**Liubomyr Vytvytskyi1, Anna Gurynovych2**

*1 Lviv Polytechnic National University, Lviv, Ukraine, liubomyr.vytvytskyi.pp.2023@lpnu.ua*

*2 Lviv Polytechnic National University, Lviv, Ukraine, anna.s.hurynovych@lpnu.ua*

**INTEGRATING PHYGITAL SOLUTIONS IN SMART CITIES TO ENHANCE ACCESSIBILITY**

It is stated that the population of the Earth is above 8 billion now. According to the World Health Organization (WHO), 16% or 1,3 billion live with disabilities. Furthermore, more than half of the impaired people live in cities. The key to improving their quality of life is smart cities. According to International Business Machines Corporation (IBM), smart city means an urban area where technology and data collection help improve quality of life as well as the sustainability and efficiency of the city operations. Technologies are the heart of this city type. The question is what can be done to alleviate the living conditions of the disabled people. The proposed solution is the Phygital concept.

Phygital concept was coined by Chris Weil in 2007. According to the marketing dictionary of Monash University, it is defined as a bridge between the digital world and the physical world with the purpose of providing unique interactive experiences for the user. [1] The most famous example of the concept being implemented is the Pokémon go. It is an app where people need to catch Pokémons using their smartphone’s camera and GPS aiming to grow their collection. The game, created in 2016, still has about 90 million active users in 2024.

One of the challenges in implementing the phygital experience is working with old buildings that require refurbishment to meet the needs of the disabled. A case worth noting in implementing the phygital experience in an old infrastructure of the New York subway system, first operated in 1904. In 2020 the Transit Tech Lab launched a startup competition, where they chose 9 companies to improve accessibility. Among them was Okeenea Digital with its audio-based indoor navigation app Evelity. It is adapted for all type of disabilities and can easily build the best route regarding person`s special needs. Later, the underground was equipped with beacons to advance the accessibility even more. The field of interests of Okeenea Digital covers not only underground and public transport, but also includes workplaces, universities, museums and hotels.

Another example worth mentioning is Tactile Studio, specializing in designing educational solutions enhanced by sensory experiences – touch, sound, smell. The Tactile studio promotes the phygital concept through the idea of the interactive hybrid between physical (gestures) and digital (screens). It requires programming, modern electronics, 3D modeling and involving the leading experts. One of their greatest projects was visualizing 16 stations, creating a tactile trail at the Pavilion de I’Horloge at Louvre. [2] On the path the visitors can find the archaeological sights and identify the specific period to which it belongs, as well as the explanation of the decorative elements with the ability to touch the reproductions. In this case, the sensitive consoles with infrared sensors are placed in every room, allowing interaction by passing the hand over it to light up the corresponding room and get the information about it. The Tactile studio provides a comprehensive experience with audio devices and Braille text. Furthermore, Louvre is equipped with video materials with sign language specifically for the hearing-impaired people. The actors in the videos wear historical costumes to make the experience more immersive and entertaining.

Another point we would like to cover is the significant progress in creating application for the visually impaired people. TUAT corp. – a South Korean company that introduced artificial intelligence in their application Sullivan+ in order to recognize and vocalize objects from photos. It helps blind and low-vision individuals experience the phygital concept and understand what is around them. Implementation of the artificial intelligence makes this app accessible all around the world, irrespective of a particular city or country. Furthermore, Sullivan+ makes it easier to get acquainted with a new person because of the built-in Face recognition that can identify the age and gender. Color recognition supports single-color mode, that describes what color is in the center of the photo, and full-color mode, that indicates what color covers a large part of the entire screen. Alongside that, the Light brightness function helps the visually impaired people facing problems with understanding how bright it is around them. It can also describe the surroundings and thus help to navigate the unfamiliar spaces. [3]

Similarly, an application Lazarillo aims to make commuting easier and more efficient for the disabled people. It offers audio navigation with real time updates and multiple layers of information with the concept of the smart city in mind. As a person walks, Lazarillo will announce places of interests, streets, intersections, restaurants, shops and transit areas. In addition, it can create routes within the map and guide the users on their way to the destination. The developers offer specific personalized services to particular businesses, which include not only mapping and creating the digital plan of the facilities, but also can add accessible and interactive digital information to their physical space. [4] Applications like Lazarillo are easily-applicable in smart cities as they do not require major refurbishment, but rather work with the existing environment and Big Data.

It is of utmost importance for Ukraine to implement the advancements focused on supporting people with disabilities, particularly in light of the full-scale Russian invasion. Furthermore, constant technological developments are to be considered, as they enable to combine innovations with the existing surroundings. Ukraine promotes the phygital concept in smart cities too. For instance, in Lviv there is a project that allows the impaired people to do sightseeing and manage daily tasks. The extension to the Google maps is developing constantly and is available on any device with the access to the Internet. It was introduced in February 2024. It includes more than 100 places for visitors with different types of disabilities, providing a more inclusive environment for tourists and citizens. Restaurants, hotels, museums, administrative buildings, libraries, hospitals, parks and places for entertainment are listed, while the convenient search by category improves the user experience. [5] The Accessible City map is supported by the city council, making this project a state-endorsed one.

To sum up, smart city is about improving quality of life for every citizen using leading edge technologies and data collection. Phygital concept is the cornerstone of the smart city. It allows to implement features for the impaired people through interacting with city using different devices. The examples covered in the paper allow to trace the latest developments in the field. The first company Okeenea Digital developed Evelity app that helps disabled people to find their way by installing Beacons in New York’s underground and improve the phygital experience. Secondly, Tactile Studio that specializes in enhancing sensory experiences, have been cooperating with the Louvre Museum for 11 years, having visualized 16 stations with tactile path. Thirdly, TUAT corp. enriched the market by creating Sullivan+ that uses AI to process photos in real time, describes them using audio to facilitate commuting. Lazarillo creates the best route for its users and announces places of interests during a walk. A modern example of such technologies being implemented in Ukraine is the Accessible City map in Lviv. It provides the list of more than 100 accecible places. Projects like these create phygital experience and have a significant impact on life of disabled people, making the reality of Smart cities closer. Thus, it is necessary to support and invest in projects to alleviate everyday life of the impaired people.

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