

Quantifying Citizens' Well-Being in Areas with Natural Based Solutions Using Mobile Computing

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Abstract. Urban planners, architects and civil engineers are integrating Nature-Based Solutions (NBS) to address contemporary environmental, social, health and economic challenges. Many studies claim that NBS are poised to improve citizens' well-being in urban areas. NBS can also benefit Public Health, as they can contribute to optimising environmental parameters (such as urban heat island effects, floods, etc.), as well as to the reduction of diseases, as for example cardiovascular ones and the overall mortality rate. In addition, the usage of mobile health (mHealth) solutions has been broadly applied to support citizens' well-being as they can offer monitoring of their physical and physiological status and promote a healthier lifestyle. The aim of this paper is to present the specifications, the design and the development of a mobile app for monitoring citizens' well-being in areas where NBS have been applied. The users' physical activity and vital signs are recorded by wearable devices and the users' locations are recorded by the proposed mobile application. All collected data are transferred to the cloud platform where data management mechanisms aggregate data from different sources for combined analysis. The mobile application is currently available for Android and iOS devices and it is compatible with most smart devices and wearables. The "euPOLIS by BioAssist" application can be used as a health and other data collection tool to investigate citizen's well-being improvement in areas with NBS.

Keywords. Natural Based Solutions (NBS), Mobile Systems, Well-Being, Pervasive Computing

1. Introduction

Urban planners, architects and civil engineers are integrating Nature-Based Solutions (NBS) to address contemporary environmental, social, health and economic challenges [1-2]. NBS can be characterized as a new way for environmental management by applying solutions such as "green" roofs or walls to cool down urban areas during summer, to capture and save rain water, to reduce pollution, and to increase human well-being while enhancing biodiversity [2]. Apart from the contribution of NBS to the

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environment, many relative studies claim that NBS are poised to improve citizens' well-being in urban areas. Specifically, citizens' stress levels have been reduced, while physical activity levels are increased within NBS areas. NBS can also bolster Public Health, by contributing to the optimisation of relevant environmental parameters (e.g., urban heat island effects, floods, etc.), thus reducing the risk of diseases, such as cardiovascular ones, and, consequently, mortality rates [3].

Meanwhile, the usage of mobile health (mHealth) solutions has been broadly applied to support people's well-being [4-6]. mHealth applications have been used to support patients with cardiovascular diseases [7] with very promising results. Many studies also present the value of mHealth in the well-being of mental health patients [8,9]. The usage of mHealth technologies has been also linked to highly positive impact on public health [10,11]. By measuring and continuously monitoring the user's physical activity and vital signs, mHealth applications can be used to collect and analyse biosignals to ensure the users' good health status [12-17]. Finally, mHealth solutions can encourage a healthier lifestyle through coaching mechanisms that promote physical activity [18,19].

The aim of this paper is to present the specifications, the design and the development of an mHealth app for monitoring citizen well-being in areas where NBS have been applied in the frame of the euPOLIS project.

2. Methods

In order to achieve the aim of the study, requirement analysis took place, based on the potential user needs, as these were described by urban planners in the municipalities of the test areas (demo sites of the euPOLIS project) and medical experts. User requirements were collected through interviews from November 2020 until May 2021. The specifications of the mobile application for monitoring citizen well-being in areas where NBS are applied include location tracking, the timestamp of the visits in the areas, as well as recording of specific biomarkers, such as physical activity (number of steps, daily exercise, walking/running etc.), heartrate, SpO₂, sleep quality, and stress levels.

To collect the aforementioned data, citizens need to use a mobile phone and a wearable device, such as a smartwatch or a smart-band. Figure 1 (a) presents the recorded data flow. The user's activity data and vital signs are recorded by the wearable devices and the user's location is recorded by the mobile application. All data are transferred to the cloud platform, where information from different sources is aggregated for combined analysis. The final recorded data will be further analysed to examine the impact of the NBS on citizens' well-being.

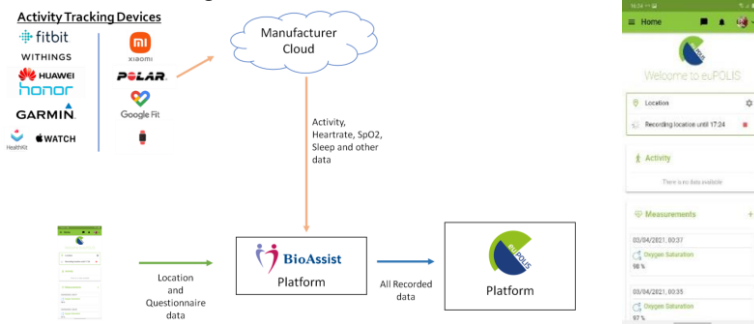


Figure 1. Collected Data Flow (a) and Mobile Application Screenshot (b)

3. Results and Discussion

A mobile application has been developed (Figure 1 (b)) to monitor the users' daily physical activity and other variables related to citizens' well-being in areas with NBS. The mobile application is currently available for Android and iOS devices and it is compatible with most commercially available smart devices and wearables. The proposed solution supports integration on the platform level, where the acquisition of measurements takes place via services supported by the cloud platforms of the device manufacturers (i.e., Apple Watch, Fitbit, Garmin, Polar, Withings, Xiaomi, Huawei, etc.). For data storage and data exchange, HL7-FAIR standards have been adopted to ensure the validity and the reliability of the system.

Users can activate the location tracking feature any time they visit the NBS pilot sites and they can also respond to related questionnaires, which are available through the mobile application. In addition, the application offers a timeline of data related to the user's physical activity and vital signs measurements. Users have access to their historical data through the timeline and can also apply filters and view the information in graph format.

The "euPOLIS by BioAssist" application can be used as a health and other data collection tool to investigate the potential improvement of citizen's well-being in areas with NBS. Relative studies have used comparable approaches to monitor people's well-being and public health using similar mHealth applications [6,11]. The expected value of the proposed application is to collect reliable and accurate data to examine citizens' well-being in an "easy-to-use" and relatively non-intrusive manner.

4. Conclusions

The aforementioned application is developed in the context of the EU-funded project "EuPOLIS - Integrated NBS-based Urban Planning Methodology for Enhancing the Health and Well-being of Citizens: the euPOLIS Approach", aiming to deploy natural systems to enhance public health and well-being and create resilient urban ecosystems. The project's solutions will be tested in four cities: Belgrade, Lodz, Piraeus and Gdansk.

Future work includes the analysis of the collected data using specific indicators to measure the improvement of the participating in the pilot study citizens' well-being, as well as the enhancement of the current mobile application with additional features for achieving more comprehensive and pervasive monitoring.

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