Design Strategies for Building a Flourishing Platform Society for Diverse People

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Abstract. In this paper, we propose design strategies for developing social platforms that consider urban environmental sustainability. The social platform must guide human behavior to encourage diverse people to contribute to improving the sustainability in our urban areas. Persuasive affordances are typically used to guide human behavior; however, the effects depend on people's personal differences. Thus, the platform that focuses on certain people may not work well to guide diverse people toward a better sustainable lifestyle although each person's contribution is essential to realizing a truly sustainable society.

Our approach begins with Seligman's PERMA model to make people thrive. We developed a framework for designing persuasive affordances based on the five factors in the PERMA model. The framework allows designers to analyze which factors are insufficient that must be enhanced to encourage a diverse population. If the platform supports all five factors by the persuasive affordances that were designed with the proposed framework, many different people will satisfy the platforms and choose to use those platforms to be guided toward a sustainable society.

This paper presents the effectiveness of our approach using a case study to encourage low-carbon communities. In the case study, we also demonstrate how Internet-of-Thing (IoT)-based technologies are effective in designing better persuasive affordances. The lessons learned offer designers and researchers useful insights when designing a future social platform to guide human behavior among a diverse population.

Keywords: Social platforms, Human behavior, Flourishness, Motivational affordances, Persuasive affordance, Gamification, Low carbon communities, IoT-based technologies

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 [19, 34]. There are several manners in which to guide human be-

havior. A typical approach is to use social norms or public policies [15]. 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.

These traditional approaches may also reduce some people's level of happiness because an approach cannot be customized to individuals, and such people may feel greatly inconvenienced by being guided through social norms or public policies [1]. A decrease in happiness may increase the number of slackers. To achieve a sustainable and flourishing society, the direction of a society's respective behaviors should be customized according to people's current situations and preferences to increase the happiness of diverse people. IoT-based technologies can be used to design services that offer persuasive affordances that create customized manners in which to guide people's behavior without reducing people's possible happiness [26].

In previous research studies, many services that offer persuasive affordances incorporating IoT-based technologies have been proposed, and such services successfully demonstrate how to guide human behavior [17, 26]. However, these existing services focus only on one aspect of people's behavior, such as stopping smoking, encouraging tooth brushing or reducing unsustainable behavior [26]. When using these technologies to develop a technology-driven social platform for guiding people's behavior toward achieving a sustainable society, we must consider how to influence a citizen's behavior seamlessly by incorporating IoT-based technologies in urban cities. Persuasive technologies can be embedded everywhere in cities and can influence citizens' behavior in their respective locations. However, there is currently no manner in which to connect these technologies to guide diverse people's behavior according to their current situations and locations.

In this paper, we first report results in two small case studies investigating how each person's personality or preferences affect his/her motivational or persuasive mechanisms. From the experiences of the case studies, we extracted some insights and developed a framework for pervasively motivating diverse people who is appropriate for designing a technology-driven social platform.

Based on the insights extracted from the case studies, we propose a framework for designing a social platform that will lead toward achieving a flourishing society. Our design framework is based on Seligman's PERMA model as proposed in positive psychology [35] and some insights from experiences with developing our previous design frameworks [29, 30, 33, 34]. The proposed framework indicates which factors in Seligman's PERMA model can be realized by a set of mechanisms to motivate humans. Therefore, when designing a social platform, our framework suggests which mechanisms should be chosen to develop a social platform that will enable a diverse population to achieve a flourishing society.

We also present a case study demonstrating how to use the proposed framework for designing a social platform based on a scenario-based analysis. The case study we

investigate encourages low carbon communities [10, 11], in particular, to aim for a car-free city. A car-free city promises to make our society more sustainable [7]; 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 Section 2, we present some issues that occur when designing persuasive affordances. In particular, we show two case studies using persuasive affordances and analyze how these affordances are used by diverse people. In Section 3, we propose a framework to design persuasive affordances for diverse people. This section details how we conducted workshops to extract the framework. Section 4 describes how the framework can be used in the low carbon communities case study. The case study seeks to develop a social platform to encourage low carbon communities to increase environmental sustainability. In Section 5, we discuss some lessons learned from the case study, and Section 6 concludes the paper.

2 Designing Persuasive Affordances

2.1 Persuasive Affordances for a Social Platform

Recently, digital marketing and social media practitioners have adopted an approach to develop information services based on game-based concepts, termed *gamification* [8, 21]. 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 [14], gamification is also defined from a service-marketing perspective as "*A process of enhancing a service with affordances for gameful experience to support user's overall value.*" 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 [18].

In this paper, we refine motivational affordances to the persuasive affordances [30] because our focus also includes unconscious social influences [4]. 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. There have been several proposals to offer design frameworks to develop persuasive affordances for guiding people's behavior [29, 30, 33]. In [33], the authors proposed the

gameful digital rhetoric framework, in which the framework contains five rhetorical frames to offer different types of persuasive affordances. A service developer considers various aspects of a target service that the developer wants to develop by examining each frame. In [29], the authors proposed a *value-based analysis framework*, in which the framework comprises six values for enhancing the meaningfulness of the gameful products and services. In [32], the authors proposed using fictionality to design persuasive affordances. In particular, the proposed approach attempts to exploit the use of transmedia storytelling, in which fictionality is incorporated into multiple media. If the media are placed in their surroundings, people believe that the fictionality has been successfully incorporated into the real world. Finally, in [16], the authors proposed design strategies called *alternative reality* to enhance the meaning of the real world. This approach adopts virtual reality techniques to insert virtual scenes constructed using a 3D model into real scenes.

As shown in the next subsections, we observed that the effects of current gamification approaches depend on people's personalities. In [1, 18], the authors also claimed similar results, and in [31], the authors showed that people's personalities affect individuals' feelings regarding the reality of incorporated virtuality. This study also observed that lost reality significantly decreases people's motivations to perform a task enhanced by virtuality although a social platform must be usable by a diverse population. If some people do not like to use the platform or cannot be encouraged by incorporated persuasive affordances, the platform will not effectively enhance the entire society.

Our approach is to adopt Seligman's PERMA model, which enhances our daily experiences. If all people feel the blossoming of their experiences when using a social platform, all people will want to use the platform, and the social platform will guide people toward a desirable lifestyle.

2.2 Persuasive Affordances for Human Well-Being

Although it is said that five measurable factors, *accomplishment, positive relationships, meaning, positive emotions,* and *engagement*, are important for improving human well-being, in the present circumstances, no scientific methods and measurements are available to improve the five factors [35]. There is, however, an exercise called *Three Good Things (TGT),* which demonstrates scientific measures and the effectiveness of improving well-being by continuing this exercise for one week [20].

In this case study, we elected to analyze the relation between tools that are designed based on each of the five factors and their influences on well-being. To understand the relation, we developed motivational tools focusing on each of the five factors. Because some previous studies have examined *positive emotions* and *engagement* using game contents, we developed three tools that by focusing on three of the five factors, *accomplishment, meaning* and *positive relationships.* When we developed each tool, as described below, we considered what form was appropriate for improving each factor and implemented that form.

Accomplishment: A form that improves a player's sense of achievement by the process of improving in stages. Improvement occurs by continuing this exercise every day (Figure 1).

Meaning: A form that improves a player's understanding of meaning by the process of saving a world in the same manner in which a hero went on a mission to save a world. Improvement occurs by continuing this exercise every day (Figure 2).

Figure 1: Tool Focused on Accomplishment

Positive relationships: A form that improves a player's positive relationships by deepening a relationship between the player and a character that the player likes. Improvement occurs by continuing this exercise every day (Figure 3).

In this experiment, we had fifteen people engage in a preliminary experiment for one week. After that, we had the participants engage in the primary experiment for one week. In the preliminary experiment, we asked participants to comment on a Three Good Things (TGT) exercise and answer questionnaires to measure their level of well-being using a spreadsheet and without using the previously mentioned tools. In the primary experiment, we asked the participants to answer the questions using one of three tools. Five examinees used each tool. We asked the participants to perform the experiment for approximately five minutes every day.

Four examinees who used the tool focused on accomplishment reported that their feelings of achievement improved using the tool. Because their level of well-being also improved, we concluded that the improvement in their sense of accomplishment led to enhanced well-being. In the group using the tool focused on positive relationships, however, only two of the five examinees reported feeling a deepening relationship between the player and a character. Because the participants' comments indicated that the players were engaged in the story, we assumed that their well-being was improved not by a deepening relationship, but by being engaged in the story.

In this case study, we also conducted a personality test that measures the optimism of the participants to examine the effects of an examinee's personality on his or her well-being. As a result, the participants who displayed high optimism were perceived to display increasing happiness according to all three types of tools. Conversely, participants with low optimism were perceived to be less happy when using the two tools that focused on meaning and accomplishment. However, because the well-being of the participants who showed low optimism displayed improved relationships, it may

be possible to increase overall well-being if the factors in the PERMA model that are selected are appropriate for the participant. Because the elements driving the well-being of the group with low optimism cannot be easily improved compared with the group with high optimism, we must design the system considering which of the five factors are important in the PERMA model according to personality or preferences.

Figure 2: Tool Focused on Meaning. Figure 3: Tool Focused on Relationships

2.3 Persuasive Affordances for Social Sustainability

The sharing economy referring to peer-to-peer-based sharing of access to goods and services has recently attracted a great deal of attention [13]. The term covers a sprawling range of digital platforms and offline activities such as Airbnb[1], a peer-to-peer lodging service, and Uber[2], a peer-to-peer transportation network. The sharing economy typically uses information technology to provide individuals, corporations, nonprofits and governments with information that enables the optimization of resources by the redistribution, sharing and reuse of excess availability of goods and services. The services included in the sharing economy have recently been growing rapidly worldwide; however, the popularity of such services in Japan remains limited. The purpose of this case study is to encourage the Japanese people to use these services by enhancing the services by game mechanics and a pop culture atmosphere.

In the second case study, we developed a gamified sharing economy service using storytelling to encourage a user to actively use the sharing economy service. In the service named "Osusowake," as shown in Figure 4, a user can rent necessary goods from other users who do not require the goods at that moment to encourage sharing within a community. A virtual world is offered for the users in the Osusowake sharing economy. In a fictional story of the virtual world, the users become more active in the sharing economy with the help of a fictional female guide. The system adopts the following four gamification elements: badge, collection, rank and storytelling. In particular, we compare the effects of storytelling with other typical gamification ele-

[1] https://www.airbnb.com/
[2] https://www.uber.com/

ments; our study conducted an experiment to evaluate the effectiveness of a game story in increasing the motivation of a user.

Figure 4: Osusowake Sharing Economy Service

In the experiment, we recruited 13 participants and conducted interviews with those participants. The interviews suggested that storytelling helps us to understand what motivates a user. For example, a service is designed to teach a user why that user must perform an activity presented in the story or why an activity is undesirable, using concrete examples. If a user can understand the meaning of an activity that is particularly encouraged in a service or improve his/her attitude against currently undesirable activities by storytelling, the user can continue to perform the activities with his/her own internal motivation. This aspect is a strong advantage of storytelling that other gamification elements do not have because traditional gamification elements generally increase only external motivation to encourage short-term activities.

Table 1: Hypothesis and Results of Each Category of the Bartle Test

Category Name	Effective Elements (in Hypothesis)	Effective Elements (Before Experiment)	Effective Elements (After Experiment)
Achiever	Badge Rank Collection	1st: Collection 2nd: Rank 3rd: Badge 4th: Story	1st: Collection 2nd: Badge 3rd: Story 4th: Rank
Explorer	Story	1st: Story 2nd: Rank 3rd: Collection 4th: Badge	1st: Collection 2nd: Story 3rd: Rank 4th: Badge
Killer	Rank	1st: Rank 1st: Badge 2nd: Collection 3rd: Story	1st: Collection 2nd: Badge 3rd: Story 4th: Rank

We also conducted the Bartle Test[3], which classifies a person into one of four categories depending on how that user plays MMORPG (Massively Multiplayer Online Role-Playing Game). This test examined the personality of each of the 13 participants

[3] http://mud.co.uk/richard/hcds.htm/

and the influence of the user's personality on the effectiveness of the respective gamification elements used in the developed service.

In the analysis of the effects of gamification elements, we first classified all participants based on their highest personality score on the Bartle Test. We hypothesized that a person classified in a certain personality category on the Bartle Test would be effectively engaged by a different set of gamification elements. To test the hypothesis, we asked the participants to fill out questionnaires before and after the experiment. The first questionnaire investigated what each participant expected the effect of each gamification element to be, and the second questionnaire investigated how each participant was in fact affected by each gamification element after playing the game. Table 1 shows each hypothesis and the corresponding actual result. In the current experiment, only one participant's highest score was in the Socializer category; thus, we omitted this category from the table. As shown in the results, the gamification elements that we expected would offer strong effects were not in fact the most effective.

3 Design Framework for Diverse People

3.1 Seligman's PERMA Model and Persuasive Affordances

Seligman defined a well-being theory [35] 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 [20, 35]. 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.

As shown in [30, 34], the power of digital games can enhance the five factors defined by Seligman, enabling those factors to become the permanent building blocks for a life of profound fulfillment oriented toward making a society thrive. Therefore, using persuasive affordances is a promising approach to increasing human motivation, and this approach has been adopted on various digital social platforms, in particular, various recent social media such as Facebook[4] and Twitter[5]. However, traditional persuasive affordances based on gamification primarily focus only on two of Seligman's five factors: engagement and achievement, as shown in Figure 5. Therefore, it is difficult to achieve human well-being in terms of Seligman's definition. The two factors, engagement and achievement, are designed based on goal setting; however, other factors must consider meaning in our everyday lives. Therefore, it is not easy to motivate diverse people. In particular, recent trends in the use of gamification in so-

[4] https://www.facebook.com/

[5] https://twitter.com/

cial media and social games primarily seek to unconsciously engage people based on behavioral psychology and not to increase curiosity or intrinsic motivation by increasing people's joy.

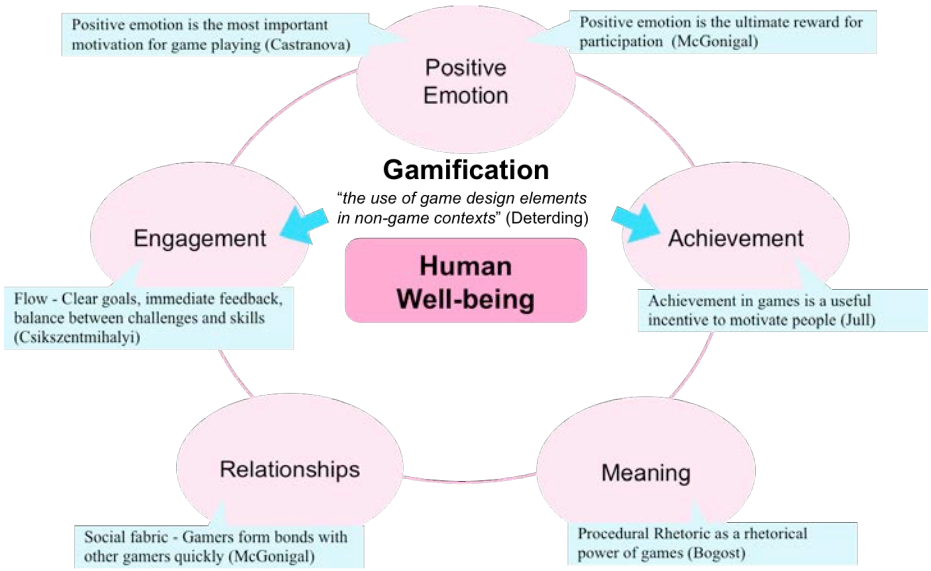

Figure 5: Well-Being and the Power of Games

In the next subsection, we extract game mechanics from existing commercial digital games and categorize these mechanics into Seligman's five factors. The design framework based on the above analysis guides a social platform designer to choose proper mechanisms for designing persuasive affordances to enhance our society through the social platform.

3.2 Extracting Design Framework through Delphi Card Sorting

Because users who play a game feel happy being immersed in the game and are motivated to continue playing, we assume that playing a game includes Seligman's five factors. Thus, if we can extract game mechanics from the games that engage people to become immersed in the game, we can create a framework for designing a social platform that will enhance society.

We conducted a workshop to extract the game mechanics that help players succeed from existing popular video games. At the beginning of the workshop, we explained the definition of each factor to the participants and classified the mechanics that we considered useful for accomplishing one of the five factors classified by Card Sorting. To extract these mechanisms, we gathered five Japanese people in their 20s (three men and two women) who were quite knowledgeable about games. In the workshop, we discussed eleven primary genres of games (Shooting, Action, Adventure, Role Playing, Puzzles, Simulation, Sports, Racing, Music, Open World, and Character). The representative games that we used in the workshop are presented in Table 2. We discussed which game mechanics motivated players to play the game in each genre,

and then we extracted the game mechanics and grouped these mechanics into Seligman's five factors. The results are presented in Figure 6.

We then refined this framework using Delphi Card Sorting[6]. The results of the refining of above framework by our knowledgeable participants (four Japanese and one Qatari) are presented in Figure 7.

Genre	Title	Link
Shooting	Splatoon	http://splatoon.nintendo.com
Action	New Super Mario Bros	http://newsupermariobrosds.nintendo.com
Adventure	Professor Layton	http://professorlayton.nintendo.com
Role Playing	Pokémon	http://www.pokemon.com/us/
Puzzle	Tetris	http://tetris.com
Simulation	My Monster Rancher	https://en.wikipedia.org/wiki/Monster_Rancher
Sports	Winning Eleven	https://www.playstation.com/en-us/games/world-soccer-winning-eleven-9-ps2/
Racing	Mario Kart	http://www.mariokart.com/wii/launch/
Music	DEEMO	http://www.rayark.com/g/deemo/
Open World	Minecraft	https://minecraft.net/ja/
Character	KINGDOM HEARTS	http://kingdomhearts.wikia.com/wiki/Kingdom_Hearts_(series)

Table 2: A List of Games

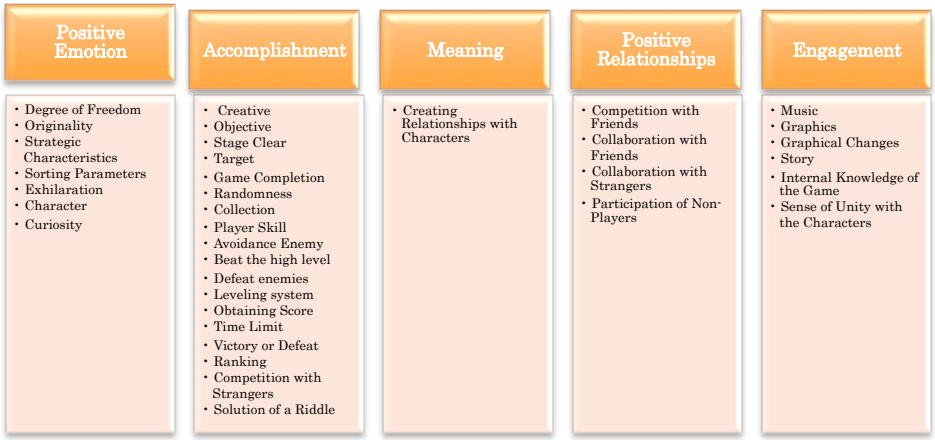

Figure 6: Results of Second Workshop

[6] https://isquared.wordpress.com/2009/09/02/card-sorting-using-the-delphi-method/

In the process of using this method, Story, Curiosity and Creativity particularly changed. Although Story was originally classified under Engagement because Story engages players in the world of the game, the mechanics were newly classified under Meaning because the view of the world created by the story immersed players in the game and the story itself motivated players toward some action. Thus, World View was added to Engagement.

In addition, Curiosity and Exhilaration were removed from this framework because most participants believed that Curiosity and Exhilaration were closely allied to feelings and not the mechanics of games.

Creativity was originally classified under Accomplishment because players felt creative when they finished their work. However, players also felt Positive Emotions when acting creatively and finishing their work while using Delphi Card Sorting; thus, the participants of this workshop said that Creativity was an element of realizing Positive Emotions.

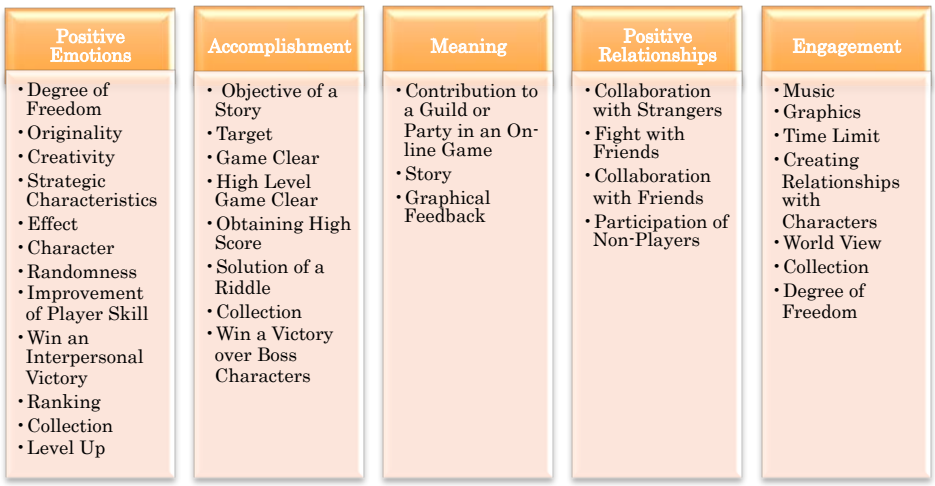

Figure 7: Results of the Delphi Card Sorting

The following sections explain game mechanics based on the above definitive framework.

The first section examines game mechanics classified under Positive Emotions.

Degree of Freedom: Degree of Freedom is classified under this element because most participants agreed that playing a game freely is sheer fun. However, some participants mentioned that some people may lose sight of the goal and become confused. Thus, if the degree of freedom is too high, the game may not be fun or all players.

Originality: Originality is produced by creative action, and when players bring original ideas to the game, Positive Emotions grow.

Creativity: Creativity also creates Positive Emotions in players because the action itself is fun.

Strategic Characteristics: Strategic Characteristics are different from Originality, which is produced more often when the game is freer. Strategic Characteristics produce Positive Emotions because players find more enjoyment in looking for a right answer when the degree of freedom in the game is more limited. Strategic Characteristics produce Positive Emotions in a manner different from Originality and Creativity.

Effect: We discussed which game mechanics cause a player to feel Exhilaration because Exhilaration was originally classified under Positive Emotions but not defined as a game mechanic. The result was that Effect in the game is the key mechanism that makes a player feel exhilarated.

Character: Character is a game mechanic that makes a player feel attached or attracted to the game. Thus Character becomes a Positive Emotion.

Randomness: Randomness produces Positive Emotions. Some participants said that interest is generated by a trade-off between Randomness and Strategic Characteristics.

Improved Player Skill: Improved skill was originally classified under Accomplishments; however, players who improve their skills in fact feel happier and become naturally stronger. Playing a better game feels like a great Accomplishment.

Win an Interpersonal Victory: Defeating a special opponent is an Accomplishment. Otherwise, a player simply feels Positive Emotions.

Ranking: Purposely achieving a high ranking generates a feeling of Accomplishment. However, a player typically becomes highly ranked without purposely increasing his/her ranking and simply feels Positive Emotions.

Collection: Collection is also included in Accomplishment and Engagement rather than Positive Emotion because the elements change with the design of the collection method. A player's collecting identical items within a defined period of time creates in that player a feeling of Engagement. If a player simply enjoys collecting, the collecting leads to Positive Emotions. If a player wants to complete a list of items, the player feels a sense of Accomplishment. Thus, the element that Collection belongs to depends on the collection method.

Level Up: Level Up was originally called Leveling System and classified as Accomplishment. However, because a player does not purposely level up, the player simply feels Positive Emotions.

The next subsection addresses the game mechanics classified under Accomplishment.

Objective of a Story: Objective of a Story, which was a combination of two mechanics, Objective and Stage Clear and originally classified under Accomplishment, is classified under Accomplishment because a player has a sense of accomplishment when he reaches the goal of a story.

Target: A player feels a greater sense of Accomplishment if rewarded with a title when achieving a target.

Game Clear: Game clear means clearing an entire game. Game clear also makes a player feel a sense of Accomplishment by finishing the game.

High Level Game Clear: If the game is difficult to clear, a player feels a sense of Accomplishment by clearing the entire game.

Obtaining a High Score: High Scoring was originally classified under Accomplishment; however, players reported that without a target score, a player did not feel a sense of Accomplishment. Thus, Obtaining a High Score makes a player feel a sense of Accomplishment.

Solution of a Riddle: Solving a riddle simply leads to Accomplishment without the difficulty of a riddle.

Win a Victory over Boss Characters: Win a Victory over Boss Characters was created by deconstructing "Victory or Defeat." If the opponent is a real person, defeating that person leads to Positive Emotions by advancing over a competitor. This mechanic is classified with Positive Emotions as "Win an Interpersonal Victory." Conversely, a player defeating a strong CPU in the game leads to Accomplishment. Thus, "Win a Victory over Boss Characters" is classified here.

Third, we explain game mechanics classified under Meaning.

Contribution to a guild or party in an on-line game: This mechanic was originally aligned with Seligman's factor of Meaning, which suggests that Meaning comes from serving a cause bigger than ourselves.

Story: As mentioned above, Story motivates players toward some action in the game, giving the game Meaning.

Graphical Feedback: Graphical Change, which was the origin of Graphical Feedback, was classified under Engagement. However, a visual of something is changed metaphorically by a player's actions as a result of the feedback that follows the action. These changes render the action meaningful; thus, not Graphical Change, but Graphical Feedback realizes Meaning.

Fourth, we explain the game mechanics classified under Positive Relationships.

Collaboration with Strangers, Fight with Friends, Collaboration with Friends: The participants of the workshop agreed that these mechanics engender Positive Relationships, whether the collaboration or fight in the game is online or offline.

Participation of Non-Players: Participation of Non-Players indicates a relationship with a person who watches the game-playing beside a player. For example, one player enjoys playing on a stage created by another player who enjoys watching the play in Mario Maker. Some participants of this workshop reported that this mechanic was difficult to classify as a relational effect; however; making this mechanic a Positive Relationship may improve the relationship. Thus, this mechanic is classified here.

The last subsection focuses on game mechanics classified under Engagement.

Music, Graphics: These mechanics are important to make a player feel a sense of immersion.

Time Limit: A time limit produces thrills and leads to immersion; thus, this mechanic is classified under Engagement.

Creating Relationships with Characters: This mechanic was originally classified under Meaning because creating relationships with characters was thought to motivate a player. However, few players play a game to improve relationships, and most comments indicated that this mechanic did not achieve Meaning. The participants said that creating relationships with characters in the game immersed the player into the world of the game. Thus, this mechanic is classified under Engagement.

World View: As described above, World View was created by deconstructing "Story" as a mechanic realizing Engagement.

Degree of Freedom: Degree of Freedom was originally classified with Positive Emotions; however, Degree of Freedom can cause a player to be deeply immersed in the game when the player is highly motivated. Thus, Degree of Freedom also falls under Engagement.

4 Applying Our Framework for Building Social Platforms

4.1 Social Platforms for Low Carbon Communities

Low carbon communities works with communities to find sustainable energy solutions [10, 11]. 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 [7]. 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 [36]. 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 [6, 22] 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.

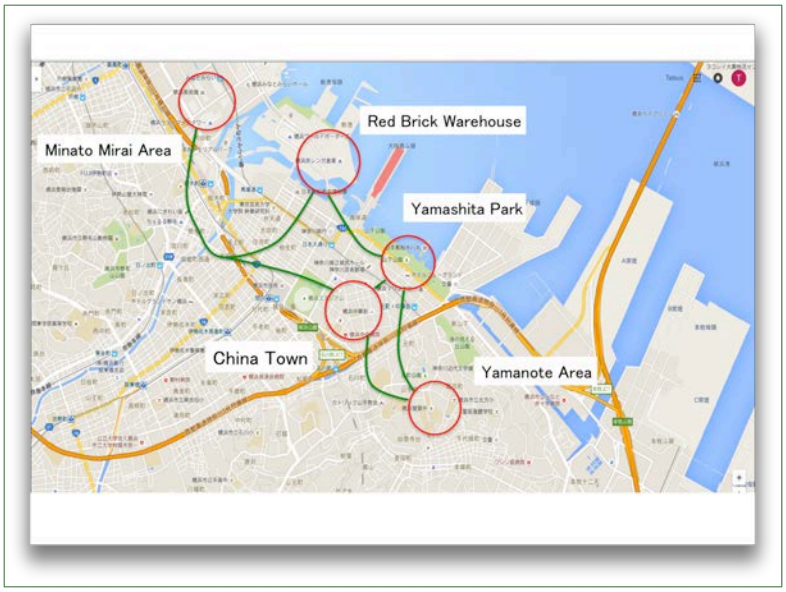

Figure 8: A Fictional Yokohama City

Yokohama has some interesting areas in which people enjoy riding bikes, as shown in Figure 8. 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.

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 or speculative design. Design fiction is a method of critical design that uses fictional and narrative scenarios to envision, explain and raise questions regarding possible future designs for society [3]. Dunne and Raby use design to offer new forms of expression for complex and critical issues; these forms of expression are grounded in the most abstract, speculative and future-focused considerations [9]. Critical questions regarding emerging technology in everyday situations have presented preferable futures as opposed to predicting the future. Dunne and Raby call the design approach speculative design. As shown in Figure 6, 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 Section 4.2, 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.

In this section, we use the case study to explore strategies to design social platforms for diverse people. There are two research questions in this study. The first question is how we can exploit the use of IoT-based technologies. As presented in the next subsection, we have developed an *Augmented Bike* prototype that uses IoT-based technologies, and Section 4.4 explains the usefulness of the prototype by conducting a user study of the *Augmented Bike*. The second research question is how to make diverse people feel good while riding bikes on public bicycle paths. In Section 4.3, we use a scenario-based analysis [12] to analyze our approach to low carbon communities. In that subsection, we show scenarios in which some persons do not like to use the public bicycle-sharing system of *Augmented Bikes*. Then, we analyze the scenarios with the design framework described in the previous section. The purpose of the analysis is to determine what types of features are missing that would enhance people's well-being while using the public bicycle-sharing system and to discuss some solutions to overcome the pitfalls.

4.2 Augmented Bike Concept

Incorporating game elements into the real world is not an easy task. Traditional gamification mechanisms such as points and badges can easily be embedded in reality; however, as shown in the previous section, these mechanisms do not satisfy the requirement of achieving all five factors in the PERMA model. Incorporating fictionality into real space addresses the pitfalls because fictionality is a key factor in introducing the majority of the game elements discussed in the previous section [17, 29, 32, 33].

There are several manners in which to incorporate fictionality into real space. One typical approach is to use live action role-playing (LARP) [25] or an alternative reality game (ARG) [23]. During LARP, players play fictional roles based on a pervasive role-playing concept [24], and a game master controls the gap between fiction and reality. ARG adopted a concept called transmedia storytelling [32], which uses multiple media to incorporate fictional stories into real space. These approaches are promising; however, the approach necessitates a rigorous plan that requires a long time to reduce the gap between fiction and reality. Augmented reality and virtual reality technologies offer another possible manner in which to incorporate fictionality into reality. For example, in [2, 5], using head mounted displays, a user immersively changes the meaning of real space to alter his or her attitude and behavior. The *Augmented Bike* adopts the second approach to incorporate fictionality into reality.

Augmented Bike is a digitally enhanced daily artifact that augments rental bicycles using 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[7]. 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 9 presents an overview of the *Augmented Bike* prototype.

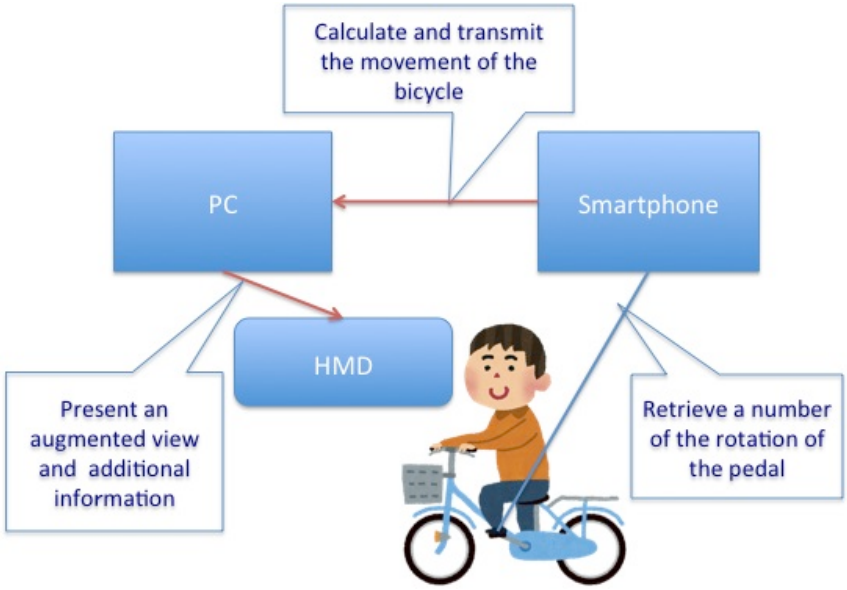

Figure 9: Augmented Bike

When using the *Augmented Bike*, an application program displays the images that enhance a user's current real view on an HMD 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 gamification effects using graphical changes.

In this paper, we abstracted game mechanics from the video games that immersed players and developed a framework for pervasively motivating diverse people as described in Section 3.2. In this case study demonstrating how to use the proposed framework to design a social platform, we chose one game mechanism from each factor of Seligman's five factors for enhancing people's ability to thrive and used these mechanisms in the *Augmented Bike* to examine how our design framework helps to build a better car-free urban area affecting citizens' success.

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

4.3 Scenarios and Their Analyses

In this section, 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.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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 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.

The next section examines how to satisfy the factors in the PERMA model that cannot be satisfied in the previous two scenarios by the framework introduced in Section 3.

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* can be increased by introducing characters, *achievement* can be increased by introducing goal-setting, *meaning* can be increased by introducing dynamic graphical changes, and *relationships* can be increased by introducing a close sense of others. In this case, we introduced user reviews of sightseeing spots or the surrounding scenery. E*ngagement* can be increased by music and special

graphic effects. To achieve this goal, we believed that incorporating fictionality into real space [17] 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.

(1) 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.

(2) 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.

(3) 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.

(4) 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.

(5) 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.

(6) 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 emo-*

tions, *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.

4.4 A Current Augmented Bike Prototype System and Its User Study

The current prototype *Augmented Bike* uses Oculus Rift as an HMD. In a typical case, the video that is captured from the real world by a camera attached to Oculus Rift is shown to a user so that the user can use his eyes to see his surroundings and simultaneously see virtual scenes generated by virtual reality technology, as shown in Section 4.2. The current prototype identifies a user by fingerprints taken before and after using the *Augmented Bike*. In addition, a smartphone application runs on Android OS, and we use Unity as a platform to execute our applications both for Oculus Lift and the smartphone. The programs are written in C# and use Node.js to communicate between two application programs. The smartphone application monitors the movement of the pedals of the *Augmented Bike* using an acceleration sensor and transmits the information to a PC. The program running on the PC generates images to Oculus Lift.

Currently, a contact-lens-type HMD is under development[8]; thus, the prototype described in this section is a realistic possibility in the near future. Our current prototype must use a desktop PC now although the prototype will work on a more powerful smartphone in the near future.

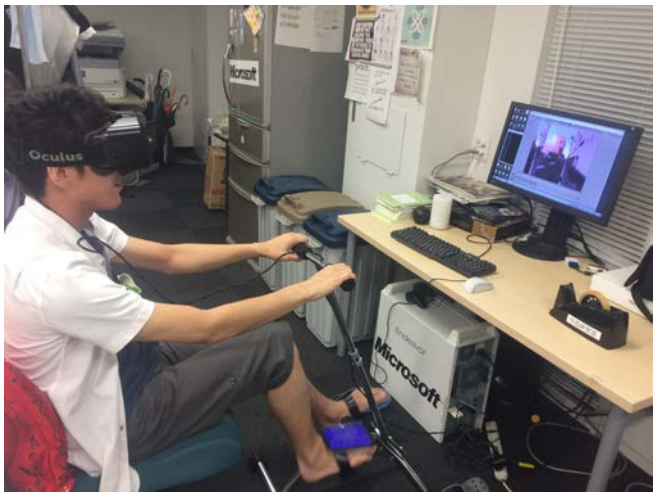

Figure 10. The Experiment Using the Augmented Bike

We conducted a user study to clarify the following two points: the problem of in fact utilizing the *Augmented Bike* and whether the *Augmented Bike* improves the well-

[8] Contact lens with integrated inorganic semiconductor devices, H. Ho1, E. Saeedi, S.S. Kim, T.T. Shen, and B.A. Parviz, IEEE, Micro Electro Mechanical Systems, MEMS 2008, Tucson, AZ, USA, January 13-17, 2008

being of a user. To clarify these points, we recruited 5 male participants to pump a pedal while watching scenery on Oculus Rift, as shown in Figure 10.

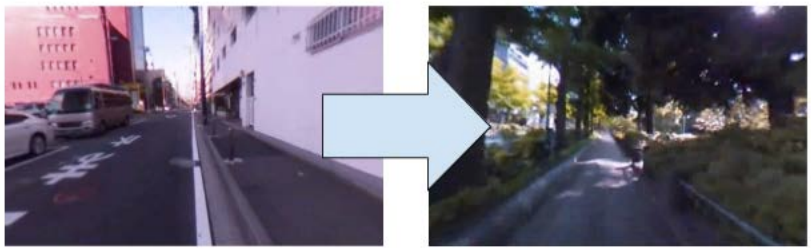

Figure 11. Changing the Scenery from Drab to Fictionally Beautiful

Figure 12. Notifying on an HMD

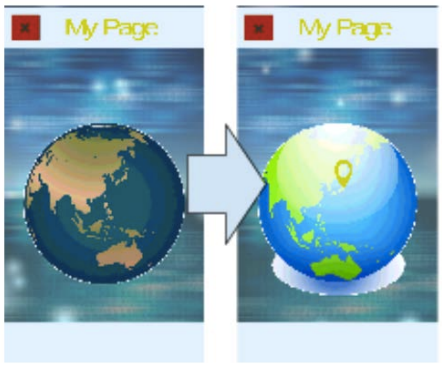

Figure 13. Smartphone Application

Figure 14. History Map

The experiment comprised several steps. First, we asked a participant some questions regarding a rental bicycle service and explained our scenario as described in Section 4.3. We then asked the participant to begin the application as shown in Figure 13 and to check the polluted earth graphic on his/her page. The experiment using the *Augmented Bike* began. In this experiment, the system showed the participant the real but unsightly scenery on the road the participant was in fact pedaling along, as shown in Figure 11. The scenery then changed to the beautiful fictional scenery of a lovely

tree-lined road. We explained that the participant had arrived at a tourist spot, and the system changed to the natural scenery of the spot. The system also began to play music appropriate to the scene, and a notification of word-of-mouth input from other people regarding the beauty of the place was inserted into the scene. After that, the experiment using the *Augmented Bike* ended, and we requested that the participant begin the application again. The participant looked at the picture of the cleaned earth on his/her page as shown in Figure 13. Then we asked the participant to touch a pin to the earth and look at a history map of the road he had pedaled along as shown in Figure 14. Finally, we asked him some questions regarding this experiment.

In our user study, we discussed the following two points with participants in terms of Seligman's five factors:

(1) How does the Augmented Bike affect the achievement of a sense of well-being?

Positive Emotion: Participants who chose to enjoy the original, non-augmented bike tended to disagree on whether the *Augmented Bike's* changing of the scenery was enjoyable. Although many participants answered, "*It is fun because the scene is not boring, but fresh,*" some participants said, "*Although the scene was changed into a beautiful open field, I still worried about crashing.*" These results inspired us to design a solution that the system only changes the scene when the user wants the scenery changed.

Accomplishment: Although the participants agreed that the rider felt a sense of accomplishment seeing the line drawn on the history map in the *Augmented Bike*, one participant said, "*I didn't feel a sense of accomplishment because the scene was changed by the system, and I can't comprehend that the line is really my track.*" We concluded that it is better to use a real map and to incorporate the achievements of traveling distance as game mechanics.

Meaning: Although a participant said, "*It is good to give feedback that represents the user's contribution to environmental issues,*" most participants disagreed that the participants felt a sense of contribution when the graphic of the earth in the *Augmented Bike* became beautiful after cycling. The respondents noted that the graphic change was too exaggerated for a contribution from an individual's bike ride. We concluded that it is better to use numerical feedback or graphic changes representative of real efforts.

Positive Relationships: Whether participants enhanced positive relationships when a review window appeared in the *Augmented Bike* divided the respondents. Some participants said, "*I felt ... a positive relationship with the strange reviewer because I can share the nice place with him,*" whereas others said, "*Reviews only give me some information. They never create positive relationships because the writer is not in front of me*." In addition, one participant said, "*It is irritating for a window to appear in my line of sight during cycling.*" We concluded that an SNS that provides communication with other users after cycling is better than using game mechanics during cycling.

Engagement: Although one participant said, "*It's like I was in a scene of a movie when I heard the BGM, and I could devote myself to it,*" most participants disagreed that the biker can be engaged in cycling when the BGM is played by the *Augmented*

Bike. BGM can enhance positive emotions rather than engagement for most participants. In addition, some participants said, "*I want to enjoy the scene and feel the wind rather than listen to music.*" Consequently, how BGM helps to create engagement depends on how the user enjoys cycling.

(2) Are there any potential pitfalls when deploying the Augmented Bike in the real world?

In our case study, we designed a system that makes users aware of their contribution to environmental issues to create meaning for users; however, the feedback was too exaggerated to be realistic and did not motivate users to use rental bicycles. Most participants noted that using environmental issues is a weak incentive to use a rental bicycle. To make people continue to use rental cycles, it is necessary to use approaches that are closely identified with individuals such as health or economic incentives such as discounts provided by neighboring shops when users arrive by bike.

In addition, there are few cycling roads in Japan. A cyclist who uses a car road may be hit by an automobile, and using sidewalks may cause an accident with a pedestrian. Many places are dangerous for cyclists, and there are few parking lots for bikes. In addition, many dangerous cyclists have bad manners because riding a bike does not require a license. Japan must build sufficient cycling roads and parking areas and enact traffic laws to familiarize the Japanese with bicycle safety.

In this experiment, we used a Desktop PC to render real-time videos on Oculus Rift. We used the PC in a room with a pedal cycling machine and some movies captured by a 360 spherical camera. This process of changing drab scenery to beautiful scenery was not well-received by the participants. A participant who was bored with cycling among drab scenery may not be appeased by a long stay in a tourist spot. If we use a compact gaming PC and conduct the experiment out of doors in safety, we could more efficiently satisfy this condition, leading to improved evaluations of changing scenery.

In addition, the degree to which the participant generally enjoyed cycling made a difference in the relation between game mechanics and Seligman's five factors. However, we did not analyze this relation in detail because we used so few participants. We believe that this system will support the use of a rental bicycle with an appropriate approach to the user and be more effective if we conduct an experiment with more participants, evaluate the *Augmented Bike* compared with how the user generally enjoys cycling and analyze the difference.

5 Lessons Learned from the LCC Case Study

This section examines the two lessons learned. 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 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 [35], 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, as shown in [17], 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 [28], 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 [39] will become a powerful theoretical foundation utilizing digital games' full powers to persuade people to enhance their communities.

Libertarian paternalism is a legitimate concept with which public institutions may influence human behavior without sacrificing freedom of choice. In [37], 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 peo-

ple and how the presentation affects their decision-making [38]. 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 [15]. 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.

6 Conclusion and Future Directions

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 proposed a framework for designing a social platform for diverse people. The framework was extracted from workshops we conducted, from examining many commercial digital games and from refinement using a Delphi card sorting method. We also 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.

As future directions, we are considering two issues. The first issue is to discuss the relations among similar frameworks. In particular, the *gameful digital rhetoric framework* [33], the *value-based analysis framework* [29], and the *alternative reality framework* [16] have been developed for designing effective persuasive affordances. We must examine how these frameworks are related and possible manners in which to integrate these frameworks into a more generalized model. The second issue is to explore the possibility of using advanced IoT-based technology to design persuasive affordances. Using sensing technologies allows us to develop persuasive affordances that are customized for each person. In addition, advanced wearable technologies may change the perceived meaning of real spaces. Technology allows us to develop more effective persuasive affordances. We must also discuss how the procedural rhetoric concept is related to the persuasive affordances that are enhanced by IoT-based technologies.

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