Building a Platform Society Towards Sustainability Based on Internet-of-Things

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Abstract. In this paper, we present a case study for designing a social platform towards environmental sustainability based on Internet-of-Things. The case study we investigate encourages low carbon communities, in particular, to aim for a car-free city. A car-free city promises to make our society more sustainable; however, people must be guided to choose a desirable lifestyle. We will show how our design framework helps to build a better car-free city without affecting citizens' success. We also show an augmented bicycle prototype that is an Internet of Things (IoT)-enhanced bicycle for promoting bicycle-sharing within communities. Bicycle sharing can help to achieve a car-free city, and IoT-based daily artifacts can contribute to building an effective social platform.

Keywords: Social platforms · Human behavior · Persuasive affordance · Gamification · Low carbon communities · IoT-based technologies · Augmented bike

1 Introduction

Our society must urgently solve a variety of fundamental social issues. For example, in the modern urban lifestyle, people generally consume large amounts of natural resources, which will render future life unsustainable. Internet-of-Thing (IoT) technologies dramatically improve the efficiency of natural resource use; however, the improvement will be limited in the future if we only consider technological factors. We must change our attitudes and behaviors and improve our daily lifestyles to reduce the use of natural resources. Guiding human behavior is crucial to achieving a sustainable society [16]. There are several manners in which to guide human behavior. A typical approach is to use social norms or public policies [11]. A government may conduct public campaigns to promote a sustainable lifestyle to maintain its country's wealth. However, this approach will only be able to improve people's average behavior, and some people may not change their behavior. The situation may be problematic because people who do not change their behavior may receive benefits without contributing effort, and other people will think their situation unfair. Finally, most people may stop contributing to the campaign. Thus, the social situation does not change and may become worse.

We present a case study for designing a social platform towards environmental sustainability based on Internet-of-Things. The case study we investigate encourages low carbon communities [6, 7], in particular, to aim for a car-free city. A car-free city

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promises to make our society more sustainable [3]; however, people must be guided to choose a desirable lifestyle. We will show how our design framework helps to build a better car-free city without affecting citizens' success. We also show an augmented bicycle prototype that is an Internet of Things (IoT)-enhanced bicycle for promoting bicycle-sharing within communities. Bicycle sharing can help to achieve a car-free city, and IoT-based daily artifacts can contribute to building an effective social platform.

The remainder of the paper is organized as follows: In Sect. 2, we present some issues that occur when designing persuasive affordances and an overview of alternative reality. The case study described in Sect. 3 seeks to develop a social platform to encourage low carbon communities to increase environmental sustainability. In Sect. 4, we discuss some lessons learned from the case study, and Sect. 5 concludes the paper.

2 Persuasive Affordances, Alternative Reality and Seligman's PERMA Model

Recently, digital marketing and social media practitioners have adopted an approach to develop information services based on game-based concepts, termed *gamification* [4]. The idea is to use game mechanics, such as the mechanics in online games, to render a task entertaining, encouraging people to conscientiously complete target goals. In traditional gamification, a set of game mechanics is widely adopted to motivate human behavior; however, incorporating game mechanics into the real world is not easy. Thus, simple mechanics such as badges, leaderboards and points are typically used. However, the gamification definition above suggests enhancing digital services with "*affordances for gameful experience,"* which suggests that exploiting the semiotic or rhetorical aspects of video games offers a novel approach to guiding collective human behavior and enhancing our daily lives. Gamification employs the use of affordances to motivate users to engage in the systems with gameful experiences. These affordances are often referred to as motivational affordances [13].

We refine motivational affordances to the persuasive affordances [14] because our focus also includes unconscious social influences [2]. The most common persuasive affordances used in gamification are points, badges, and leaderboards. Other affordances observed in academic studies and commercial applications include levels, challenges, rewards, feedback, clear goals, avatar/theme, and progress. In [15], the authors propose gameful digital rhetoric that is a framework to incorporate pervasive affordances in the real spaces with five types of abstractions named rhetoric.

Alternative Reality makes it possible to connect the real world with the virtual world from a single temporal perspective [12]. The worlds can also be seamlessly integrated because the virtual world consists of real landscapes, objects and persons. This means that it may be possible to enhance the real world by presenting fictional occurrences along with real events, and thus people experience an enhanced hybrid world in the real world rather than in a fictional world (as in a movie). Incorporating fictionality into real space strongly influences human attitudes and behavior. Thus, this approach can be used to guide people towards a more desirable lifestyle.

In *Alternative Reality*, a user watches a sequence of scenes on an HMD. The sequence consists of several scenes. Some scenes are captured from contemporary scenes in the real world. The scenes are recorded by a 360-degree camera and shown on the HMD in real-time. However, some scenes in the sequence are not real scenes; such scenes may actually be constructed through VR techniques and are fictional. Additionally, the virtual scenes may include several events that do not occur in the contemporary real world. Typically, these scenes are constructed using 3D models of real persons, objects and landscapes in advance, but some real persons who are not actually present may appear. One of the important requirements of *Alternative Reality* is that the user feels that these real and virtual scenes are continuous and, thus, is not aware of the boundary between the two scenes. Therefore, he/she feels that the virtual scenes are actually happening in the real world. The most important issue in achieving this immersion is blurring the boundary between fiction and reality.

Seligman defined a well-being theory [17] as a theme of positive psychology. In his book, he identified five factors necessary for humans to flourish in the PERMA model, including *positive emotion, engagement, relationships, meaning,* and *achievement*. The factor of human well-being steers people toward desirable behavior. For example, a husband and wife who have positive images of one another can create a fruitful married life. Additionally, positive emotions reduce the risk of catching a cold or an infectious disease. Seligman claims that people without positivity tend to think that there is no way to improve their everyday lives whereas people with high positivity can act to have more meaningful and productive lives [17]. Therefore, developing a social platform should consider how such a platform helps people achieve human well-being to guide their desirable human behavior. If the requirement is satisfied, diverse people are willing to use the platform.

3 Building Social Platforms Based on IoT-Based Technologies

3.1 Social Platforms for Low Carbon Communities

Low carbon communities works with communities to find sustainable energy solutions [6, 7]. Low carbon communities' activities involve working with households, businesses, schools and community groups to increase awareness of climate change. A car-free city is a population center that relies primarily on public transportation, walking, or cycling within the urban area [3]. Car-free cities greatly reduce petroleum dependency, air pollution, greenhouse gas emissions, automobile crashes, noise pollution, and traffic congestion. With increasing awareness of the urgent need to respond to global warming by reducing carbon emissions and recognizing the social benefits of car-free living, increasingly more city planners, advocates, and everyday urban dwellers are demanding ideas for new manners in which to build cities.

Recently, a variety of urban areas have offered a public bicycle-sharing system [18]. The public bicycle-sharing system is a service in which bicycles are made available for shared use to individuals on a short-term basis. The sharing schemes allow people to borrow a bike from one point and return it to another point. This social platform appears to be effective in encouraging car-free cities. The system is currently available in 50

countries on five continents, including 712 cities, utilizing approximately 806,200 bicycles at 37,500 stations. However, in most cities, the system does not work well primarily because riding bikes in cities is not enjoyable. Typically, the landscape in cities is boring although some small areas in the cities are quite attractive and people generally enjoy riding bikes in those areas.

In this study, we chose a fictional Yokohama city to discuss a manner in which to encourage a car-free city. This area is one of the most popular sightseeing destinations for youth in Japan. In the city, several interesting areas to visit are not accessible by public transportation. Therefore, the majority of young people use their own cars or rental cars to move around the city.

Yokohama has some interesting areas in which people enjoy riding bikes, as shown in Fig. 1. In the *Minato-Mirai* area, there are an amusement park and a museum; in the *Red Brick Warehouse* area, there are many fancy shops; the *Yamashita Park* area is a nice place to sit on a bench; in the *Yamanote* area, there are several historical houses; and in the *China Town* area, there are many excellent Chinese restaurants. However, the landscapes between these attractions are not interesting although each area has its own excellent characteristics that attract visitors.

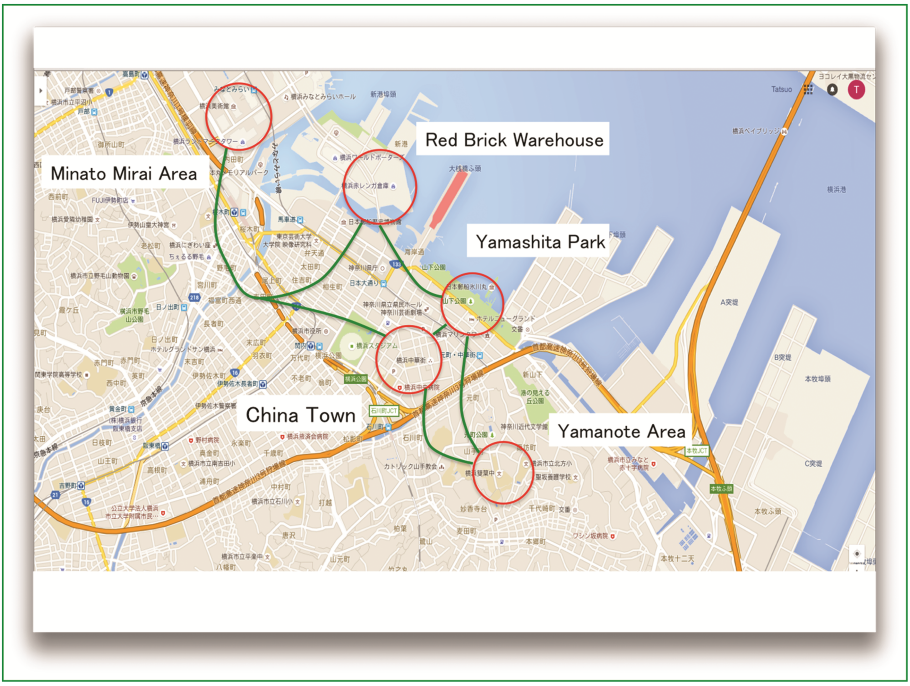

Fig. 1. A fictional yokohama city

3.2 Augmented Bike Concept

In this study, we enhance the city experience to encourage people who visit this Yokohama city to use the public bicycle-sharing system. To discuss our approach, we adopted a research method called design fiction [1] or speculative design [5]. Design fiction or speculative design is a method of critical design that uses fictional and narrative scenarios to envision, explain and raise questions regarding possible future designs for society. Critical questions regarding emerging technology in everyday situations have presented preferable futures as opposed to predicting the future. As shown in Fig. 1, we assume that each area in the Yokohama city is completely car-free. Thus, people can walk or bicycle without worrying about car traffic. In addition, we assume that there are bicycle paths depicted as green lines in these car-free areas and that people ride *Augmented Bikes,* described in the next section, on those paths.

When riding *Augmented Bikes,* people must wear head-mounted displays (HMDs). In the car-free areas, riders can directly see the landscape of the areas. The camera attached to their head-mounted display captures the real-world view of the landscape and shows the view on the HMD. However, when riders are on bicycle paths in car-free areas, the head-mounted display produces landscapes constructed by 3D models or videos capturing scenery pleasing to bike riders. In addition, the HMD makes bicyclists aware of other bikes on the paths to avoid collisions. If people enjoy riding the *Augmented Bikes* in the car-free areas, the public bicycle-sharing system will become more popular.

Incorporating fictionality into the real world is not an easy task. Traditional gamification mechanisms such as points and badges can easily be embedded in reality; however, these mechanisms do not satisfy the requirement of achieving all five factors in the PERMA model. Incorporating fictionality based on *Alternative Reality* into real space addresses the pitfalls because the real world's meaningfulness is increased by enhancing the meaning of the real space. Also, the enhancement makes people more positive.

Augmented Bike is a digitally enhanced daily artifact that augments rental bicycles using *Alternative Reality* with VR and AR technologies. When a new wearable device such as Google Glass or a contact-lens-type display becomes popular and most people wear the device in the near future, the devices can be used for facilitating a car-free city by augmenting rental bicycles with the new wearable devices and motivating people to use a rental bicycle. Using an *Augmented Bike*, people can easily rent a bike by touching their IC cards or using a fingerprint or an implanted IC chip that contains their personal information. Let us imagine a situation in which people always use an HMD and the display does not impede their sight, unlike a current HMD such as Oculus Lift[1]. The *Augmented Bike* enhances people's view and shows additional information on the HMDs that they wear. In addition, traveling distance and trail information are recorded on their smartphones, and people can check the information anytime. Figure 2 presents an overview of the *Augmented Bike* prototype.

[1] https://www.oculus.com/.

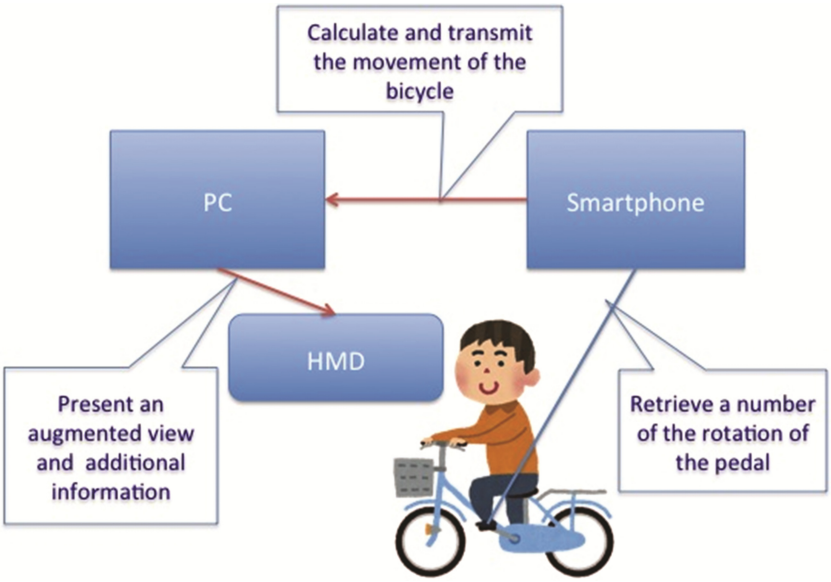

Fig. 2. An overview of augmented bike

When using the *Augmented Bike*, an application program displays the images that enhance a user's current real view on an HMD based on *Alternative Reality* and shows pop-up information regarding the images to provide the rider with additional information. We also developed an application program that records traveling distance and trail information, and we offer some persuasive affordances using graphical changes.

3.3 Scenarios and Their Analyses

In this subsection, we use the case study to explore strategies to design social platforms for sustainability. The research question is how to make diverse people feel good while riding bikes on public bicycle paths. We use a scenario-based analysis [8] to analyze our approach to low carbon communities. We show scenarios in which some persons do not like to use the public bicycle-sharing system of *Augmented Bikes*. The purpose of the analysis is to determine what types of features are missing while using the public bicycle-sharing system and to discuss some solutions to overcome the pitfalls. We analyze the user experience when a user rents a car to go sightseeing, uses a rental bike, and rides on an *Augmented Bike* based on the scenario analysis. A persona in the scenarios stays in Yokohama, one of the most famous cities in Japan, for a week. The developed persona is used in the scenarios as follows.

Rin likes to travel and to tour sightseeing spots; however, she is not happy that it takes so long to get from spot to spot. Because cars are fast and comfortable, she often rents a car and drives it to travel around. Unless the street is particularly beautiful, she drives without enjoying the scenery. Rin likes sightseeing, and she wants to protect the

beautiful scenery of sightseeing spots although Rin believes that there is nothing she can do to protect the scenery.

In the following first scenario, Rin drives a rental car.

i. *Rin travels to Yokohama, a famous tourist spot in Japan, and decides to stay there for a week. Rin rents a car and tours and goes sightseeing by car. She decides to drive to the Yamanote area, Yamashita Park, the Yokohama Red Brick Warehouses, and the Minato-Mirai area.*
ii. *The road between her hotel and the Yamanote area is a plain residential street. Rin is bored while driving the car. Finally she arrives at the Yamanote area and looks for a parking space. Because of the consecutive holidays, all parking areas near the park are already full. Rin feels stressed from looking for a parking space but finally finds a space a short distance from the Yamanote area and parks the car. It takes a few minutes for Rin to walk from the parking lot to the Yamanote area. The walk from the parking area is boring; thus, Rin walks quickly without thinking. Rin finally arrives at the Yamanote area and enjoys the scenery.*
iii. *Next, Rin drives to Yamashita Park, which is famous for its beautiful seaside scenery. Again, Rin has trouble finding a parking space and then walks along the seaside road. Rin enjoys the scenery of the park and feels comfortable in a sea breeze.*
iv. *Then, Rin drives toward the Yokohama Red Brick Warehouses. The road to the Red Brick Warehouses is a main street, and the traffic is heavy. Rin becomes irritated when she is caught in a traffic jam. After enjoying the shopping at the Red Brick Warehouses, Rin decides to go to see the scenery around the Minato-Mirai area, but the traffic is quite heavy.*
v. *After going back to the hotel, Rin falls asleep immediately because she is tired from looking for parking and being caught in a traffic jam.*

Using a rental car makes it difficult to enjoy the scenery because the typical streets in a city have been developed based on their efficiency, not people's well-being. Looking for parking or being caught in a traffic jam can become stressful. However, if Rin uses a rental bike, the scenario changes.

i. *Rin travels to Yokohama, a famous tourist spot in Japan, and decides to stay there for a week. She learns that there is a widely utilized bicycle rental service in Yokohama. Because she is concerned about the environment, she decides to rent a bike to tour Yokohama. The Yamanote area is near her hotel; thus, Rin plans to start from the Yamanote area and then go to the Yokohama Red Brick Warehouses through Yamashita Park and to the Minato-Mirai area to enjoy the scenery.*
ii. *Rin rents a bike near her hotel and starts to pedal. The road between her hotel and the Yamanote area is a plain residential street, and the ride is boring. Finally, she arrives at the Yamanote area. The bike is slower than a car, which causes some tension; however, when she arrives at the Yamanote area, Rin feels a sense of achievement. In addition, all of the parking spaces she saw near the park were full, making Rin think it was a good idea to rent the bike. Rin enjoys the beautiful scenery of the Yamanote area.*

iii. *After that, Rin goes to Yamashita Park, which is famous for its beautiful seaside scenery. She pedals along a seaside road in Yamashita Park. She enjoys the scenery of the park and feels comfortable in the sea breeze.*
iv. *Then, she pedals toward the Yokohama Red Brick Warehouses. The road to the Red Brick Warehouses is a main street, and the traffic is heavy. Although Rin avoids being caught in a traffic jam, the scenery on that road is dull and the air is bad. She feels bored while she rides the bike. After enjoying shopping at the Red Brick Warehouses, she decides to go to see the scenery in the Minato-Mirai area; however, the traffic is heavy and the scenery is miserable. Pedaling along the road with the dull scenery makes Rin jealous of cars that can move faster and arrive at their destination earlier.*
v. *After going back to the hotel, Rin immediately falls asleep because all the pedaling made her tired. She thinks that it is hard to ride a bike and that it takes more time than driving a car. She wants to use a rental car next time.*

As shown in the above scenarios, using a rental bicycle solves the problem of stress caused by traffic and parking difficulties. However, riding a bicycle is more difficult than driving a car and more time-consuming. Unpleasant scenery while riding a bicycle is worse than in a car. However, a user's sense of achievement is greater after pedaling around the city.

We analyzed these two scenarios with the Seligman's PERMA model's five factors of well-being that we mentioned in the previous section. Positive emotions are not satisfied while driving a rental car. Riding a rental bicycle may create positive emotions because the rider can tour without looking for a parking space; however, riding along streets with unpleasant scenery destroys those positive emotions. Achievement is satisfied when the user arrives at the destination. At this point, bikes create a stronger sense of achievement than cars. Meaning is not satisfied at all when using a rental car. Even if the user understands that biking contributes to protecting the environment, it is difficult to believe that one single action truly contributes to environmental protection. Relationships is not satisfied by either a rental car or a rental bicycle. Engagement may become stronger using a rent-a-cycle than a rental car because people can feel the wind on their bodies.

Our basic approach is to adopt game elements that increase the factor in the PERMA model that is not well-satisfied in the above scenarios. According to the framework, *positive emotions (P)* can be increased by introducing characters, *achievement (A)* can be increased by introducing goal-setting, *meaning (M)* can be increased by introducing dynamic graphical changes, and *relationships (R)* can be increased by introducing a close sense of others. In this case, we introduced user reviews of sightseeing spots or the surrounding scenery. *Engagement (E)* can be increased by music and special graphic effects. To achieve this goal, we believed that incorporating fictionality into real space based on alternative reality was a promising direction. In particular, introducing a character and enhanced fictional sights is consistent with introducing fictionality.

From the above analysis, the scenario when a user uses the *Augmented Bike* becomes the following.

i. *Rin travels to Yokohama, a famous tourist spot in Japan, and decides to stay there for a week. She learns that there is a widely utilized bicycle rental service in Yokohama. Because she is worried about the environment, she decides to rent a bike to tour Yokohama. The Yamanote area is near her hotel; thus, she plans to start from the Yamanote area and then cycle to the Yokohama Red Brick Warehouses through Yamashita Park and finally to the Minato-Mirai area to enjoy the scenery.*
ii. *Rin rents a bike near her hotel. The rental bicycle is equipped with Augmented Bike functionalities. Rin installs the Augmented Bike application on her smartphone and confirms her my-page. Scenery is displayed on her my-page; however, the scenery is not beautiful. A cute character is also displayed on her my-page. Rin wears an HMD and starts pedaling.*
iii. *The road between her hotel and the Yamanote area is a plain residential street. Then the scenery displayed on her HMD changes into a beautiful seaside road. Rin enjoys the virtual scenery while she pedals to the Yamanote area. All of the parking spaces that she sees near the park are full, making Rin think it was a good decision to come by bike. Rin enjoys the beautiful scenery of the Yamanote area.*
iv. *After that, Rin goes to Yamashita Park, which is famous for its beautiful seaside scenery. Yamashita Park naturally has beautiful scenery. The scenery displayed on her HMD changes into the actual view of Yamashita Park, and cool music appropriate to the sea is played. She pedals along a seaside road in Yamashita Park. When Rin has traveled nearly halfway across Yamashita Park, a pop-up window appears in the corner of her HMD. The window displays a user review: "The flowerbeds in Yamashita Park are so beautiful." Rin decides to drop in there for a short visit. The flowers in the flowerbeds really are beautiful, and Rin enjoys scenery that could not have been seen from a car. Rin appreciates the user who wrote the review.*
v. *Next, Rin pedals toward the Yokohama Red Brick Warehouses. The road to the Red Brick Warehouses is a main street, and the traffic is heavy. The scenery is terrible; however, the scenery displayed on her HMD is a beautiful tree-lined road. Rin enjoys the virtual scenery while she pedals to the Red Brick Warehouses. After enjoying shopping at Red Brick Warehouses, she decides to go see the scenery near the Minato-Mirai area. Although the traffic on the road is heavy and the scenery is unpleasant, Rin enjoys the virtual scenery on her HMD.*
vi. *After going back to the hotel, Rin checks the my-page of her smartphone application. The graphic of the earth is a little cleaner than when Rin had looked in the morning. The character in the application joyfully says, "The earth becomes cleaner, thanks to you. Rin feels that she can contribute to protecting the environments and scenery, and this makes her happy. In addition, there is a map on the application, and the roads she has ridden on are colored. This gives her a sense of achievement. She wants to use a rent-a-cycle from now on, and to color more roads on the map in the near future.*

Thus, the *Augmented Bike* overcomes the drawback that biking is boring when a user is in an area with drab scenery. A normal bicycle cannot increase positive emotions, achievement, relationships and meaning; however, the gamification-based approach

with the framework we introduce in this paper can overcome such pitfalls, and the user will feel positive about the experience although pedaling can be difficult.

3.4 A Current Augmented Bike Prototype System and Its User Study

The current *Augmented Bik*e consists of the following two parts. The first part runs on a desktop computer and delivers sound and movies to an HMD. The second part runs on a smartphone, and is connected to the first part. The first part changes the current view that a user sees according to the location. As shown in Fig. 3, the boring view when a user

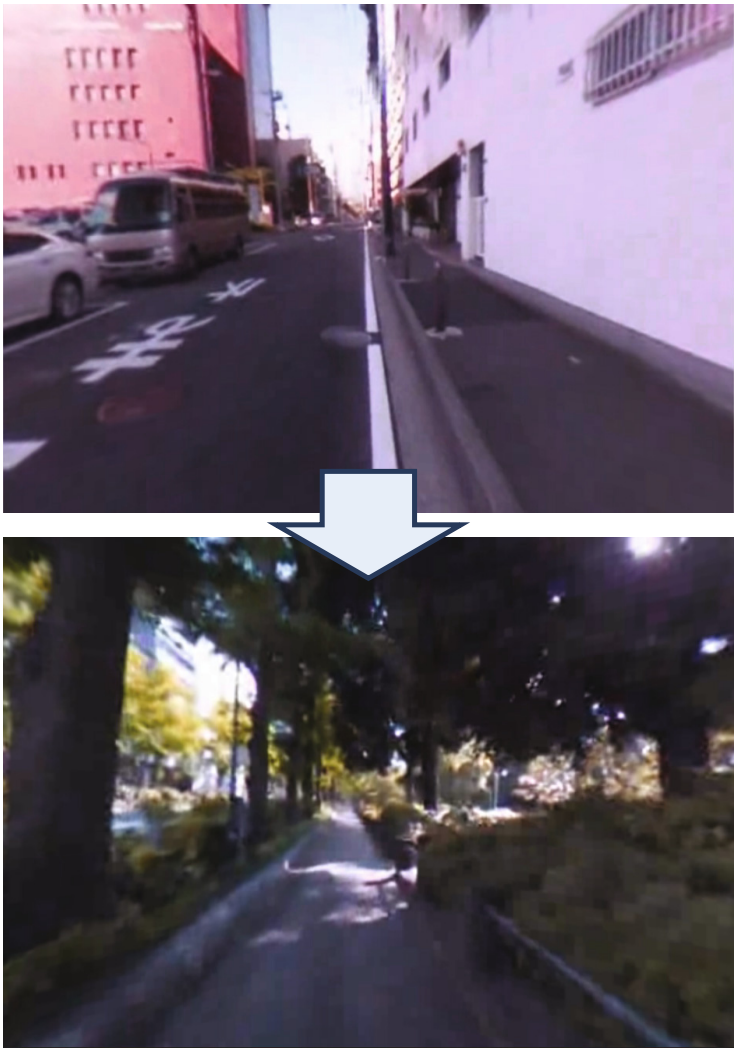

Fig. 3. Changing a user's view in augmented bike

rides on a bicycle on a usual cycle road between sightseeing places is changed to a more attractive view. The current prototype adopted Oculus Lift as an HMD. Of course, the current HMDs are too big and heavy to carry and the angle of its vision is narrow for the practical uses, but the contact-lens-shaped displays are recently developed and the technologies will make *the Augmented Bike* concept more practical in the near future [10].

The second part running on a smartphone records the road that a user passes through on its map and reports the travel distance as a feedback to him/her (Fig. 4). As the screenshots showed in Fig. 5, it displays the picture of polished earth before using *Augmented Bike* and cleaned earth after the cycling.

Fig. 4. Route map

As a user experiment, we recruited five participants. We asked the participants to use the *Augmented Bike* prototype system and discussed with them about the advantages and disadvantages of our current approach. They also investigated potential pitfalls for making our prototype system more practical. The five participants are male and early twenties.

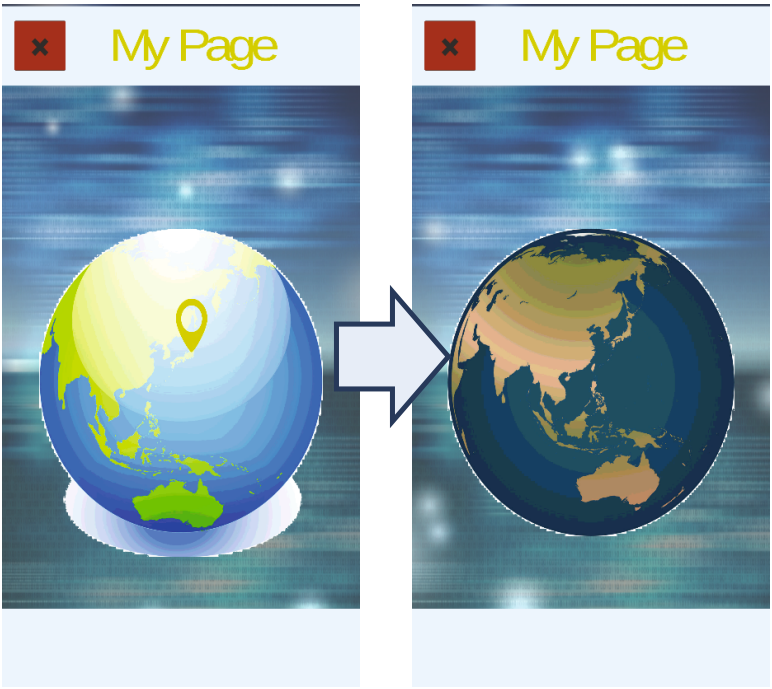

Fig. 5. A metaphor for sustainability

The approach that the picture of earth becomes clean after enough cycling seems to motivate participants and to notice them that using a bicycle is more environmental-friendly than to use an automobile because riding on a bicycle does not excrete carbon dioxide. However, from the interview after the experiment, the approach did not motivate the participants well because the approach does no make them to feel their actual contribution to make our environment sustainable. In addition, we found that the approach is not enough strong as an incentive to use a rental bicycle. The approach more directly related to individuals is requires, for example, showing the effects related to their health issues or to offer economic incentives like the discounts of local shops or restaurants.

Furthermore, some participants said that there are few cycling roads especially in Japan. When cyclers run on a usual car roadway, they have some risks of traffic accidents with automobiles, but on the pedestrian area they may hit and injure pedestrians. There are many dangerous places for cyclers in Japan and there are also few bicycle parking lots. Many cyclers currently do not understand the importance of traffic rules because they need no licenses to ride on bicycles. There are also some cyclers inherently with bad manners and dangerous driving. To promote rental bicycling more safely, it is necessary to prepare enough cycling roads and parking lots and to establish more appropriate traffic laws for bicyclers.

We assume that *Augmented Bike* is used in the outside environment, but our experiment was conducted in our laboratory setting because our prototype system currently

requires a powerful desktop computer to process and deliver a movie to a participant's HMD. Thus, it is difficult to safely conduct the experiments in the actual outside environment. The current prototype system attached acceleration sensors to the indoor exercise pedals. The HMD that a participant wears presents movies that were taken with a 360-degree camera (bublcam[2]). The movies are switched according to the participant's situation as described before. The display rate of the movies is changed according to the value retrieved from the acceleration sensors. In our scenario, the road where participants passes in the experiment presents boring scenery and is familiar with them. Thus, the prototype system shows a movie of boring scenery while the system assumes that the participant takes a bicycle in a cycling road, between sightseeing places and the scenery is changed while the system assumes that the participant arrives at a sightseeing place. However, because of the indoor experiment, the boring road is an unknown place for the participants, thus the effect of the change of scenery could not be investigated well. In the next step, we like to conduct an outdoor experiment with a powerful portable computer for making the experiment close to the scenarios described in the previous section, then we will be able to conduct the effect of the scenery change in more details.

The Participants who like cycling claimed another opinion about the relationship between game mechanics used in the *Augmented Bik*e and the Seligman's five factors. However, we could not analyze the detailed reasons well due to the current limited number of participants, but in the next step, we also like to investigate the issues and more appropriate approach to promote to use rental bicycles. One issue that we found is that the Seligman's five factors are related to the total user experience, but the game mechanics are related to a part of the experience [9]. Thus, although some games mechanics may enhance the five flourished factors, there are other many possibilities to decreased the five factors in the actual user experience while riding an *Augmented Bike.*

From the insights extracted in the above experiment, the most important finding is that the flourished five factors should not used for designing game mechanics in a platform society to enhance the human flourishness. We need to focus on how the total user experience should be designed not only game mechanics because game mechanics may have unexpected effects on user experience according to a user's current situation.

4 Lessons Learned from Designing Flourishness in a Platform Society

This section examines the two lessons learned from designing and evaluating the *Augmented Bike*. The first lesson involves design strategies to encourage diverse people. The basic idea of the proposed approach in the paper is to define multiple frameworks with which to design services. The frameworks offer different angles to investigate how each person responds to the services and how to enhance the services to motivate each participant. In this paper, we defined a persona, created scenarios regarding the persona, and examined whether the scenarios worked well. If we identified potential pitfalls, we

[2] https://www.bublcam.com/.

discussed which framework should be reconsidered. The approach allows us to overcome potential pitfalls by considering different personas incrementally.

The above approach potentially raises two issues. The first issue is how many personas must be examined before the design finally becomes saturated. The second issue is more serious. To extract multiple frames, we generally consider an average number of people. For example, in [17], Seligman proposed five factors to enhance our lives. However, the model only shows that the possibility becomes higher if people satisfy all of these factors. Some people may feel well-being in areas in which other people do not. However, when designing social platforms as social infrastructures, diverse people must be satisfied using the platforms, and we must investigate improved strategies for *designing for diversity*.

The second lesson is how we can use IoT-based technologies to design social platforms. The most important power of IoT-based technologies is to model our real world and change the strategies according to the current conditions in the model. This approach offers a powerful technique to guide human attitudes and behavior. However, constructing an accurate digital model of the real world is difficult; in particular, there is no manner in which to construct a completely generic model because of the frame problem identified by the artificial intelligence research community.

Changing the meaning of the real world is an effective manner in which to change human behavior; currently, however, there is no systematic manner in which to guide the meaning, and it is difficult to predict the effect on behavior changes. In addition, if there are inconsistencies between the enhanced world and the real world, people may not make correct decisions. For example, in the *Augmented Bikes*, if people are not aware of potential risks while riding, the possibility of accidents becomes higher. It may also be a good idea to replace humans' five senses. For example, a human's visual sense can be replaced by the auditory sense. However, it is not clear whether humans can correctly understand the meaning of the real world when their five senses are replaced. The necessity remains to investigate the best manner in which to enhance the meaning of the real world without biasing human decision-making and leading to accidental decisions.

To build a social platform, a concept named crowdsourcing is a promising approach to promoting a community's willingness to achieve their goals. This approach has been shown to be successful in several service areas [15], and it is desirable to integrate the concept in our case study to motivate the community's activities. In addition, to encourage people, a concept called procedural rhetoric is promising for designing persuasive affordances based on digital game concepts. The concept offers an interesting direction that complements the gamification concept to design better persuasive affordances. Procedural rhetoric [21] will become a powerful theoretical foundation utilizing digital games' full powers to persuade people to enhance their communities. However, currently, it is not clear how the design of procedural rhetoric is related to the Seligman's five factors. We need to investigate how the meaning is assigned to procedural rhetoric and how the meaning enhances the five factors. However, as presented in the previous section, we also need to investigate how the meaning is used to design the total user experience offered by a platform society.

Libertarian paternalism is a legitimate concept with which public institutions may influence human behavior without sacrificing freedom of choice. In [19], Thaler and

Sunstein defined libertarian paternalism as paternalism that "*… tries to influence choices in a way that will make choosers better off, as judged by themselves*"; the concept of paternalism implies a restriction of choice although it is libertarian that "*people should be free to opt out of specified arrangements if they choose to do so.*" Choice architecture allows designers to design how choices can be presented to people and how the presentation affects their decision-making [20]. Thus, the libertarian paternalists support the intentional design of choice architecture to nudge people toward personally and socially desirable behaviors such as saving for retirement, choosing healthier foods, or reducing their energy consumption.

In 2010 the British government commissioned research into influencing behavior by policy. What the research produced was a report called MINDSPACE that offers guidelines for implementing the libertarian paternalism concept as public policy [10]. Our approach to enhancing the meaning of real space in which people live by augmented reality and virtual reality technologies is implementing the libertarian paternalism concept using information technology. Currently, there is scant research on how to coordinate policies and technologies to achieve a better society. We expect our approach to become a first step in a promising direction.

5 Conclusion and Future Direction

In this paper, we discussed design strategies to build social platforms for diverse people. Our modern society is becoming increasingly complex, and we are becoming busier and more stressed. The well-being of our society is one of the most important social issues of the near future. In particular, our social platform must consider a thriving society in a manner that extends beyond our daily lives. We presented a case study to demonstrate the effectiveness of the proposed design framework. The case study promotes low carbon communities by using IoT-based technology. We developed *Augmented Bikes* to enhance people's enjoyable experiences in an urban setting without sacrificing our immediate environment.

Libertarian paternalism is a legitimate concept with which public institutions may influence human behavior without sacrificing freedom of choice. In [19], Thaler and Sunstein defined libertarian paternalism as paternalism that "*… tries to influence choices in a way that will make choosers better off, as judged by themselves*"; the concept of paternalism implies a restriction of choice although it is libertarian that "*people should be free to opt out of specified arrangements if they choose to do so.*" Choice architecture allows designers to design how choices can be presented to people and how the presentation affects their decision-making. Thus, the libertarian paternalists support the intentional design of choice architecture to nudge people toward personally and socially desirable behaviors such as saving for retirement, choosing healthier foods, or reducing their energy consumption.

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