

# Improving the Impact of Wearable Devices in Health Promotion and Wellbeing: the WEHMIX Project

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**Abstract**— The promotion of healthy lifestyles has become a priority to tackle the spread of chronic diseases. Digital technologies, such as wearable devices, show great potential to support positive behaviour change and enable healthier behaviours. The WEHMIX project aims to offer new tools and a new user experience to improve the effectiveness and impact of these technologies for health promotion. This paper illustrates the results of the pilot testing of WEHMIX in two separate settings and scenarios of use.

**Keywords**—wearable; platform; user experience; impact; digital health.

## I. INTRODUCTION

The rise of chronic diseases represents one of the major challenges for health and health care systems worldwide. According to the World Health Organization (WHO), such diseases – in particular cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes – cause the majority of global deaths and burden of disease, affecting in particular the elderly but increasingly also the young and middle-aged individuals [1]. Chronic diseases represent a burden also in economic terms: only in Europe, they absorb around 70-80% of the health care costs, and their negative impact on overall labour supply and productivity has been found to cause a relevant loss of Gross Domestic Product (GDP) and growth [2]. At individual and family level, chronic diseases can have dramatic economic effects, by reducing income and enhancing the costs of necessary care [1].

Fighting the chronic disease epidemic is therefore a policy priority at international level. Fortunately, a key role can be played by prevention, and in particular by primary prevention via the promotion of healthy lifestyles. Indeed, it is widely acknowledged that a considerable share of the global burden of chronic diseases could be reduced or avoided by promoting people's healthier behaviours, in particular by tackling 4 lifestyle-related health risk factors: tobacco consumption, physical inactivity, unhealthy diet, and harmful alcohol use. According to existing research, the adoption of healthier behaviours in these four areas could lead to a reduction of up to 80% the global risk of chronic diseases [3], although other factors as well play a key role, including stress and sleep habits [4].

The WEHMIX for Healthcare project (WEearable Human Machine Interaction user eXperience for Healthcare,

WEHMIX in short) aims to contribute to this challenge by proposing a new digital health solution in support of healthier lifestyles. In particular, WEHMIX proposes the integration of multiple wearable devices into a single platform, accompanied by personalised eHealth services to support the adoption and monitoring of healthy lifestyles. This paper presents the results of the pilot testing of WEHMIX in two different settings and scenarios of use. The paper is structured as follows: Section II illustrates the key project assumptions, highlighting in particular the potential of digital and wearable technologies for health promotion and behaviour change. Section III introduces the key innovations of WEHMIX and its distinctive features. Section IV describes the main outcomes from the work in progress, describing the WEHMIX technological platform, its pilot experimentation in the two settings, and the main findings from the user feedback and evaluation exercise. Section V illustrates the main conclusions of the study.

## II. MAIN IDEAS, MODELS AND ASSUMPTIONS INVOLVED

The use of digital technologies in the field of wellbeing and health promotion is a fast-growing trend. Indeed, there is increasing consensus around the fact that such technologies, and in particular mobile and wearable technologies, can contribute to more personalised prevention, monitoring, and self-management of disease. This consensus is reflected in a number of recent policies at international and national level (e.g., the European eHealth Action Plan 2012-2020) that support the adoption of e- and m-health solutions in various areas including health promotion.

Significant interest is raised in particular by an emergent plethora of wearable devices (smart watches, head/shoe-worn devices, wrist bands, smart shirts, clips, etc.) that are able to measure physical activity levels, as well as number of relevant biometric variables, providing valuable information on an individual's health, at any time and with increasing accuracy. As these devices become smaller, cheaper, and more widespread, interest in them increases; however, it should be noted that the use of such devices cannot be expected to automatically imply better health for their users.

A key question is the following: to what extent can wearable devices become effective and reliable tools for health promotion? To what extent can they have an impact beyond simple monitoring, towards actually promoting actual behaviour change for better lifestyles? A recent review [5] has looked at existing evaluation studies of these devices

and provides encouraging evidence of their impact on behaviour change; however, it also underlines that the effectiveness of these devices depends on a number of factors, including their capacity to incorporate adequate incentives and support. Indeed, it is acknowledged that people are empowered, i.e., acquire a higher control of the decisions and actions that affect their health [6], when a number of conditions are met: they are effectively informed about correct lifestyle choices, have a correct perception of their health and of possible risks, are motivated and can see the results of their virtuous choices, are technically and emotionally supported, and can rely on adequate decision support tools to make the best choices for their health [7]. In particular, the possibility to track one's improvements in physical activity seems to motivate people in a constant progress towards their goals, while at the same time it increases the perception of self-efficacy [5]. The user experience (UX) of these wearable devices is another critical factor, since it determines the way in which people "interpret, understand, gain motivation and act on their data" [8], and more generally contributes to determining the long-term retention and motivation to use the device, which has also been found to be a critical issue [9]. All these elements affect the effectiveness of wearable devices for empowerment and behaviour change, and call for their careful design taking into consideration also the human, beyond the technological factors.

The idea of the WEHMIX project is to develop an innovative platform and web app that can improve the user experience and added value of wearable devices for users, hence improving their impact on health and encouraging the change of individual lifestyles for good.

### III. INNOVATIVE FEATURES AND POTENTIAL OF THE WEHMIX PLATFORM

The key innovation features of WEHMIX can be summarised as follows.

First of all, WEHMIX allows users to connect different wearable devices to a single digital platform, purposely designed to aggregate the data and to organise it in a smart and easy-to-read way. Thanks to this, users have an immediate and unique access point to consult a synthesis of all their data, without having to access the app of each single device. Moreover, by supporting devices of different brands and types, WEHMIX does not bind the user to a specific brand or device, and if the user decides to change it, WEHMIX ensures perfect integration of the new data into historical records.

Secondly, WEHMIX gives users the possibility to create a personalised health/training plan, with specific goals and activities monitored. In doing so, WEHMIX offers value to a broad range of potential targets: sporty people willing to improve their physical activity, elders willing to monitor their health and prevent chronic diseases, or employees with sedentary jobs willing to improve their wellbeing and productivity thanks to a healthier lifestyle.

Thirdly, WEHMIX allows users to access personalised support from a team of health and wellbeing professionals, in particular for goal setting, data interpretation, and feedback

on progress made. In order to connect the user with the professionals, WEHMIX offers an internal chat service; moreover, it provides a specific platform interface for the professionals to visualise in real time the user's data.

## IV. MAIN OUTCOMES FROM WORK IN PROGRESS

### A. Technology Development

The WEHMIX platform is made of three main parts:

- a backend side, connected with devices from major brands
- a mobile app, to allow customers to interact with the data and with the doctor or coach from remote
- a web portal, for the doctor or coach to view the data recorded by the user's devices.

The core of WEHMIX is therefore a *modular* distributed platform that is able to interact with a high number and variety of devices (potentially, any) chosen by the users on the market. A modular model is used by WEHMIX to work with different kinds of data models of different brands and devices, retrieving data from the cloud and giving them back to the user and the professionals in a clear and standardized format. A broad variety of devices has been bought and tested by WEHMIX during past the 2 years, and finally, three devices have been chosen for the first development of the platform, based on an evaluation of quality, price, and errors. These are: Garmin Vivosmart smartwatch for activity and heart rate recording, Fitbit Aria scale for weight and body mass composition, and iHealth for blood pressure measurement.

WEHMIX is based on API LED architecture by the MuleSoft framework MULE ESB, which permits a quick integration with third-party API of different wearable device brands (Figure 1). With MULE ESB, we can expose different layers of API to control the system security. The mobile app and the web app are developed with Ionic and AngularJS framework and communicate with the server side via a JSON REST interface, exposed by the superficial layer of the stack of MULE ESB.



Figure 1. WEHMIX structure

In the eHealth environment, the standard that we decided to use is Open mHealth, promoted by a startup for the integration of all the eHealth services in the world. The idea at the basis of Open mHealth is clearly stated on the company's website: "In healthcare, common data schemas

are particularly important because of the semantic importance and complexity of health data. For example, the distinction between fasting and non-fasting blood glucose is critical to its clinical meaning [...] Our common schemas define the meaningful distinctions for each clinical measure, increasing the overall clinical utility of digital health data and improving the ability of developers to quickly build clinically usable products” [10].

Ensuring privacy of the data constitutes one of the main priorities for WEHMIX, and a constant area of research and improvement. After the first release, we moved our core database into CHINO.io, an awarded start-up focused on the privacy of health data, and started working in partnership with them on this project.

### B. Use Cases and Experimentations

The WEHMIX platform has been pilot tested with 20 people in two separate experimental settings and scenario of use: a Corporate Wellness (CW) scenario and an Active and Healthy Ageing (AHA) scenario.

The CW experimentation was done involving 12 employees of two insurance companies based in Milan. Each user received the monitoring devices (Garmin Vivosmart, Fitbit Aria, iHealth smart scale), was visited by 2 professionals (1 general practitioner and 1 personal trainer), and was given access to the WEHMIX platform and services. To start, each user set his/her own personal plan with the help of the professionals, subsequently they used the devices and platform to monitor their weight, body mass composition, sleep, heart rate, blood pressure, and physical activity, for a period of 3 months. The users could at any time consult their wellness plan and monitor progress via the mobile or web app of WEHMIX; the same data was also visible in real time by the professionals.

The AHA experimentation was developed with a group of 8 users aged between 50 and 67, recruited via a physiotherapy studio located in Cologna Veneta, a town in the Italian province of Verona. They included people with minor and temporary physical issues, which were taken into consideration but not directly addressed by the intervention. In this experimentation, the physiotherapist acted as the supporting professional for the user group, and a slightly different model was tested: the users were given only the Garmin Vivosmart bracelet for tracking physical activity, heart rate, and sleep, while the other two devices (iHealth sphygmomanometer and Fitbit Aria scale) were placed in the studio and used once weekly together with the physiotherapist.

The expected impacts of both experimentations were to raise awareness of users concerning their health and lifestyle, improve attitudes and incentives towards a healthier habit, improve trust in the new technologies for health, improve user experience and usability of the devices, enable the production of data in an easily shareable way, and ultimately improve health, wellbeing, and quality of life and work.

### C. User Feedback and Evaluation

The two experimentations were used as an opportunity to not only test the technology, but also better understand its

potential impacts, and to collect direct and practical feedback for improvement by the users. We carried out the evaluation using a two-step process, consisting of a pre-test analysis (aimed at capturing an initial profile of each user, understanding their previous experience with health and fitness technologies, and collecting their expectations), and an ex-post evaluation (aimed at analysing impacts and collecting actual feedbacks).

We used a qualitative evaluation approach, with a combination of standard questionnaires and in-depth individual interviews; this was considered ideal for the small number of users involved (which allowed for direct contact and more in-depth analysis), and for the type of feedback and indications that we aimed to collect at this stage.

Altogether, the evaluation confirmed the potential of WEHMIX, and the added value brought about by its key innovations. At the same time, the study shed light on the significant differences that exist in practice between the perceptions and preferences of different target groups, and pointed to the need to design specifically tailored solutions for different markets and scenarios of use. Moreover, the study brought the attention to the need to consider pre-existing limitations and barriers to the use of wearable technologies by each type of user, limitations that cannot be addressed directly by WEHMIX, but are nonetheless an important pre-condition for its success.

Below, we summarise the key points emerged from the feedback of the two experimental groups.

**Main uses of the WEHMIX platform.** The potential use and added value of WEHMIX was perceived differently by the two groups, which reported different priorities and expectations. In the CW scenario, the majority of the users looked at WEHMIX as a valuable tool for health promotion, i.e., for improving their overall lifestyle and everyday habits, with the goal of improving present wellbeing and preventing future diseases. The users of the AHA experimentation, on the other hand, were more sceptical about the possibility to change their behaviours and lifestyles under the stimulus of a digital technology, and were more interested in WEHMIX as a monitoring tool for keeping track of specific, already known, health conditions.

**Flexibility towards the use of different devices.** The possibility to connect different devices to the same platform, and to change them over time without losing their data, was perceived as positive by the majority of users in both groups. Nonetheless, this feature was perceived as more relevant by the CW group, especially by the most “expert” technology users, who were more likely to buy and change different devices over time. In the AHA group, the possibility to change devices was appreciated in theory, but not immediately perceived as a priority. Some users, however, showed concern regarding the cost of the devices, which suggests that the possibility to choose their own device (eventually opting for a “cheaper” one) could actually make WEHMIX more broadly accessible for them.

**Access to professional support and coaching.** The incorporation into the platform of a specific, professional coaching service was considered an important added value of

WEHMIX. In the CW group, this was considered the most important feature, and a truly distinctive feature. Users appreciated the initial health assessment and the support received in goal setting received by the professionals, at the same time they gave suggestions to improve the following interaction with them in terms of remote monitoring and periodic feedback. Users also pointed out that they would prefer the support of specific and complementary experts (e.g., nutrition specialist) rather than general practitioners. Similarly, the users of the AHA group argued that WEHMIX would hardly be valuable for them without the presence of a health professional that looks at the data collected by the devices. This was in line also with a generally lower trust of this group in the value of technology “alone” for the purpose of health and wellbeing. They further emphasised the need that the professional be a trusted person, and rejected the idea that he/she may be a “virtual doctor” (e.g., a chatbot), or a person that only operates from remote. The AHA users suggested that WEHMIX should partner with some trusted and recognisable health institution for this service.

**User Experience.** The interviews also collected feedback and suggestions regarding the user experience of WEHMIX. Part of the feedbacks concerned basic elements, such as the on-boarding process, the connection of the devices, and the functionality and visual features of the app. Other feedback concerned key aspects, such as the visualisation of the data: here the users stressed the importance of finding the right balance between quantity and clarity of the data displayed, and asked for more detail but without replicating the original source. The visualisation of personalised goals and exercises was seen as a critical aspect and some suggestions were given for improvement.

The most important feedback, however, concerned the desired level of interaction of the platform. In this respect, CW users expressed a preference for higher interaction (e.g., welcome messages, targeted alerts, weekly feedback, etc.), while AHA users preferred a lower level of interaction, avoiding push notifications except for emergency situations.

**Economic incentives and rewards.** A future version of WEHMIX is expected to include additional features, such as incentives (bonus, rewards, etc.) for the achievement of a certain target. Although this is not present as for now, we asked the users a feedback on this idea. The CW group gave positive feedback, expressing preferences for rewards, such as discounts on their health insurance premium, on the purchase of new devices, or on personalised health consultancies. The AHA group, on the other hand, expressed lower interest and in some cases scepticism: they pointed out that for them healthy behaviours are strictly motivated by the desire for good health, and the idea of a platform offering other types of rewards would make them suspicious regarding the actual quality of the services, which would be seen as more commercial and less professional in some way.

**Willingness to pay.** Lastly, we asked users about their willingness to pay. Most opted for a low amount (below 5 euros/month) for the basic functionalities of WEHMIX; nonetheless, it also emerged that if all the improvements discussed were introduced successfully, users would start comparing WEHMIX with alternative fitness and wellness

programmes (e.g., in gyms or specialised centres), and would be available to consider a higher price, given the higher flexibility offered by WEHMIX.

## V. CONCLUSION

The WEHMIX project aimed to provide an innovative solution for improving the impact and user experience of wearable devices in the field of health promotion and wellbeing. The main product developed by the project, i.e., a digital platform able to connect with different wearable devices of the user, and to support the provision of personalised services with the contribution of a team of health and wellbeing professionals, has been tested in two different scenarios of use to collect feedback and identify future challenges and possible improvements.

The evaluation performed confirmed the high innovation potential of WEHMIX, while at the same time shed light on the possible areas of improvement and further development. In particular, our findings shed light on the possible challenges and opportunities emerging from the specific targeting of this and similar services towards specific target groups and customer segments.

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