The Role of Design as Technology Enabler: A Personalized Integrated Predictive Diabetes Management System

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Abstract. According to the International Diabetes Federation, in Europe 59.8 million people have diabetes and the number will rise to 71.1 million adults by 2040. Research on new models of care organisation demonstrates that advanced technologies and ICT systems and services may have the potentiality to respond to the increasing burden of diabetes and the complexity of managing it, and, in doing so, to contribute to the sustainability of health and care systems. In this paper we propose the development of a new Personalized Integrated Predictive Diabetes Management System, based on a *design-driven approach* in contrast with the *technology–driven* one generally used in medical field. The Novel System here presented is called Dia_Friend, an integrated care models, oriented to the needs of the user and focused on the way *technology* is used and shaped for him, instead of on the mere instrumental use of it.

Keywords: Design-driven approach · Technology · User experience · Diabetes

1 Introduction

Diabetes mellitus represents a significant burden on individuals and healthcare systems in the European Union and beyond. In the world 415 million adults have diabetes and by 2040 this will rise to 642 million. Type 2 diabetes accounts for approximately 95% of diabetes cases in adult patients and about 20% of them are under insulin treatment.

The management of insulin therapy is indeed often problematic due to the several variables that affect glucose homeostasis and hence exogenous insulin requirement; the most important are food, physical activity, stress, and illness.

Therefore, patients under insulin treatment often suffer for severe glucose oscillations and hyperglycaemic or hypoglycaemic episodes. Hypoglycaemia, in particular, can disrupt many everyday activities and cause well-recognized neurological events such as coma and seizures.

Despite several emerging technologies have been developed, the management of diabetes is still anchored to traditional pathways. ICT services, for example, are not decision-supporting and not empowering the patients to the self-management of the disease. Indeed we want to develop a Novel System, *DIA_Friend,* thanks to which we are willing to re-design a smart health and care systems to develop integrated care models that are more closely oriented to the needs of patients and elderly:

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multidisciplinary, well-coordinated, anchored in community and home care settings, and shifting from a reactive approach to a proactive and patient-centred care.

The main objective is to go beyond the instrumental aspects of product use and usability and focus on the *user experience* by shaping the technology in a desirable and meaningful way for the user reasoning on the metaphorical and cultural level of the smart system. Briefly our focus is to make the technologies really *enabling and meaningful* for the final user.

2 User Experience and User Oriented Approach

We live in a world pervaded by new advanced technologies that have been changing the way we live and experience the surrounded. New technologies also enable product innovation at different levels. Nevertheless, innovation doesn't lie just in the technological development and in its hard aspects but also in the meaningful use of it for the final user. In order to generate innovative "interconnected" systems a new perspective is needed: the shift from an instrument-oriented view of the technology towards a broader view that includes aspects like aesthetics, acceptance and comfort.

As Pine and Gilmore [1] argue, recently we have moved from a *service* economy to an *experience* economy. A user is more interested in living experiences than in performing actions and in the best way possible the most advanced technologies.

At this point a highlight on technology and experience meaning is needed.

Donald Schön (et al.) defined "extension of human capabilities" as a main goal of technology. Schön [2] Philosopher Peter-Paul Verbeek added the principle that technology is not something that humans work with, but something that is part of being human. Verbeek [3] Indeed, technology is not just a pole of the interaction but a mediator between human beings and the World [4].

Technologies change the way the *people behave* (interact). Different Technologies defines the behaviour of artefacts, environment and system [5].

New Technologies are uncovering new ways to interact with users so as to engage, entertain and inform them, coding new languages of communication and interaction.

Technology, has become deeply embedded in our ordinary everyday experiences that are improving the way our environment helps and entertains us.

The advancement in technology may not be enough for a product to succeed on the market [6] and perceived as useful for the final user. In the history of design, a first phase of products' digitalisation has seen the arising of "smart" concepts, which were technically feasible but not successful on the market. The field of smart home is full of these examples.

For example, although the rapidly emerging "smart homes" movement worldwide, a literature evaluating the validity, efficacy, practicality of smart homes technologies is comparatively sparse [7].

Moreover, the diffusion of home automation technologies is taking place at a slow pace. Such a slow diffusion could be reasonable due to technical reasons (communication standards, for example) or high cost, but to a lack of addressing users real needs. Indeed as different people have varying needs, the system must be tailored to each individual [8].

But while those concepts were not successful, today we are witnessing the development of industrial products with digital interfaces that enable plenty of new functions that users love to have [9].

One good example is in the ICT world: the way mobile phones evolved (compare to refrigerators) into products that offer way more functions than the just the primary one (that is to make phone calls). The success of such development is certainly based both on the technology, that enables the development of the new functions, and on the new experiences of interaction that smart phones elicit (for example the very simple way you can take and share pictures with other people).

This is the reason why it is worth exploring and understanding the relevant role of user experience in smart system.

The user experience of the product is considered the key battlefield to generate a real meaningful level of innovation (Holland 2011). The use of new technologies is indeed useless without paying attention to the user experience.

Designing an experience means to design not only its functional elements, but also the features that should be able to involve the user at a more emotional level.

And, speaking in particular of smart systems, we should focus on the user experience given by the man-product interaction. Indeed, a good experience will make the user have a *good feeling* about a system. In consequence, when a user has a good experience of interacting with a device he/she perceives it as a value of the product. In this perspective, the good experience is a value to seek.

Given these preliminary remarks, we – being design researchers - are interested to design a "meaningful experience".

User experience is at the core of the interaction design discipline that is about making connections *between people through a system*, not connecting to the system itself [10].

There are four approaches to Interaction Design: (i) User-centred design (UCD); (ii) Activity-centred design; (iii) Systems design; (iv) Genius design.

The user category to which Dia_Friend is referred, patient with Diabetes II, has specific needs and requires ad-hoc design solutions. Besides, user experience is dynamic as it is constantly modified over time due to changing usage circumstances and changes to individual systems as well as the wider usage context in which they can be found.

Consequently, authors, as designer researchers decided to put the emphasis on the *user-centred design* approach, in order to develop an innovative System focused not only on *function* and *performance*.

The philosophy behind user-centred design is that users know best. The people who will be using a system know what their needs, goals, and preferences are, and it is up to the designer to find out those things and design for them. Designers focus on what the user ultimately wants to accomplish. The designer then determines the tasks and means necessary to achieve those goals, but always with the users' needs and preferences in mind.

Since the experience is both a user need and an intangible value, we presume that the designers, rather than the engineers, are called to develop it.

As Buchanan states [11], engineers are used to design for the "necessary", while designers design for the "possible".

What we believe is that a real progress is reached when engineers and designers cooperate from the very beginning to the development of products that are not just technically feasible but also useful and enjoyable [12, 13]. In other words, innovation should be driven by design and technology together, not by technology alone.

3 Dia_Friend System

The DIA_Friend System is not an existing concept yet but it is based on theoretical and user studies. The research project was submitted for receiving founding from Horizon 2020 Call on May 2016 but unfortunately it did not succeed. Authors are trying other ways to get founding fro the project execution.

DIA_Friend (Personalized Integrated Predictive Diabetes Management System) main objective will be the development of a new therapeutic strategy aimed to reduce the acute and chronic clinical complications in patients affected by type 2 diabetes mellitus under insulin treatment.

The management of insulin therapy is often problematic due to the several variables that affect glucose homeostasis and hence exogenous insulin requirement; the most important are food, physical activity, stress, and illness. Therefore, patients under insulin treatment often suffer for severe glucose oscillations and hyperglycaemic or hypoglycaemic episodes. The novel system will be based on a decisional support system (DSS) where an algorithm for insulin management has been already validated at pre-clinical level. Dia_Friend will be framed into three major conceptual elements:

- A decisional algorithm. It elaborates three kinds of data: (i) personal data (food and physical activity), (ii) SMBG (self-monitoring of blood glucose) or continuous glucose monitoring (CGM) (iii) insulin treatment.
- Educational tools for favouring patient acceptance and compliance to the therapy with possible teleconsultation.
- A smart system interface to easily update and let the user understand how to manage the disease and hazardous situation.

It plans to provide: (i) the development of a cloud based network between operators and patients as the base for an integrated diabetes management system; (ii) a novel predictive algorithm integrated in a user friendly and personalized interface to support patient empowerment, self-care, adherence to care plans, decision making support and treatment when necessary (sensors, new glucometers, applications).

3.1 The Designer Perspective

Based on the theoretical consideration previously highlighted on *the use* and *the used technology* the solution will pay attention: to overcome barriers from technological, social and organizational points of view especially for the old people; to be personalized on the basis of patients' profiles; to be accepted by users both at social and organizational level. The key innovative elements of the proposed new therapeutic strategy are: (i) A cloud-based infrastructure designed to support the detection of

personal physiological data, to simultaneously send them in a centralized repository for their elaboration. This includes new tele-monitoring solutions integrated with new advanced decisional support ICT based to improve the self-management of the therapy; (ii) A clinical DSS, based on the combination of the above reported data, able to generate, thanks to a decisional algorithm, a set of therapeutic options to be validated by the clinicians. It will elaborate these data in order to support through counselling and ultimately propose the right personalized dosage of insulin required by the metabolic conditions of the patient; (iii) A smart user interface to easily update and let the user understand how to manage the disease and the hazardous situations, in order to motivate the patient to accept the technology and solution provided (Fig. 1).

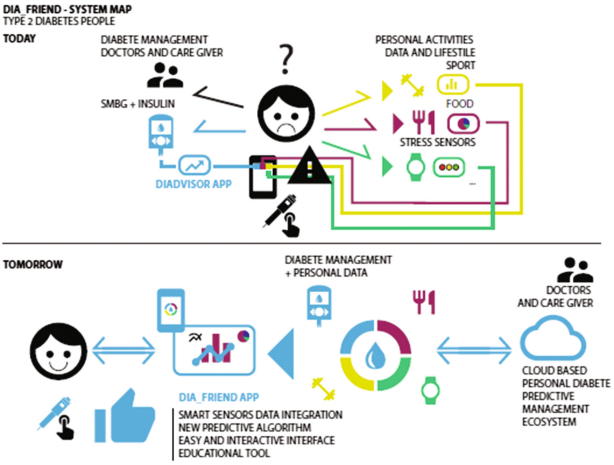

Fig. 1. System framework and novelty

Dia_Friend will mainly consist of a framework that will merge Existing Systems (in term of functions, technological infrastructure, algorithm and interaction) in order to figure out the effective personalized ad-hoc solution for the patient with Diabetes type 2 of the near future.

From Designer Researchers' point of view the lens is on the definition of the Requirements for the System. The requirements from the System Integration will be collected through UCD methods such as Personas and Stakeholders interviews. In our perspective, the Patient (user) is a subject and not an object of the assistance.

ICT based new educational pathways, applications; the system will be designed in order to promote self-management of the therapy. The patient becomes one of the actors involved in the management of diabetes. We focus on the role of psychology of the experience and behaviour modification in addition to education as a cornerstone for self-management.

4 Conclusions

Diabetes mellitus represents one of the major chronic diseases, and it is also a heavy healthcare financial burden. Despite the rapid diffusion of advanced technology the market does not offer solution aimed at support the patient during the management of diabetes disease in a "smart" way. This could be reasonable due to a lack of systems tailored on users real needs. Indeed, the management of diabetes is still anchored to traditional pathways.

In this paper we suggested a new approach and perspective that is to develop solutions focused on the user experience, not only on *function* and *performance*: to go beyond the instrumental aspects of product use and usability and focus on the *user experience* by shaping the technology in a desirable and meaningful way for the user reasoning on the metaphorical and cultural level of the smart system.

With the Novel System *DIA_Friend* we are willing to re-design a smart health and care system closely oriented to the needs of patients. We want to create new scenarios where products, interfaces and services interact smartly by putting the user at the centre, empathizing with him, understanding his needs and behaviours in order to improve his quality of daily life. The user-oriented approach is indeed useful and purposeful to make the technologies really *enabling and meaningful* for the final user.

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