ECO-DIDACTIC DESIGNS IN THE CONTEXT OF SUSTAINABLE COMMUNICATION IN PUBLIC SPACES THROUGH PARALLEL REALITY DISPLAYS

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Türker Orhun and Ölgen Burcu. "Eco-Didactic Designs in the Context of Sustainable Communication in Public Spaces Through Parallel Reality Displays". idil, 111 (2023 Kasım): s. 1805–1816. doi: 10.7816/idil-12-111-03

ABSTRACT

Sustainable communication is a concept that is frequently used today and affects a broader area day by day. Many different applications and technologies are in development to use this concept effectively in daily life, and even public spaces are starting to be designed in this way. When the concept of sustainable communication is examined, not only the message but also how the message is conveyed is important. In this study, we developed a model regarding the design of the message given and how the designs are displayed in the public space. While developing this model, we examined the Parallel Reality technology, in the context of sustainable communication and associated it with eco-didactic contents. Parallel Reality allows a large number of people to have personalized digital experiences simultaneously on a single screen without using equipment. This technology qualifies communication systems to produce diverse content continuously with less screen usage. This unique and sustainable format creates a potential for the public spaces to be a "place of change" that constructs community dialogues resulting in eco-didactic environments. This study aims to use Parallel Reality technology to create eco-didactic environments that could serve the UN's Global Sustainability Development Goals (SDGs), regarding sustainable cities and communities. Parallel Reality could provide economically and technologically sustainable communication in public space while spreading ecological awareness and encouraging citizens to adopt sustainability in daily life. We ask how to transform public spaces people encounter the most into eco-didactic environments using Parallel Reality.

Keywords: Design, Sustainable Communication, Public Space, Parallel Reality, Augmented Reality

Makale Bilgisi:
Geliş: 10 Ekim 2023 *Düzeltme:16 Kasım 2023* *Kabul: 23 Kasım 2023*

Introduction

Parallel Reality technology has been foreseen to be used primarily in places with immense human traffic to prevent communication clutter. It allows sharing multiple contents on a single screen that is perceived differently depending on the user's position. Unlike other reality technologies, such as Augmented, Virtual, and Mixed Realities, Parallel Reality can be experienced without the requirement of a device. Accordingly, a broad diversity of content can be shared continuously with less screen usage, resulting in a sustainable system. Therefore, this technology offers an excellent opportunity for sharing ecology and sustainability related content in everyday public spaces, and this can create public learning environments, initiate community dialogues, and encourage action on the environmental issues. This paper focuses on the potential of Parallel Reality experiences to create eco-didactic public environments that can benefit goal number eleven of the United Nations Global Sustainability Development Goals (SDGs), sustainable cities and communities. Every day public spaces can become eco-didactic environments and "places of change" (Cucuzzella, 2019, p.283-285). Parallel Reality can potentially provide economically and technologically sustainable communication in public space, spreading ecological awareness and encouraging a sustainable life. Given these, we selected subway stations for this study to develop an engaging and informative activity in a public space that people frequently use in a daily basis. An eco-didactic Parallel Reality demonstration for subway stations was developed within the study.

Sustainable development consists of three crucial aspects. These are economic, environmental, and social. According to Harris, on a continuous basis, an economically viable system should have the ability to generate products and services, control government and foreign debt, and prevent extreme sectoral imbalances that could negatively impact agricultural or industrial production. To achieve environmental sustainability, it is crucial to ensure the maintenance of a stable resource base, prevent over-exploitation of renewable resources, and avoid depleting non-renewable resources without investing in adequate substitutes. Furthermore, this involves the preservation of biodiversity and atmospheric stability, as well as other ecosystem functions that are not typically considered economic resources. For a system to be deemed socially sustainable, it must attain equity in both distribution and opportunity, provide sufficient social services such as healthcare and education, ensure gender parity, and promote political accountability and participation (Harris, 2001, p.3-107).

Sustainable development in public space is a topic that has been studied frequently for a long time and from diverse perspectives. Many attempts have been made to create sensitivity and awareness on this issue (DeKay, 2011; Dobson, 2007; Reiter 2004; Sanei et al., 2017; Tweed & Sutherland, 2007). The United Nations carried out the largest of these initiatives in 2015. Leading countries have agreed on 17 Sustainable Global Goals (SDGs) to dissolve extreme poverty and combat inequality and injustice by 2030 (Url 1). Today, individual, and institutional studies continue to make a change in diverse areas, according to SGDs. One of the essential aspects carried out within the SDGs is to inform society in public spaces. It is known that public space can be used as a communication platform to inform and educate the public about the environment, global climate concerns, and the importance of sustainability (Keunhye Lee, 2021, p.9-15). In this context, public spaces can be designed as eco-didactic environments, where community dialogues on ecology occur, and the public is informed and educated.

Eco-didactic environments emerged from public places containing an art form that differentiates itself by carrying an ecological message. This art form is called "eco-art installation." Therefore, Cucuzzella argues that this art form demonstrates ecological concerns and contains the crucial need for explanation that shares the "eco-message" in the public space (Cucuzzella, 2019, p. 287-288). Eco-art installations of today are found in strategic areas in the public realm and form an eco-lesson they pursue to explain the current situation of the environment (Cucuzzella et al., 2020, p. 1-3). Both indoor and outdoor public spaces can be the potential environments for eco-didactic experiences. However, in this study, we focus on a transportation space, a subway station, which is a space that people constantly use.

Various technologies can be used in eco-didactic environments to enhance the learning experience and facilitate the understanding of complex concepts. Many technologies can be used to provide effective communication in eco-didactic environments. These technologies, which are used to make communication more effective, may vary within the framework of the environment, participants, and economic opportunities. Using this technology in eco-didactic environments aims to create interactive and engaging learning experiences that help visitors understand and appreciate the natural world and inspire them to take action to protect and preserve it.

Eco-didactic environments can be formed depending on the eco-art or eco-design installations that are demonstrated in the area. Following technologies have been seen in these installations: interactive displays and kiosks, Virtual Reality (VR) and Augmented Reality (AR) experiences, sensors and monitoring equipment, simulation and modelling tools and smart phone apps. However, comparing abovementioned technologies, even though Parallel Reality is a newly developed technology, it offers a highly innovative way of delivering messages to individuals.

Parallel Reality technology is an experiential technology like Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR). This technology simultaneously shows different content to dozens of people from a single screen. The imaging and pixel technologies specially designed for Parallel Reality allow each individual in the environment to see the customized content on the entire screen, which is specifically designed for them. This process can be applied by up to about a hundred people simultaneously. Parallel Reality technology is foreseen to be used mainly in crowded public areas, such as airports, subway stations, and other transport hubs. Additionally, the system contains a sensor that allows the pixels to direct light and colors according to the user's location. Thus, the customized content can be directed to follow the individual in the space with an angle they can always see. In this case, one person's content is only visible to another person if they look at it from the same angle.

Given these, we believe that Parallel Reality technology is closely related to sustainable development since it requires decreased screen usage for multiple contents. Every personalized content can be displayed simultaneously on one screen for a vast audience. Parallel Reality can offer a sustainable solution to the overconsumption of screens with standard pixel technology. This paper proposes a setup in which Parallel Reality is constructed in public space within the scope of the Sustainable Development Goals, goal number eleven: Sustainable Cities and Communities. We believe that Parallel Reality has great potential to support the SDGs, share their values, and create public awareness. In this context, the objectives are the following: (1) understanding the Parallel Reality, (2) revealing its meaning in space, and (3) creating content and relationships within the context of SDGs, and we construct the paper as follows: In chapter two, we define the fundamental notions of the study, which are Parallel Reality, sustainability, and eco-didacticism. This chapter also includes our methodological approach. The third chapter proposes our ideas on Parallel Reality experience in eco-didactic environments. Finally, last chapter presents conclusions and recommendations on the eco-didactic context of Parallel Reality technology in the public space.

1. Understanding Parallel Reality in Architectural Environments

In this section, we examined the Parallel Reality concept in the context of concept and technology. In 1994, the diagram developed by Milgram and Kishino was updated by including Parallel Reality. In addition, this section includes where and how Parallel Reality was introduced and in which field it is used today. Since this technology was first applied in a public area in the middle of 2022, the new information on the subject is limited. Although the resources on the internet were scanned in detail, and every updated information available was shared with the reader.

1.1. Parallel Reality

Technology is a phenomenon that changes daily, and these changes lead to the emergence of innovations in every field it touches. As in every field, there are technological developments in display technologies. Parallel Reality (PR) technology is one of the most recent examples that can be defined as an improved version of LED display panels. Parallel Reality allows the pixels on LED screens to transmit directional light and color. Today the pixels in LED screens produce an image with a linear angle and constant light intensity. However, PR technology allows pixels to distribute light and color versatilely. Thus, different, and personalized content can simultaneously be displayed on a single LED screen for dozens of people (Dietz & Lathrop, 2019, p. 34).

In Parallel Reality, digital content is presented to viewers as in other realities. This digital content is presented in Mixed-Reality (MR) and Augmented Reality (AR) regarding the real world, while Virtual Reality (VR) consists of a completely virtual environment that surrounds users. However, in Parallel Reality, it is possible to present digital content for the needs or interests of the audience in a way that does not reduce the users' connection with the real world, unlike the others.

Parallel Reality technology is an engineering product that emerged through technological development, just like AR, VR, and MR technologies. Development of the mobile devices and their supporting infrastructure expanded the usage area of Augmented Reality. On the other hand, with the development of head-mounted player equipment and three-dimensional image processing software, Virtual and Mixed-Reality technologies and applications have become widespread. The technologies that spread over a wide area of use have higher development speed.

1.1.2. The Concept of Parallel Reality

This title probes the context of the virtuality continuum diagram, which includes the real world (environment) and the virtual (digital) environment, AR, VR, and MR concepts. The virtuality continuum diagram was first used in 1994 by Paul Milgram and Fumio Kishino in a research paper on Mixed-Reality. In their study, the authors explained the theoretical underpinnings of MR using diagrams. One of these diagrams, the virtuality continuum, basically describes a line from the real to the virtual environment Milgram & Kishino, 1994, p. 1325). In the diagram: starting with the Real Environment on the left is the environment that people experience without using equipment or devices and where there is no digital content. In short, it refers to the real world we all live in and see. On the next point, the concept of Augmented Reality is placed; there is a digital layer between the physical world and the user. Augmented Reality is a technology in which digital content and the real environment are brought together and interact (Terzioğlu et al., 2023, p. 94). This digital layer is connected to the real world but not interacting. It is a digital layer formed by taking the real environment as the reference. However, the user in the physical environment interferes with the content (Chiang et al., 2022, p. 130). In addition, to experience AR, users must have a smart device. The third point is Augmented Virtuality (AV), which refers to the actual content added to the user's virtual environment (Flavian et al., 2019, p. 550). With AV, users experience more immersion in the virtual environment and fewer distractions from outside. A console and glasses are typically used together to create this designed environment. The last point of this diagram is the Virtual Environment, which defines Virtual Reality. There is no connection between the user and the Real Environment in the Virtual Environment. Users have this experience in an entirely digitally designed environment with wearable equipment and devices.

On the other hand, the concept referred to as Mixed-Reality in the diagram covers situations where the Real Environment and digital contents can be simultaneously independent of each other. As mentioned earlier, in Augmented Reality, the experience is realized by referring to the objects in the Real Environment. In Augmented Virtuality, most of the content is digital, and the part that is interacted with is experienced concerning the physical world. In both concepts, users are dependent on the physical environment. Therefore, Mixed-Reality encompasses these two concepts in the diagram. However, with technological developments and device evaluations, a concept has emerged that should be added to this diagram. Consequently, the concept of Parallel Reality has been added to Milgram's (1994) virtuality continuum diagram according to how the audience experiences it (Türker, 2022, p. 12).

Unlike other realities, in Parallel Reality, people can experience personalized digital content in the real environment without needing a device or equipment. Moreover, these types of equipment are sometimes less affordable than the average user can afford. While it is enough to own a smart device for Augmented Reality, purchasing special equipment for Virtual Reality or Mixed-Reality experiences is necessary. This disadvantageous situation is considered a significant obstacle to the widespread use of these technologies.

As mentioned earlier, PR technology creates digital content for each viewer. Compared to AR, it is clear that the digital content created is more relevant to the real environment. Therefore, it can be positioned between the Real Environment and Augmented Reality in the diagram. Thus, the concept of Parallel Reality is anchored as the first step between the Real Environment and virtuality.

1.1.3. The Terminology of Parallel Reality

Literature shows that the term Parallel Reality was first used by Hsu et al. (2013). However, in 2013, the term was only associated with the device's position when having an Augmented Reality experience, as today's technology still needed to be created. In the related article, the term Parallel Reality describes how the device used and held in experiencing Augmented Reality interacts with the object rather than information about today's pixel technology. Therefore, it is clearly understood that this term was not used in its current meaning.

Paul H. Dietz, one of the inventors of Parallel Reality and one of the founders of the developer company, Misapplied Science, was the first person to use the term "Parallel Reality" in its current meaning in the literature. It was first used in 2019 and the patent for this technology, whose creation started in 2014, was obtained in 2017. Although the patent was granted in 2017, people had to wait three years before they could experience this technology. Misapplied Sciences introduced Parallel Reality technology at CES 2020 in the United States. They designed two demo areas to showcase PR technology. Visitors were shown examples of how Parallel Reality technology works in these demo areas. In 2022, for the first time in the world, a LED screen with Parallel Reality technology was used at an airport (Url 2). The airport was the first choice to apply this technology because Parallel Reality offers personalized content for a large audience

(Dietz and Lathrop, 2017, p. 34). Besides, airports are known as areas with diverse and wide crowds, which makes guidance essential (Mijksenaar, 1997, p. 129). The term is named Parallel Reality because people can see different content while looking simultaneously at the same screen in space. This feature would position PR technology differently from all other developments in display technologies.

1.1.4. The Technology of Parallel Reality

Since this technology is only used by Misapplied Science today, no detailed technical explanation has been shared with the public. There is only one content-related publication which is the patent description titled "The Multi-view advertising system and method." Therefore, only limited information is available on how this technology works. This information was summarized here to provide insight into the technology.

In general, there is no difference between LED screens and Parallel Reality technology in terms of their external structures. Both displays use LEDs, and both look like conventional panels from the outside. The critical point here is the ground-breaking development of the pixels that build up the LEDs. Parallel Reality software and high-performance processor architecture allowed each pixel to be directed to one million angles (Url 3). It is a very complex system called full-stack technology. Apart from the standard pixel understanding, a unique optical system has been developed for this technology. The basic operating principle of Parallel Reality is as follows: All electronic devices we can see and use around us have a pixel infrastructure on their screen. These linear pixels transmit light and colors in one direction with the same intensity. In pixels developed with Parallel Reality (Multi-View Pixel) technology, the light can be directed to the desired location for each person, and different colors and light intensity can be transmitted to different angles simultaneously. This allows different content to be shown to many people in multiple locations in the same environment on a single LED screen. The sensor follows people in a specific area and aligns the pixels according to their location. This way, the images can follow people according to their perspective. The images transmitted to the person on the screen appear so that they can only be seen from the eye level of the person whose location is detected by the sensor. The sensors transmit the person's location they detect to the steerable pixels. No other individual than the targeted one can see this personalized content.

To explain the working principle of the technology in detail, we prepared a figure (Figure 1) which demonstrates that; the sensor (a) identifies the passengers who show the boarding pass to the scanner and detect (b) their position and height in a rectangular frame. Then, the passenger's position and height information are transmitted to the pixels (c) on the screen developed with Parallel Reality technology. The passenger (d) looks from the point of view (e), followed by the sensor, and sees the image (f), which is the personalized content, on the screen. The content, which is adapted to the information about the person whose position and the sensor determines height, cannot be seen by anyone at other angles. In addition, people detected by the sensor see the contents prepared for them on the entire screen, not just a part of the screen (Türker, 2023, p. 962).

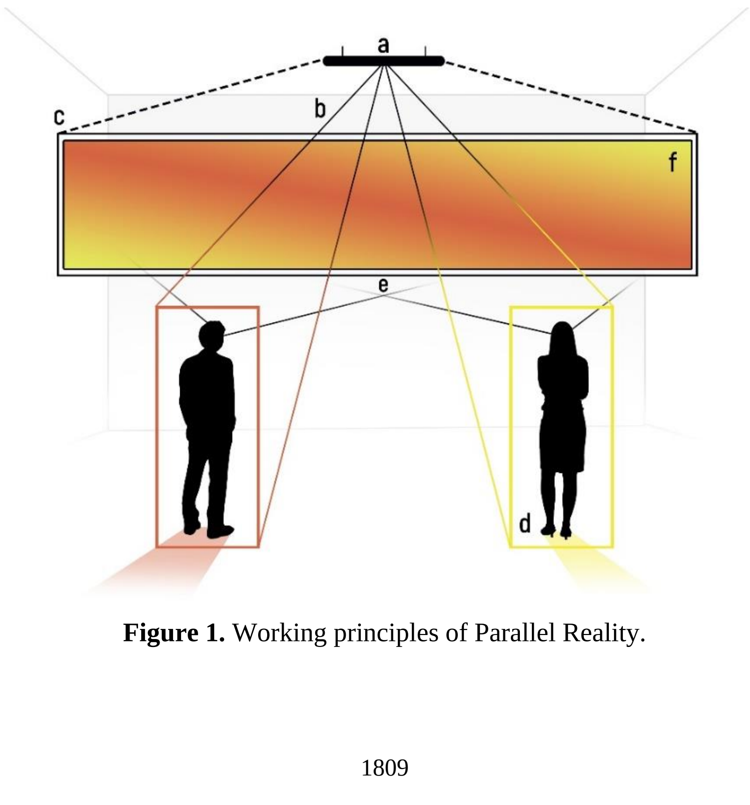

Figure 1. Working principles of Parallel Reality.

Given these, we believe Parallel Reality has great potential to perform sustainability in public spaces. Furthermore, it can contribute to personalized and efficient eco-didactic experiences in the public realm. With this intention, we provide information on eco-didactic experiences in the next section.

1.2. Eco-didactic Experience in the Public Environments

Public space is the most impactful place due to the high levels of human circulation during the day. It is the ideal place to create conversations on ecology and sustainability. It is a place that provides environments for exchanging ideas, identification of issues, and encouraging action. Keunhye Lee (2021, p. 14-15) claims that there are diverse engagement modes regarding different public space places: Symbolic landmarks or architecture, gathering places, and streets. People are encouraged to engage with each other and their surroundings in gathering spaces. This makes gathering spaces experimental environments. Landmarks and architecture visually impact individuals and directly affect their psychology and behaviors. Also, the façades of the buildings and landmarks visually contribute to the urban identity as memorable components of the city. Streets, however, are considered everyday spaces and have the highest potential to reach many people. They also create urban identity, moreover, reflect the mutual values and goals of the local citizens. Everyday spaces provide environments for people to have a chance to engage, experience, and communicate (Lee, 2021, p. 9-11).

Cucuzzella et al. state that "public spaces can become hinges for exchanging knowledge towards awareness and eco-action" (Cucuzzella et al., 2020, p. 11). Eco-messages, which carry essential issues such as climate change, can be shared in the public space. Community dialogues can be shaped on these issues, potentially creating behavior shifts. Art is one of the most effective mediums that can start these dialogues. Art speculating on ecological and environmental awareness is known as "ecological art" or "eco-art." Wallen says, "eco-art stimulates dialogue, sparks the imagination, and contributes to the socio-cultural transformations whereby the diversity of life forms found on earth may flourish" (Wallen, 2012, p. 235). According to Weintraub: "eco artists may be testing the limits of art's tolerance for change" (Weintraub, 2012, p. 5).

Kagan provides another description of ecological art from the "ecoartnetwork," an invitational network started in 1999: "ecological art embraces an ecological ethic in its content and form/materials. Artists considered to be working within the genre' generally subscribe to one or more of the following principles: (1) Attention on the web of interrelationships in our environment—to the physical, biological, cultural, political, and historical aspects of ecological systems. (2) Create works that employ natural materials, or engage with environmental forces such as wind, water, or sunlight. (3) Reclaim, restore, and remediate damaged environments. (4) Inform the public about ecological dynamics and our environmental problems. (5) Re-envision ecological relationships, creatively proposing new possibilities for co-existence, sustainability, and healing" (Kagan, 2014, p. 1).

Therefore, eco-art can state the eco-message in an aesthetic way that can have a captivating emotional influence on people (Simon, 2016, p. 145). More specifically, art can convince the public to take action on climate change and reflect sustainability in their behaviors and habits (Thomsen, 2015, p. 9-10). Meaning needs to be created to make the public internalize the eco-message. In the meaning-making progress, Karimioshaver et al. claim that these three aspects between people and the artwork are the most significant: relation, participation, and experience. It is crucial to provide engaging experiences for the public to relate to and participate in the shared content (Karimioshaver, 2021, p. 13-15). This can be achieved by creating personalized content for each individual in the public space. The multi-image sharing feature of Parallel Reality provides personalized content simultaneously with hundreds of people.

Considering these points, we propose a setup for an eco-didactic environment at the subway station using Parallel Reality technology regarding SDG's goal number eleven. We selected a transportation space due to the potential to reach a wider audience.

1.3. The Potential of Parallel Reality Regarding SDGs

This study elaborates on the SDGs, goal number eleven: Make cities and human settlements inclusive, safe, resilient, and sustainable. The 2022 SDGs report clearly states that an estimated 7 out of 10 people will live in urban settlements by 2050. Cities lead economic growth and contribute to global Gross Domestic Product (GDP) of more than 80 percent. The report envisions that if urban development is adequately planned, it can be sustainable and achieve comprehensive prosperity. The importance of open public spaces is highlighted in the report on their role in economic and social life, also the vitality of accessibility (UN, 2022).

According to the topic, sustainable cities and human settlements: "cities are hubs for ideas, commerce, culture, science, productivity, social, human and economic development,” and one of the relevant issues provided under this topic is the access to information. We believe Parallel Reality will have a vital role related to this issue in the future. There is great potential in providing sustainable information and communication in public spaces by reaching a vast public with reduced usage of screens. Moreover, allowing intentionally personalized access to the information could benefit the clarity of the shared message and facilitate the internalization process, which could lead to a change in behaviors.

This study adopts the reconceptualization approach where the theoretical groundwork of the Parallel Reality technology was constructed, and a concept was proposed on using Parallel Reality in eco-didactic environments. We have selected the content to display on the Parallel Reality screens, according to goal number eleven: Sustainable Cities and Communities of the SDSs. Within this approach, we followed a brainstorming method called “forced connections” to better understand how Parallel Reality can improve the eco-didactic experience and sustainability in the public space (Parnes, 1976; Burns, 1983).

This study is developed with a single resource on the subject in the literature; therefore, the research is carried out by elaboration on the concept knowledge, technical system, and application areas. The only relevant research on the subject was a conference paper by the team who created this technology. Thus, the insufficient of the resources on this subject, the fundamental information has been collected primarily from limited web sources. Also, the patent manuscript of the technology was considered for the technical structure. Furthermore, we designed the graphical content to present a potential showcase that could be used in eco-didactic environments with Parallel Reality screens.

2. Parallel Reality Display Concept with an Eco-Didactic Context

In this section, we designed a concept for Parallel Reality in an eco-didactic environment and provided an application setup. We designed a concept that can be applied in the real environment. Given that, the setting needs a ceiling to place sensors, an electrical connection for the system to work, and an internet connection to manage the system. Therefore, to integrate our concept, we chose a subway station due to the above-mentioned requirements and a high flow of people (Figure 2).

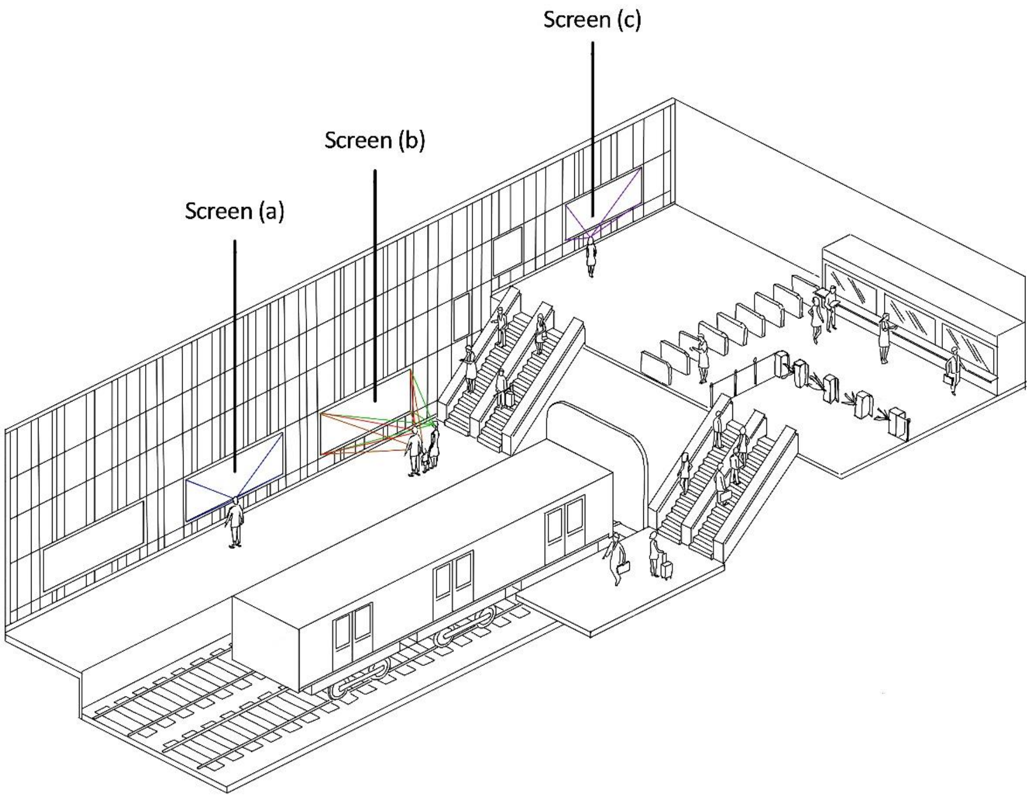

Figure 2. Parallel Reality Screen setup placed in the subway station.

This setup is based on the family standing in front of Screen (b) in Figure 2. A sample detail of the scene of Screen (b) is given in Figure 3. Screens are located in the most visible circulation spaces and placed according to the average person's height. Moreover, the architectural design suggested for this setup is based on the continuity of a pattern that covers the entire wall behind the screens. Integration of the screens with the space is important regarding holistic architectural design, by making the screens a part of the space.

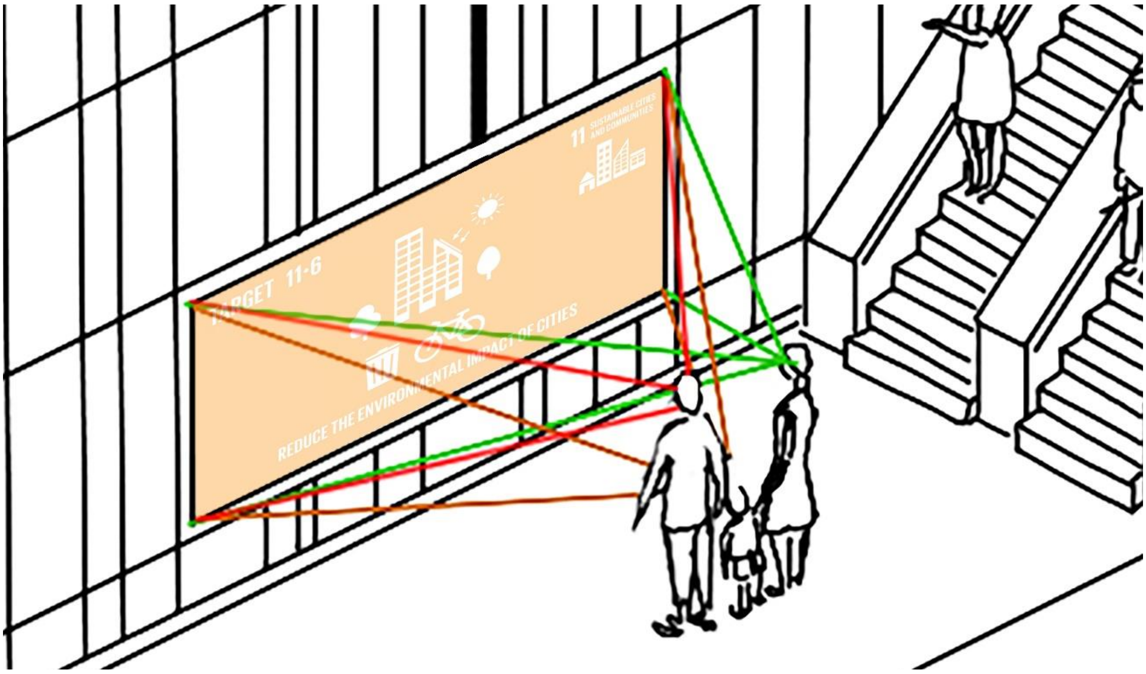

Figure 3. Detail of the previous drawing.

In this setup, we used the SDGs' sub-objective cover images to explain the subject on the screen clearly, and we included these images in the following figures. We chose these images as examples; a real-life application should include a visual communication design approach. Studies demonstrate that designing the content shown in these settings with emotions and proper visual communication design strategy increases the effectiveness of the content. For instance, in advertisement industry, it is necessary to adopt the right visual communication design to achieve better sales results. This strategy could be beneficial for better targeting the environmental messages. Optimized content can convey the targeted idea to the audience more clearly, creating a more compelling narrative language for people. An expert graphic designer should prepare visual communication design content for SDGs. It will be possible to obtain more efficient results from the content that is prepared for the target audience with specific purposes.

Three of the eleven SDGs targets used in this setup are shown in color in Figure 4. These are Target 11-2: Affordable and Sustainable Transporting Systems, Target 11-4: Protect the World's Cultural and Natural Heritage, and Target 11-6: Reduce the Environmental Impact of Cities.

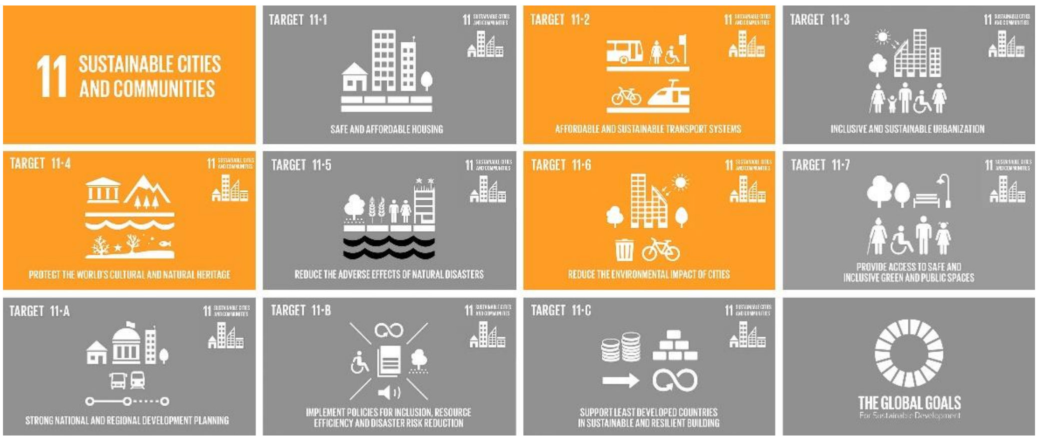

Figure 4. The selected sub-goals from the 11th SDGs.

For the setting, we determined the participants as a woman, a man, and a child and positioned them side by side, facing the screen as in Figure 5. We designated A, B, and C for the three different schemes in the figures. Scheme A represents the person and the content only he or she sees, scheme B represents how the ceiling sensor sees people, and scheme C represents each pixel bulb. Screen's processor directs light and color in pixel bulbs according to the coordination data from the sensor. In Figure 5, the participant sees content related to Goals 11-2. The sensor is activated so the concerned individual can only see this content. Sensors scan and track by enclosing the people in a rectangle, as in scheme B.

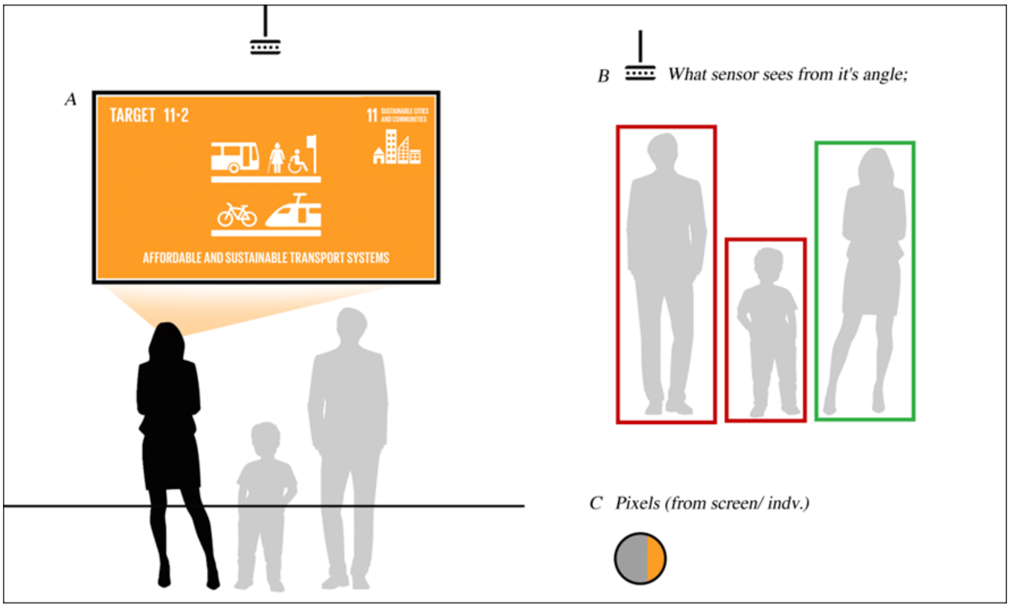

Figure 5. Descriptive image for Target 11-2 by woman’s viewport.

The contents in the example may contain different messages in different visual communication styles. For instance, for the 11-4 goal, content could share sustainable solutions in the transportation system with an everyday life example that participants better comprehend. If graphically aesthetic and relatable content is displayed, this could be more effective than a standard target of SDGs. Moreover, in Figure 6, the content can be designed specifically for children, which results in a more straightforward message on complex subjects like the protection of natural and cultural heritage. The content displayed for children can easily be divided since the sensors can detect people's position and height.

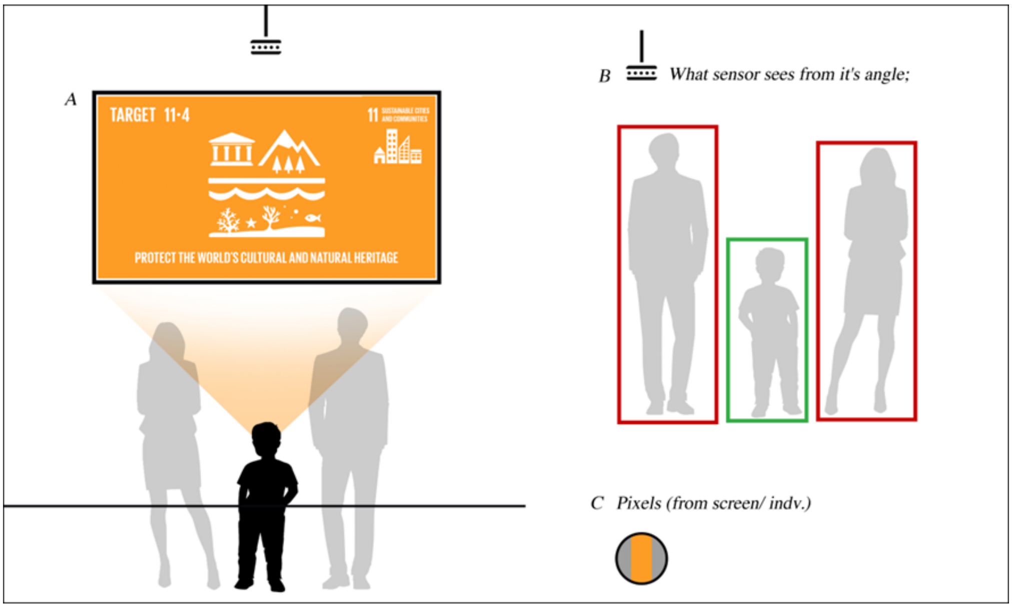

Figure 6. Descriptive image for Target 11-4 by child’s viewport.

In Figure 7, we illustrated the displayed content related to the target: Reduce the Environmental Impact of Cities. In this setup, the sensor focused on a single person, and the light and color in the pixel changed its position so that only one person could see it (C).

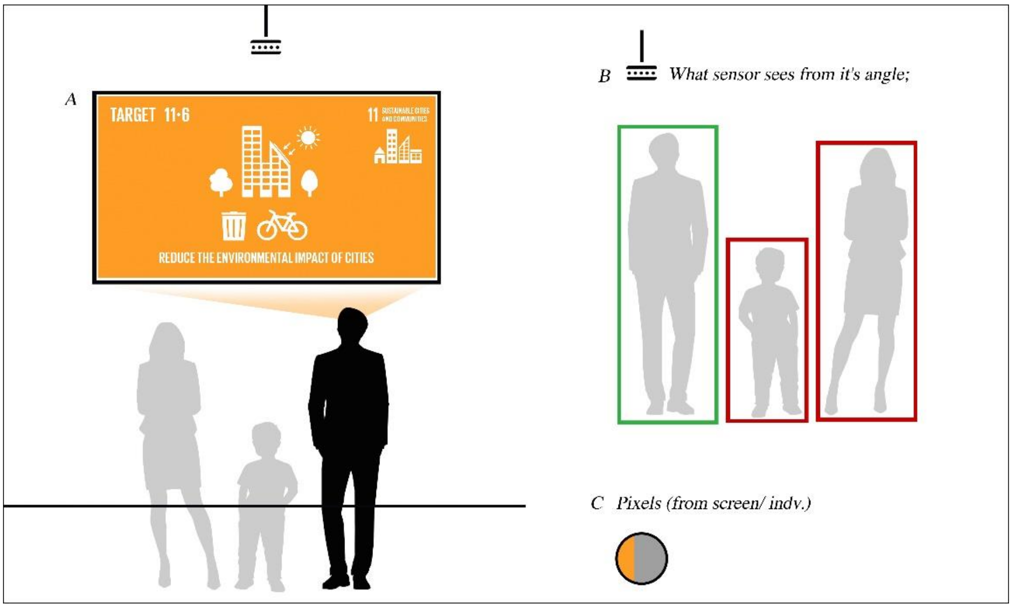

Figure 7. Descriptive image for Target 11-6 by man's viewport.

We created this demonstration with three individuals to illustrate the context and the idea more clearly. However, as much content can be displayed as the number of individuals in the environment. At this point, the sensors can simultaneously follow up to a hundred people from different angles. The sensors follow the individual and direct the contents on the screen according to their location until they leave the tracking angle. In this way, it is ensured that individuals can see content independently of each other.

The contents can be fixed to be viewed from a certain angle on the Parallel Reality screen. For example, a single piece of content can be edited for people who will see the screen from the right and a different content for people who will see the screen from the left. Thus, images can be transmitted to people at different angles with the most basic fixed angle without using a sensor. Alternatively, people can experience Parallel Reality with the GPS location taken from their mobile phones (Türker, 2022, p. 1131). However, sensor detection, one of the most basic methods, was used in this setup. As mentioned, the contents can be shaped according to the age group of the individuals. Therefore, we can provide more effective and permanent information about SDG targets.

Conclusions and Recommendations

Parallel Reality allows a large number of people to have personalized digital experiences simultaneously on a single screen without using equipment, unlike Virtual, Augmented, and Mixed Realities that require a device. This technology qualifies communication systems to produce diverse content continuously with less screen usage. This unique and sustainable format creates a potential for the public spaces to be a "place of change" that constructs community dialogues resulting in eco-didactic environments. Parallel Reality has a significant potential for sustainable public communication resulting in eco-didactic experiences by reaching a vast audience in many urban spaces. This eco-didactic application of Parallel Realty benefits the UN's Sustainable Development Goals regarding sustainable cities and communities and allows public spaces to become places of change while providing sustainable personalized communication. This study aims to utilize Parallel Reality technology to create eco-didactic public environments that could serve the UN's Global Sustainability Development Goals (SDGs): regarding sustainable cities and communities. Based on the decreased screen usage that Parallel Reality proposes, we structured a hypothesis that speculates the potential of Parallel Reality to provide technologically and economically sustainable communication while creating environmental awareness and elevating sustainability in public space. We questioned how Parallel Reality could transform public spaces people encounter the most into eco-didactic environments. Therefore, we proposed an eco-didactic setup using Parallel Reality technology to communicate sustainability and environmental matters with the public. Due to high daily usage, we chose the subway station as a sample public space for this setup and developed informative and engaging environmental communication.

Rapidly advancing climate change requires immediate attention from all possible perspectives. In this regard, public communication is vital in the collective action plan. Parallel Reality allows specifically personalized and targeted information to be received by the correct individual, which could increase the clarity of the given message and the relatability of the meaning. Therefore, this creates great potential for the individual to internalize the shared message, creating dialogues and even changing behaviors. Given these, some key points need to be taken into consideration when utilizing Parallel Reality for environmental communication in public space:

- Screen Location: The most circulated spaces must be chosen for the correct location.
- Architectural Design: Screens must be spatially integrated for a holistic architectural design experience.
- Context Design: Virtual Communication Design must be applied in the shared messages that are strategically designed by a professional graphic designer with the support of an educators' team.
- Targeted Individual: The audience must be categorized carefully to provide information (e.g., different age groups) correctly.

Parallel Reality technology is only used at one airport today, and product development processes continue. When this technology becomes more accessible, using it in different fields will be inevitable. At this point, it may be necessary to get opinions about the content from experts in different fields and to benefit from their experiences. These applications will likely be used more quickly, especially in cultural areas and advertising. For instance, no study has yet been found in the architecture field examining Parallel Reality. Considering the possibilities offered by this technology, many works can be produced in the architectural field. This area is closely related to spatial adaptation of the Parallel Reality screens, the relation between their function and the interiors, as well as the architectural navigation design and even façade design. Parallel Reality can also be used to direct human traffic indoors and outdoors. Directing the masses of people to the correct exit in emergencies is also possible with today's other technologies, but it will be feasible to obtain even healthier results with Parallel Reality. However, since these systems are not widespread, the cost is thought to be very high. With the widespread use of Parallel Reality, the costs will decrease, and it will be a high-technology product that institutions will prefer.

The sensor infrastructure in Parallel Reality technology could be used effectively by empowering it with Artificial Intelligence (AI) technologies. AI can be used to classify people with the information in the database and show them more specific information. Therefore, the content will be delivered to people as individual targets, not mass targeted. Artificial Intelligence has not been used with Parallel Reality before. However, considering the development speed of the technology, it is foreseen that the use of these two technologies together will take place shortly. This subject will be examined in further studies.

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Figures:

Figure 1-7: Designed by authors.