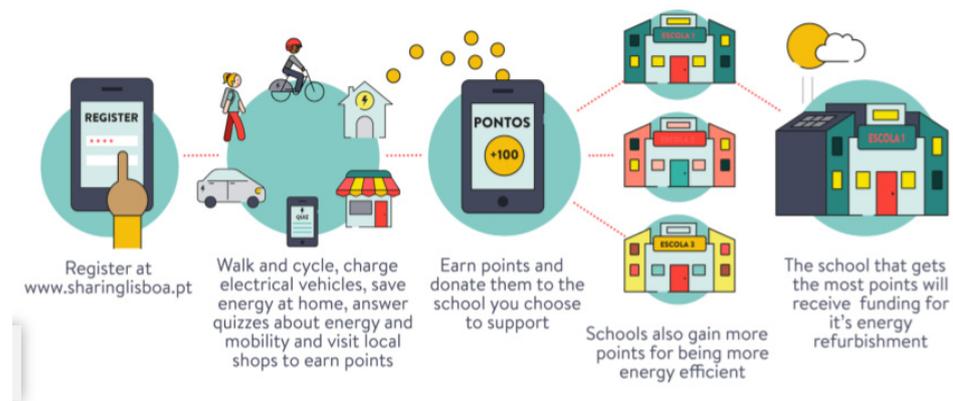


Figure 6. Sharing Lisboa: how does it work?

The Sharing Lisboa APP was composed of several components, that were developed with the team following the aims of Sharing Lisboa and the concept developed is presented in Figure 7:

- Integration with external accounts to monitor behaviours (Google Fit, Strava, EDP Distribuição, CEiiA);
- Participants history page to check progress, points and contributions;
- Common causes page to check schools progress, points and contributions; and
- Thematic quizzes (sustainable mobility and energy efficiency), used to educate and motivate participants to earn more points.

Step 6. Sharing Lisboa Pilot Launch

The Lisbon Digital Social Market—Sharing Lisboa pilot was launched in November 2018 working for a period of 6 months. During the duration of the Pilot, data were collected through monitoring of the Sharing Lisboa APP.

Step 7. Sharing Lisboa assessment

Data were collected on several indicators such as: number of new registrations, number of total transactions, points obtained, number of specific transactions (e.g., walking, quizzes, etc.), number of kilometers travelled through walking and cycling, number of check-ins performed and number of bonuses claimed. Due to data privacy constraints, it was not possible to collect information on the type of user (e.g., student, teacher, staff, parent, other), gender and age.

In order to assess the impacts of Sharing Lisboa on user behaviour, two questionnaires were conducted. One of the questionnaires aimed to assess energy and mobility patterns and changes in behaviour due to Sharing Lisboa. The second questionnaire was conducted to assess users Sharing Lisboa APP usage patterns (e.g., how many times per day they accessed the APP, average time per usage, etc.). Of the 1260 users, the return of both questionnaires was 3.17% (40 answers) for the former and 1.03% (13 answers) for the latter. Due to privacy issues, it is not possible to connect the answers with the user profile from the Sharing Lisboa APP, which would provide us with more information regarding APP usage patterns.

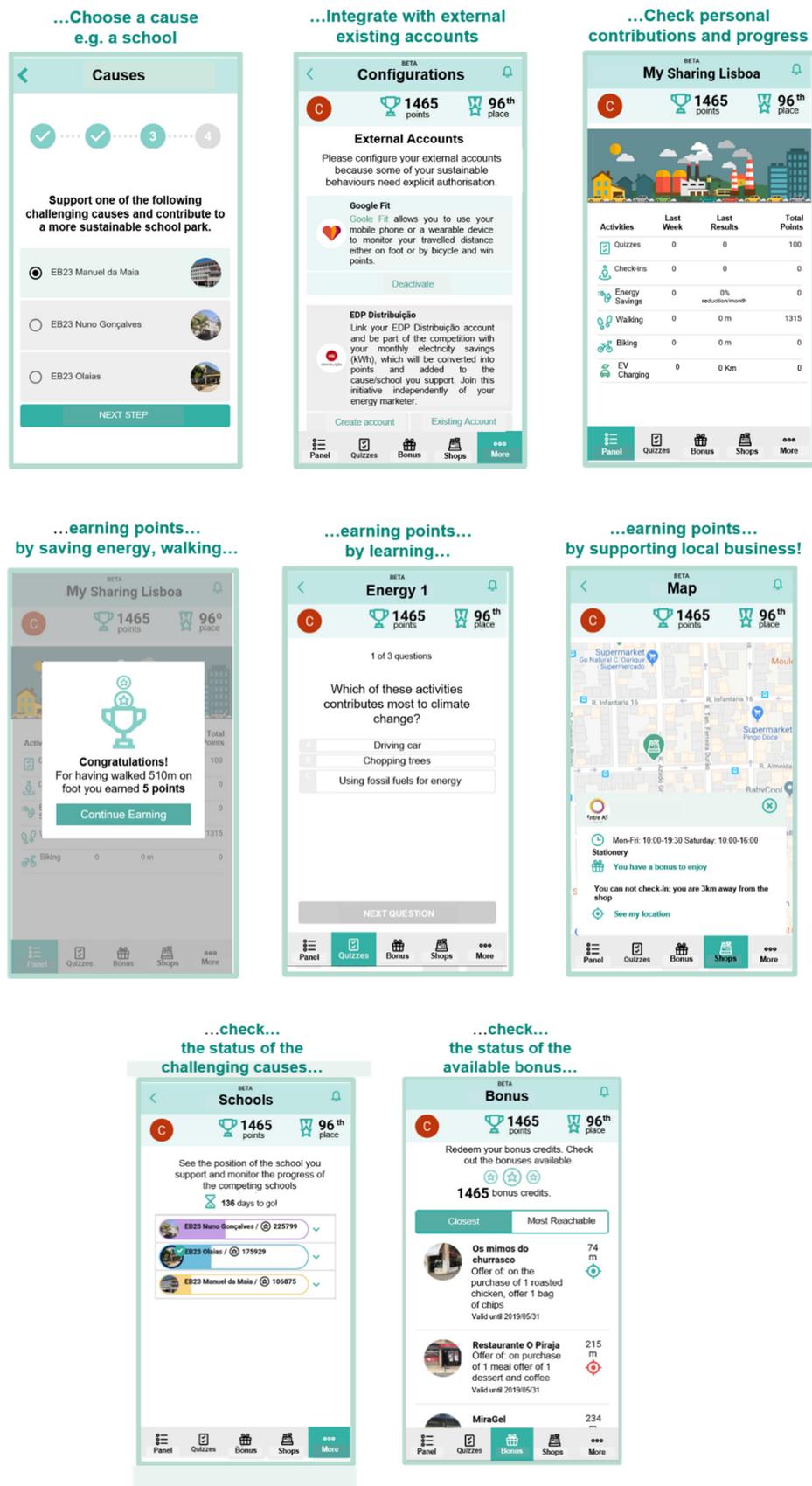


Figure 7. Sharing Lisboa APP screens.

4. Sharing Lisboa Results

Over the 6 months during which Sharing Lisboa operated, a total of 1260 users registered in the Sharing Lisboa APP, collecting more than 850,000 points through a total of approximately 17,000 transactions done in the APP, can be seen in Table 2. Among these transactions, it is possible to ascertain that the higher number of transactions was collected through filling the thematic quizzes, with approximately 7500 transactions, followed by check-in at local shops, walking and cycling. Regarding walking and cycling distance, more than 16 000 km were travelled within the Sharing Lisboa community. A total of 258 bonus were claimed in the local shops network over the 6 months.

Table 2. Sharing Lisboa indicators.

Schools	Sharing Lisboa								
	Users	Points	Transactions	Walking Transaction	Cycling Transaction	Quizz Transaction	Check-in	Walking Distance	Cycling Distance
Nuno Gonçalves	632	487,599	11,999	2486	99	4490	4292	10,468	584
Olaias	372	238,642	3010	674	25	1848	91	2916	70
Manuel da Maia	256	141,495	2209	606	37	1121	445	1888	136
Total	1260	867,736	17,218	3766	161	7459	4828	15,272	790

Regarding evolution over time and differences between schools, it is possible to see from the following figures (Figures 8–10) that the number of participants, transactions and points increased through the 6 months implementation period in a consistent way, with an average of 119% increase per month. Additionally, Nuno Gonçalves School always presented higher numbers than the two other schools.

Similar patterns were observed for the different transactions: quizzes, check-in, walking and cycling, as presented in Figures 11–14.

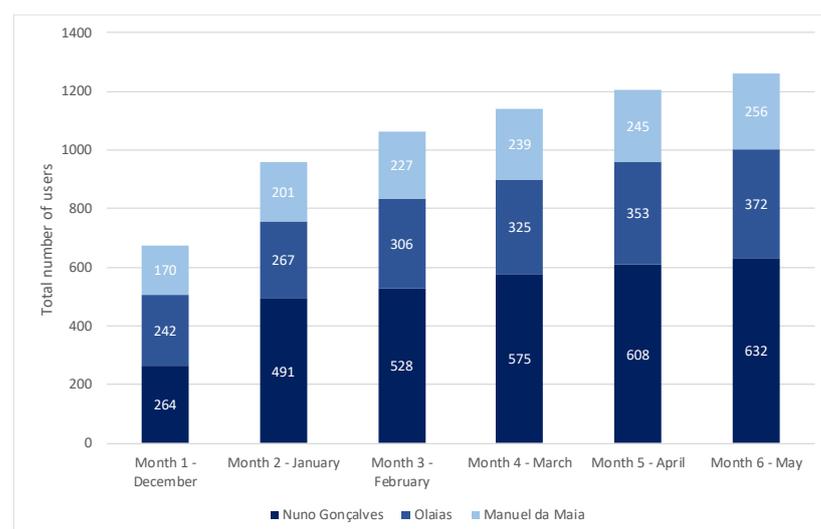


Figure 8. Evolution of total number of users per school and over time.

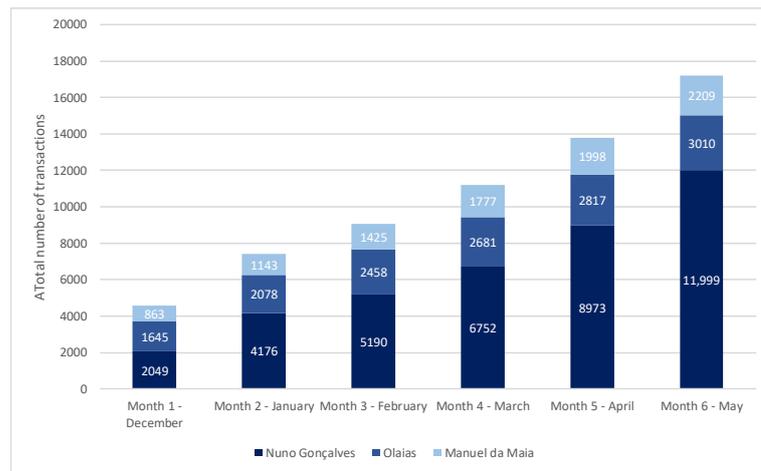


Figure 9. Evolution of total number of transactions per school and over time.

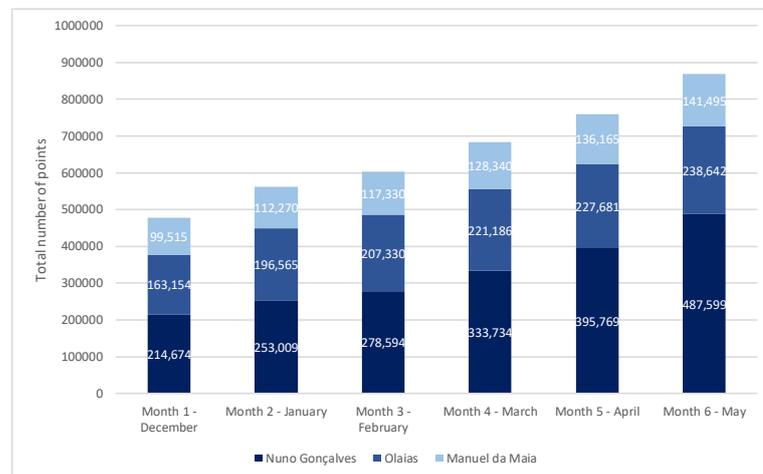


Figure 10. Evolution of total number of points per school and over time.

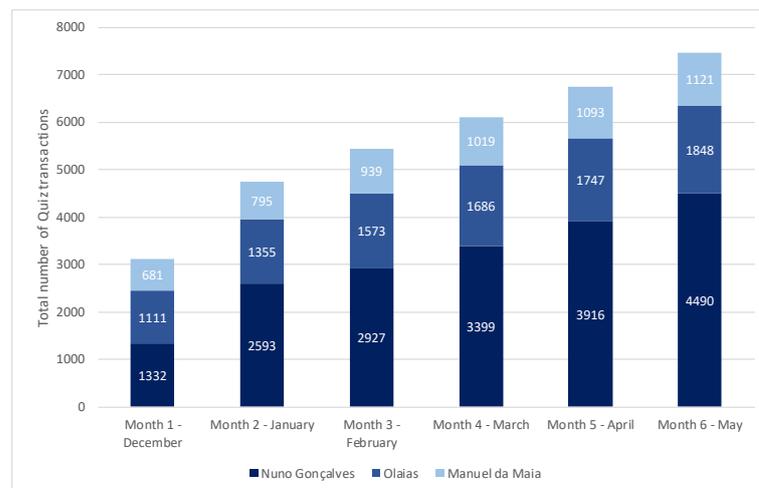


Figure 11. Evolution of total number of quiz transactions per school and over time.

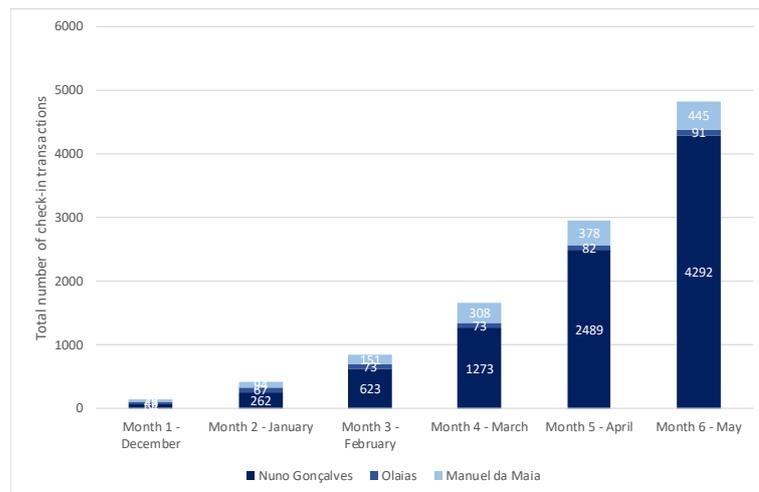


Figure 12. Evolution of total number of check-in transactions per school and over time.

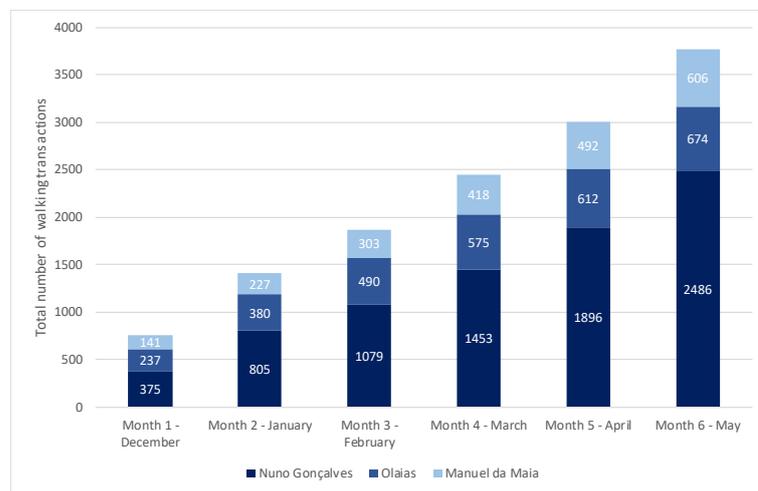


Figure 13. Evolution of total number of walking transactions per school and over time.

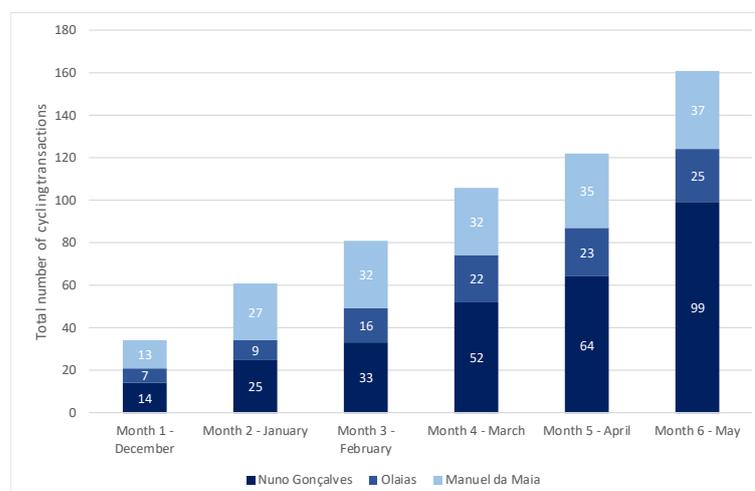


Figure 14. Evolution of total number of cycling transactions per school and over time.

Figures 15 and 16 present the evolution of the kilometers travelled walking and cycling, with data revealing an increase in kilometers over the last months of the pilot

implementation, particularly in what concerns cycling, which might be explained due to improvement in weather conditions.

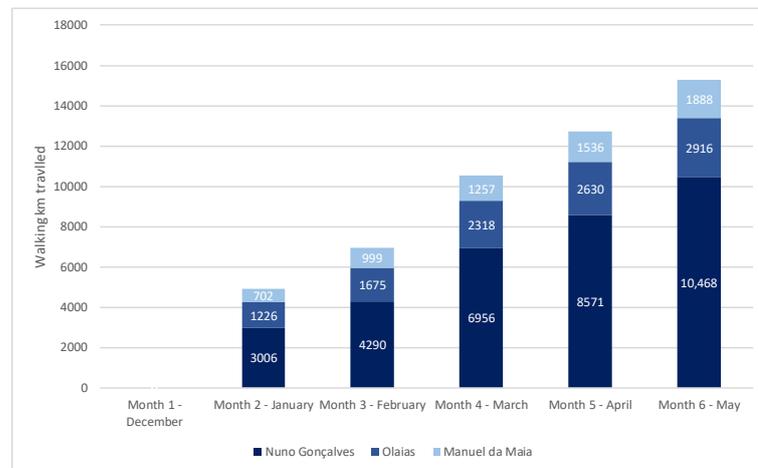


Figure 15. Evolution of total number of km travelled walking per school and over time.

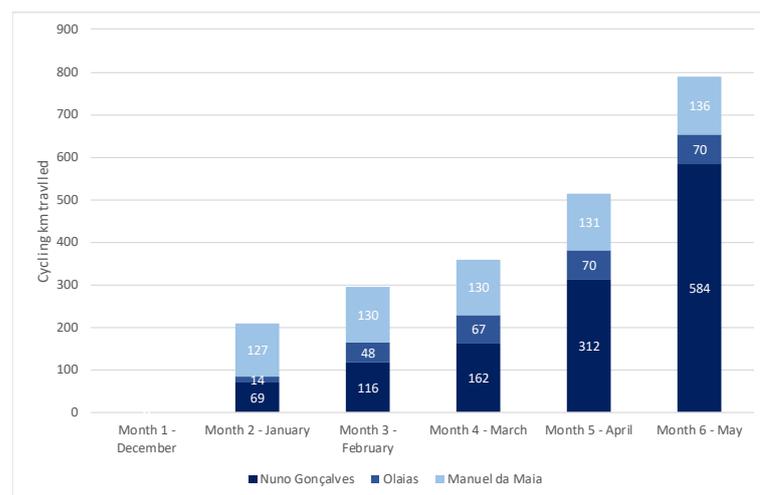


Figure 16. Evolution of total number of km travelled cycling per school and over time.

5. Impacts on User Behaviour and Sharing Lisboa Usage Patterns

5.1. Impacts on User Behaviour

As previously mentioned, 40 answers were obtained from the questionnaire to assess energy and mobility patterns and changes in behaviour due to Sharing Lisboa. A majority, 45%, of the respondents were school staff (teachers and staff), followed by parents (23%), neighbourhood residents (15%). Regarding students, only three students filled the questionnaire. Regarding age, 58% of the respondents are between 36 and 55 years, with 8% being younger than 18 years representing the students. Furthermore, 65% of the respondents were female and 35% male.

When questioned about their concern regarding their energy consumption at home, the majority of the respondents revealed they are extremely concerned, as can be seen in Table 3. While 97% of the respondents indicated they knew how much they spent in Euros per month on energy, only 57% indicated they knew what that represented in kWh.

Table 3. Level of concern with energy consumption at home according to type of use.

Level of Concern Regarding Energy Consumption at Home	Parents		School Staff		Neighb. Resident		Other		Total	
1 (not concerned)	0	0%	0	0%	0	0%	0	0%	0	0%
2	0	0%	0	0%	0	0%	0	0%	0	0%
3	1	11%	0	0%	0	0%	0	0%	1	3%
4	4	44%	4	22%	3	50%	3	50%	14	38%
5 (extremely concerned)	4	44%	14	78%	3	50%	1	17%	22	59%
Total	9	100%	18	100%	6	100%	4	67%	37	100%

All students indicated they considered that saving energy is important, while 70% of the respondents indicated that they consider it is extremely important to save energy, particularly school staff, as can be seen in Table 4. The main reason for this is related to: contributing to a more sustainable environment (29%) and saving the planet resources (27%), followed by reducing bills and decreasing CO₂ emissions, as can be seen in Table 5.

Table 4. Importance level attributed to saving energy according to type of user.

Importance Level Attributed to Energy Saving	Parents		School Staff		Neighb. Resident		Other		Total	
Not important	0	0%	0	0%	0	0%	0	0%	0	0%
Low importance	0	0%	0	0%	0	0%	0	0%	0	0%
Important	1	13%	0	0%	0	0%	0	0%	1	3%
Very important	3	38%	4	22%	2	33%	1	25%	10	27%
Extremely important	5	63%	14	78%	4	67%	3	75%	26	70%
Total	8	100%	18	100%	6	100%	4	100%	37	100%

Table 5. Reasons for saving energy according to type of user.

Why do Think It Is Important to Save Energy	Parents		School Staff		Neighb. Resident		Other		Total	
Contribute to a more sustainable environment	9	30%	14	26%	6	32%	4	33%	33	29%
Save planet resources	7	23%	17	31%	4	21%	4	33%	32	28%
Reduce bills (EUR/year)	7	23%	13	24%	5	26%	2	17%	27	23%
Decrease CO ₂ emissions	7	23%	10	19%	4	21%	2	17%	23	20%
Total	30	100%	54	100%	19	100%	12	100%	115	100%

Students revealed they already had knowledge on most energy-saving behaviours presented to them, with the exception of changing light bulbs for more efficient ones, choosing new appliances according to energy efficiency evaluation and using eco-programs with washing machine and dishwasher (Table 6).

As for the main transport mode used daily, walking is the main mobility option used by 53%, followed by private car (18%), as can be seen in Table 7. The main motives to use main transport mode is because it is easy (81%), it is good for the health (57%) and it is good for the environment (54%), as can be seen in Table 8.

Table 6. Students' knowledge of energy-saving behaviours.

Student's Knowledge of Energy-Saving Behaviours	I Know		I Do Not Know	
	Count	Percentage	Count	Percentage
Turn off the lights when leaving a room	3	100%	0	0%
Only use the washing machine/dishwasher when in full capacity	3	100%	0	0%
Change old lamp bulbs for more efficient ones (e.g., LED)	2	67%	1	33%
Always turn off electronic devices (e.g., tv) from the plug	3	100%	0	0%
Always turn off appliances (e.g., dishwasher) from the plug	3	100%	0	0%
Always choose new appliances in accordance with energetic evaluation	2	67%	1	33%
Do not leave the phone charger plugged	3	100%	0	0%
Change a non-efficient appliance, device or equipment with a more efficient one	3	100%	0	0%
Only use eco programs to wash clothes and dishes	2	67%	1	33%

Table 7. Main transport mode used according to type of user.

Main Transport Mode	Students		Parents		School Staff		Neighb. Resident		Other		Total	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
Walking	1	33%	4	44%	11	61%	4	67%	1	25%	21	53%
Bus	1	33%	0	0%	0	0%	1	17%	0	0%	2	5%
Bike	0	0%	2	22%	0	0%	0	0%	0	0%	2	5%
Car	1	33%	1	11%	4	22%	0	0%	1	25%	7	18%
Subway	0	0%	1	11%	0	0%	0	0%	1	25%	2	5%
Motorcycle	0	0%	1	11%	0	0%	0	0%	0	0%	1	3%
Train	0	0%	0	0%	3	17%	0	0%	0	0%	3	8%
Other	0	0%	0	0%	0	0%	1	17%	1	25%	2	5%
Total	3	100%	9	100%	18	100%	6	100%	4	100%	40	100%

Table 8. Main reasons for using main transportation mode according to type of user.

Why Do You Use This Mode of Transportation	Parents		School Staff		Neighb. Resident		Other		Total	
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
It is good for my health	4	44%	10	56%	4	67%	3	75%	21	57%
It is good for the environment	6	67%	9	50%	3	50%	2	50%	20	54%
It is easy to move this way	6	67%	16	89%	5	83%	3	75%	30	81%
I like to use this transportation mode	6	67%	4	22%	3	50%	0	0%	13	35%
It is the cheapest	3	33%	8	44%	2	33%	2	50%	15	41%
I have free parking	1	11%	0	0%	0	0%	0	0%	1	3%
It is the fastest	1	11%	4	22%	3	50%	2	50%	10	27%
It is the more flexible one	2	22%	1	6%	1	17%	0	0%	4	11%
It is the one that best fits the family routine	2	22%	2	11%	1	17%	0	0%	5	14%
The other transportation modes are not accessible	0	0%	1	6%	0	0%	1	25%	2	5%
Other: to be able to be on time	1	11%	0	0%	0	0%	0	0%	1	3%
Other: I would like to use train but it does not offer a quality service	0	0%	0	0%	0	0%	1	25%	1	3%
Total of respondents	9	-	18	-	6	-	4	-	37	-

Since using Sharing Lisboa APP, all students mentioned they started practicing behaviours to save energy. The same pattern is observed by parents (78%) and by school staff, both at home and school (72%). Half of those living in the neighbourhood revealed they did change their behaviours (Table 9). All students indicate they started plugging off electronic devices and two students indicated they no longer left the phone charger plugged, as can be seen in Table A1. Regarding school staff, both at home and school, 72% turn off the lights when leaving the room and 17% no longer leave their phone charger plugged in. Parents mentioned they changed a non-efficient device or appliance with a more efficient one (85%), they started using eco programs and unplugging the phone charger (71%), as seen in Table A1.

Table 9. Adoption of energy-saving behaviours after using Sharing Lisboa APP by type of user.

Since You Started Using Sharing Lisboa Have You Started Practicing Any Behaviour to Save Energy	Students		School Staff				Parents		Neighb. Resident		Other			
	At Home		At Home		At School		Home and School							
No	0	0%	3	17%	1	6%	1	6%	1	11%	3	50%	1	25%
I do not know	0	0%	0	0%	0	0%	0	0%	1	11%	0	0%	1	25%
Yes	3	100%	0	0%	0	0%	13	72%	7	78%	3	50%	2	50%
Total of respondentes	3	-	18	-	18	-	18	-	9	-	6	-	4	-

Using the Sharing Lisboa APP also led to some changes in the use of transport modes. For students, even though the use of most transport modes remained the same, one student indicated that the bus was more used, and that private car was used less. Regarding parents, these indicated that they started walking more (78%) and have decreased the use of the private car (56%) and bus (22%), as can be seen in Table 10. Of the school staff, 67% indicated they used the car less and 39% indicated they used more public transportation (subway—39% and bus—22%). Neighborhood residents revealed they started walking more after starting to use the Sharing Lisboa APP (Table 10). When questioned about the reasons for changing behaviours (Table A2), users mentioned that they did so because they learned the importance of using energy in a more efficient way (73%), of using less pollutant transport modes (55%) and helping the school they supported (48%). Of them, 30% mention they changed behaviours to gain more points, while 13% did not change behaviours.

5.2. Sharing Lisboa Usage Patterns

As previously mentioned, the questionnaire related to the usage patterns of the Sharing Lisboa APP was answered by 13 users. While the number of responses is not representative, they can be indicative of some aspects of the APP usage, mainly related to access to the APP frequency and duration, which pages were visited, etc. No students filled the questionnaire and 38% were school staff. Furthermore, 62% were older than 46 years old, and 38% were aged between 26 and 45 years old and 54% were female.

The respondents knew about Sharing Lisboa through friends/colleagues (38%), as seen in Table 11, and school activities were also the main modes of contact with Sharing Lisboa, either through the publicising panels (31%) or through sessions conducted at the school (23%). Helping the school win a reward was the main motive indicated to register in Sharing Lisboa, followed by the interest in learning about sustainable behaviours (37%), as seen in Table 12. Furthermore, the majority of users reported they found it extremely easy to register in the APP (Table 13).

Table 10. Transportation mode usage patterns after using Sharing Lisboa APP by type of user.

After Using Sharing Lisboa Did the Use of Transportation Mode Change		Car	Bus	Subway	Bike	Walking	Scooter
Students	Same	2	2	3	3	3	2
		67%	67%	100%	100%	100%	67%
	Less	1	0	0	0	0	0
		33%	0%	0%	0%	0%	0%
	More	0	1	0	0	0	0
		0%	33%	0%	0%	0%	0%
Parents	Same	4	7	9	8	2	7
		44%	78%	100%	89%	22%	78%
	Less	5	2	0	0	0	1
		56%	22%	0%	0%	0%	11%
	More	0	0	0	1	7	1
		0%	0%	0%	11%	78%	11%
School staff	Same	6	11	8	11	18	12
		33%	61%	44%	61%	100%	67%
	Less	12	3	3	3	0	6
		67%	17%	17%	17%	0%	33%
	More	0	4	7	4	0	0
		0%	22%	39%	22%	0%	0%
Neighb. resident	Same	6	6	6	4	2	4
		100%	100%	100%	67%	33%	67%
	Less	0	0	0	2	0	2
		0%	0%	0%	33%	0%	33%
	More	0	0	0	0	4	0
		0%	0%	0%	0%	67%	0%
Other	Same	3	4	3	2	1	2
		75%	100%	75%	50%	25%	50%
	Less	1	0	0	1	0	2
		25%	0%	0%	25%	0%	50%
	More	0	0	1	1	3	0
		0%	0%	25%	25%	75%	0%

In what concerned frequency of use, 38% of the users indicate they accessed the APP at least once a day and 23% used it more than once a day, as shown in Table 14. Each visit to the APP revealed to be of a short duration, lasting less than 5 min for 54% of the users or between 5–10 min for 46% of the users (Table 15).

The most visited page of the Sharing Lisboa APP was the school progress page (85%), in which the points obtained by each school were revealed, probably not only because most of the respondents were school staff but also because one of the main reasons to use Sharing Lisboa mentioned was to help the school (see Table A3). Individual progress pages and summary pages were also visited by a majority of the participants (69%). Nonetheless, the only page all of the respondents visited was the Quizzes page, in which users could gain points by filling quizzes, as seen in Table A3. Regarding the Bonus and local shops, around half of the respondents did not visit the page.

Regarding the level of satisfaction towards the pages visited, respondents were satisfied with the pages they mostly visited (Table 16), like Quizzes (85%) and schools progress (69%). However, respondents also revealed to be indifferent to some of the pages visited, such as the Individual progress page (46%) and the Summary page (54%), which might be indicative that the exclusive interest in using the APP was, once again, related with contributing to the school and not individual interests.

Table 11. Knowledge of Sharing Lisboa.

Knowledge of Sharing Lisboa		
Friends/colleagues	5	38%
Panels at school	4	31%
School sessions	3	23%
Website	1	8%
Leaflet	0	0%
Local shops	0	0%
Other	0	0%

Table 12. Motivation to join Sharing Lisboa.

Motives to Participate		
To help the school win a reward	12	63%
To learn about sustainable behaviours	7	37%
Win bonus	0	0%
Other	0	0%

Table 13. Level of easiness to register at Sharing Lisboa.

Level of Easiness to Register		
1 (extremely difficult)	1	8%
2	0	0%
3	1	8%
4	4	31%
5 (extremely easy)	7	54%

Table 14. Frequency of access to Sharing Lisboa.

Frequency of Use		
More than once a day	3	23%
Every day	5	38%
2-4 times a week	3	23%
Once a week	1	8%
Every two weeks	1	8%
Once a month	0	0%
Less than once a month	0	0%

Table 15. Duration of each access to Sharing Lisboa.

Average Time Per Visit		
Less than 5 min	7	54%
5–10 min	6	46%
11–20 min	0	0%
More than 20 min	0	0%

Table 16. Level of satisfaction with different features of Sharing Lisboa.

Level of Satisfaction Towards Different Features of the Sharing Lisboa APP	Unsatisfied	Not Satisfied	Indifferent	Satisfied	Very Satisfied
Profile	0%	8%	46%	38%	8%
Schools	0%	0%	31%	46%	23%
Maps	8%	0%	38%	46%	8%
Progress	8%	0%	46%	31%	15%
Settings	0%	0%	46%	38%	15%
APP sharing	15%	15%	31%	31%	8%
Talk with us	8%	15%	38%	31%	8%
Tutorial	0%	0%	69%	15%	15%
Glossary	0%	8%	69%	15%	8%
Sharing Cities	0%	0%	62%	31%	8%
Case study	0%	8%	46%	46%	0%
Terms and conditions	0%	0%	77%	15%	8%
Summary page	0%	0%	54%	38%	8%
Quizzes	0%	0%	15%	62%	23%
Bonus	0%	0%	38%	46%	15%
Shops	0%	8%	38%	38%	15%

Overall, respondents considered, as seen in Table 17, that connecting with external accounts (38%) was one of the most difficult aspects of Sharing Lisboa usage, while 15% and 31% indicated that gaining mobility and energy consumption points, respectively, was extremely difficult. Of them, 69% were indifferent to the local shops' check-in processes and 54% to using the bonus feature. For 69% of the respondents, it was easy or extremely easy to navigate and explore the APP. Additionally, 85% revealed it was easy or extremely easy to fill a quiz, 38% considered it was easy to use a bonus. Regarding gaining points, 62% and 31% indicated that it was easy or extremely easy to gain mobility and energy consumption points, respectively.

When asked about what type of other local shops they would like to be included in Sharing Lisboa, these include (Table 18): bookstores and stationery (85%), museums (62%), followed by electronic devices stores, Apparel and shoes, supermarkets and mini-markets and local produce shops (54%). The majority of respondents would recommend Sharing Lisboa to others (77%).

Table 17. Level of easiness to use different features of Sharing Lisboa.

Level of Easiness of Using the Features of Sharing Lisboa APP	Extremely Difficult	Difficult	Indifferent	Easy	Extremely Easy
Navigate and explore	0	1	3	5	4
	0%	8%	23%	38%	31%
Connect with other accounts (e.g., google fit)	0	5	4	3	1
	0%	38%	31%	23%	8%
Shops Check-in	0	2	9	2	0
	0%	15%	69%	15%	0%
Fill a quizz	0	0	2	6	5
	0%	0%	15%	46%	38%
Use bonus	0	1	7	5	0
	0%	8%	54%	38%	0%
Win points—sustainable mobility	2	1	2	4	4
	15%	8%	15%	31%	31%
Win points—energy consumption	4	0	5	3	1
	31%	0%	38%	23%	8%

Table 18. Types of businesses users would like to be included in Sharing Lisboa.

Type of Businesses to Include in Sharing Lisboa APP		
Toys	2	15%
Bookstores and Stationery	11	85%
Electronic devices	7	54%
Sports equipment	5	38%
Museums	8	62%
Apparel and shoes	7	54%
Cosmetic	0	0%
Supermarkets	7	54%
Mini-supermarket and local produce shops	7	54%
Butcher and fishmongers	4	31%
Movies	6	46%
Concerts and festivals	6	46%
Other	0	0%
Total	13	100%

6. Discussion

Several other gamification-based strategies to promote behaviour change have been addressed in several other programs similar to that of Sharing Cities, either focusing on energy efficiency or sustainable mobility. Sharing Lisboa addresses these two fields in the same gamification tool to incentive behaviour change. Over its six months' trial in three schools, 1260 users registered in the APP and over 17,000 transactions were made, in line with results obtained with the Bellidea APP [19] deployed in Switzerland and those of the GAIA Project [21] that involved 3000 students and 200 educators in Greece, Italy and Sweden. The main reason to participate in Sharing Lisboa was the ability to help one school win a prize, which is in line with the findings obtained from the focus groups conducted with the citizens, that stood out that the existence of a common cause that they

could contribute for would motivate more the participation instead of personal gains. The majority of participants are extremely concerned (59%) with energy consumption at home and consider that it is extremely important to save energy (70%). Nonetheless, results indicate that after using Sharing Lisboa APP parents (78%) and school staff (72%) adopted some energy-saving behaviours at home that they did not before, such as replacing an appliance with a more efficient one or using only eco programs with the washing machine or dishwasher. This is in line with results obtained in the ChArGED project [22], in which participants self-reported improvements in energy-saving behaviours adopted in the work environment.

Regarding mobility, the main transport mode for 53% of the users is walking and 18% use different transport modes. Their motives for using these transport modes are its health and environmental benefits, but 81% mention that it is easy for them to use such a transport mode and 41% because it is cheapest. The three schools are located, as previously mentioned, in the demonstration area of the Sharing Cities program, which includes residential and old neighbourhoods, in which parking a car can be difficult, which might be indicative of why, aside from already awareness of environmental issues, sustainable transport modes are already used by most participants. Nonetheless, 56% of the parents and 67% of school staff mentioned that they used the car less after starting to participate in Sharing Lisboa, in line with results obtained with the Traffic Snake Game Network, in which sustainable trips went from 68% to 78% during the game campaign.

Such a scheme like the one developed in Lisbon within the context of the Sharing Cities program was ground-breaking, since it enabled the city with the creation of a tool with the potential to, through gamification strategies, support and incentive behaviour change and the adoption of energy-efficient behaviours at a building and/or residential level and sustainable mobility options. The definition and design of the concept and the development of the APP was a time-consuming process that involved, as previously mentioned, several steps and the involvement of different stakeholders and, most importantly, the participation of the citizens. However, the approach enabled developing and deploying a tool for a more sustainable city taking into account its users' perceptions and their needs. Nonetheless, one of the limitations of this approach was that in the end the DSM was limited to school community involvement, even though a strong effort was made to involve the surrounding neighbourhood and community, which also led to limited results in the community. Furthermore, the deployment of the DSM in several schools implied the need to have a full-time human resource dedicated to the promotion, implementation of Sharing Lisboa and engagement with the students, teacher and school staff. However, the existence of this human resource was crucial increasing awareness of the school community and for its successful engagement and participation. Regarding the APP design and functioning, budget and time constraints did not allow the inclusion of some features, such as pop-up notifications that would allow reminding users to use the app or to notify outside the APP of new challenges, for example. The collection of user socio-demographic data was not possible to collect due to new RGPD guidelines, as previously mentioned.

Through gamification, Sharing Lisboa was able to increase awareness in sustainability and energy efficiency and incentive behaviour change, while creating a community within the city, promoting local and small businesses increasing engagement between citizens and the municipality/parishes. Considering the results obtained with this pilot, mainly in what concerns the adoption of energy-saving behaviours at home and of walking or cycling, if Sharing Lisboa was expanded to the whole city, the potential energy savings both at household and transportation level would be crucial for the mitigation of local pollutants emissions. Consequently, the adoption of such a tool at a city level, has the potential to change the layout of a city, the way people move, behave and use the different features and services of the city and, therefore, improve the quality of life of the citizens and transform cities into more liveable places. However, and taking into account inputs collected from the citizens over the design and development process of Sharing Lisboa, such a tool must

be simple to use and adopt, supported by awareness campaigns and information on why they are important for the city.

7. Conclusions

After the implementation of the Sharing Lisboa pilot, it is possible to ascertain that it is definitely a tool that can increase the engagement of citizens with municipality/parishes. However, some important factors need to be addressed for this expansion to take place, such as developing a business model that is both profitable and useful for the city, businesses and citizens, understanding where will the investment come from, how to attract users and create a highly competing service and APP that attracts the citizen. Besides promoting proximity between the citizen and municipality, such a tool can also be used to promote awareness on sustainable behaviours, promote local businesses, using immediate rewards/gratifications to incentive engagement. The format of Sharing Lisboa can also be adjusted to other formats and contexts, such as deployment within the municipality buildings/departments, internal use in companies, etc., and replication in other cities. However, it is essential to develop and define a business model that is profitable and that will allow the scale-up of the scheme to the city or replicating it in other cities, since investment will be required for infrastructure and management of such a market. Furthermore, besides developing profitable business models, it is of crucial importance to develop a tool that gains the general citizen interest attracting not only highly aware citizens or those already involved in similar environmentally conscious activities.

Such a service like the one offered by Sharing Lisboa has the potential to be a vehicle of change not only in what concerns people's behaviour but also in the overall functioning of the city, leading to a more sustainable living context with decreases in energy consumption and pollutants emissions and to the improvement of citizen's quality of life. Such a scheme can integrate existing and new solutions for communication and dissemination purposes and, most essentially, to educate citizens. Furthermore, it can enable developing new services building upon existing systems and platforms, incentivising the sharing of data among its participants.

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Data Availability Statement: Data was collected under the Sharing Cities Lighthouse program and most particularly within the Sharing Lisboa APP context. While the participants gave consent on the collection of data for APP usage and questionnaires, the consent provided was to analyse data in an anonymous way and raw data should be maintained private.

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Appendix A

Table A1. Energy-saving behaviours adopted after using Sharing Lisboa APP by type of user.

Behaviours Started Practicing after Sharing Lisboa Experience		I Always Turn off the Lights When Leaving a Room	I Only use the Washing Machine/Dish-washer When in Full Capacity	I Changed old Lamp Bulbs for more Efficient Ones (e.g., Led)	I Always Turn off Electronic Devices (e.g., tv) from the Plug	I Always Turn off Appliances (e.g., Dish-washer) from the Plug	I Always Choose New Appliances in Accordance with Energetic evaluation	I do not Leave the Phone Charger Plugged	Changed a Non-Efficient Appliance, Device or Equipment with a More Efficient One	Only Use Eco programs to Wash Clothes and Dishes	Other: I Do Not Throw Garbage in the Floor Any-more	Total of Respondents
Students	At home	1 33%	0 0%	0 0%	3 100%	0 0%	0 0%	2 67%	0 0%	0 0%	0 0%	3 -
	At school	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	1 33%	3 -
	Home and School	2 67%	0 0%	0 0%	0 0%	0 0%	0 0%	1 33%	0 0%	0 0%	0 0%	3 -
School staff	At home	2 11%	13 72%	14 78%	13 72%	11 61%	13 72%	9 50%	8 44%	14 78%	0 0%	18 -
	At school	1 6%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	0 0%	18 -
	Home and School	13 72%	1 6%	0 0%	1 6%	1 6%	0 0%	3 17%	0 0%	0 0%	0 0%	18 -
Parents	At home	4 57%	3 43%	4 57%	2 29%	1 14%	4 57%	5 71%	6 86%	5 71%	0 0%	7 -
	At school	0 0%	0 0%	0 0%	2 67%	1 33%	0 0%	2 67%	0 0%	0 0%	0 0%	3 -
	Home and School	1 50%	1 50%	2 100%	1 50%	1 50%	1 50%	2 100%	1 50%	2 100%	0 0%	2 -

Table A2. Motives for behaviour changes by type of user.

Why Did You Change Behaviours	Learned the Importance of Using Energy in a More Efficient Way	Learned the Importance of Using Less Pollutant Transportation Mode	To Help the School I Supported	To Gain More Points	I Did Not Change Behaviour
Students	3 100%	3 100%	3 100%	0 0%	0 0%
Parents	6 67%	4 44%	3 33%	4 44%	3 33%
School Staff	16 89%	11 61%	8 44%	5 28%	0 0%
Neighb. resident	2 33%	2 33%	3 50%	2 33%	2 33%
Other	2 50%	2 50%	2 50%	1 25%	0 0%

Table A3. Access to different features of Sharing Lisboa.

Usage of Different Features of the Sharing Lisboa APP	I Did Not Visit The Page	I Did Not Visit the Page. I Did Not Know About It.	I Visited the Page
Profile	54%	0%	46%
Schools	15%	0%	85%
Maps	38%	0%	62%
Progress	23%	8%	69%
Settings	38%	0%	62%
APP sharing	38%	8%	54%
Talk with us	54%	8%	38%
Tutorial	69%	0%	31%
Glossary	69%	8%	23%
Sharing Cities	46%	8%	46%
Case study	46%	23%	31%
Terms and conditions	54%	0%	46%
Summary page	23%	8%	69%
Quizzes	0%	0%	100%
Bonus	46%	0%	54%
Shops	62%	0%	38%

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