A methodology for multi-actor evaluation of the impact of eCare services

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Abstract— **The healthcare sector is an incredibly complex system with many public and private actors and a wide diversity of services. Because of the aging society and the growing evolution of health expenditures, pressure on available resources (time, people, budget, etc.) is increasing. Innovative ICT supported eCare and eCure services are expected to increase efficiency, coordination and organization of care.**
Currently many initiatives already introduced ICT-supported eCare services into the current healthcare ecosystem. However, it's quite a challenge to estimate the impact and expected uptake of these new eCare services. It's no surprise that only few services commercially succeeded. This paper presents a methodology that identifies and evaluates the PEST factors (political, economical, social and technological aspects) that impact the involved care actors when introducing eCare services. The model takes into account the overall socio-economic aspects of the service, but also the subjective importance that an individual actor can ascribe to a particular eCare service. Combining the impact of these PEST factors leads to an expected adoption rate. Both new services and existing initiatives can be compared to one another and the impact of economies of scale can be investigated. In case a negative impact on some actors is observed, the model proposes cost allocation or service offer alternatives to ameliorate the business case for a particular service. Finally, a sensitivity analysis helps to indicate the most significant parameters that drive the business case.

Keywords-component; Impact analysis, eCare services, Cost allocation, PEST evaluation, multi-actor

I. INTRODUCTION

Because of the further increasing pressure on the healthcare sector, mainly due to an aging population and growth in health technology investments, the need for service and process improvement as well as an overall increase of resource efficiency never was clearer before. Last decade, interest in innovative ICT supported care and cure services grew significantly [11] [12] [23]. On the one side there are the eCare services with a strong focus on the improvement of the care process and personal wellness e.g. telemonitoring of chronic heart failure patients, fall detection, etc. [2] [21]. On the other hand, there are the eCure services for supporting, automating and facilitating medical treatments and/or processes such as teledermatology [24], hospital information systems HIS, etc. Both kinds of services already proved a positive impact on quality of life and resource efficiency.

When focusing on care dependents at home (thus outside the traditional care institutions), an evolution towards Integrated Personal Health and Care Services can be noticed [15]. These eCare services aim to fill the care gap between the patient (the care dependent), the informal care network (neighbors, friends), the primary (general practitioner) and secondary care network (physicians). Already a lot of eCare initiatives are being tested and deployed (e.g. The patient Briefcase , MyDoctor@Home, etc. [15]). Currently all these solutions are offered in a fragmented way. Offering these eCare services via a communal care platform could lead to less fragmentation and more integration of the service provisioning [13] [19].

Moreover, many of those eCare services fail or are being shut down after the pilot phase because they are unable to accurately predict their uptake [9] [20] [21], or because their offer leads to unexpected negative impacts on other relevant care actors. It is of crucial importance to make sure that the business case for each stakeholder for their service offering is viable, otherwise that service will not succeed.

Therefore, having a methodology and model for categorizing and assessing these various impacts for all the actors involved would be a great help when debating the best way of introducing eCare services.

II. OBJECTIVES

The goal of our research is to construct a model that is able to identify the impacts on the involved actors when offering eCare services (focus on eCare services only) in a qualitative (e.g. increase of patient self-actualisation level) and quantitative (e.g. decrease in administrative overhead for the formal caregivers) way.

It also wants to provide insights into why some eCare services work better or have a higher uptake than others. Next to an impact evaluation of a single eCare service, the model is able to evaluate complete service packages offered via an

eCare service platform. Whenever an actor is impacted in a negative way, the model should be able to formulate service offer improvement guidelines based the evaluations of the service.

III. METHODOLOGY

A four step methodology is developed for being capable of formulating service integration guidelines (see Figure 1 for a schematic overview). A first step is called target population modeling. By defining characteristics of the user target groups, the potential market size and its evolution can be modeled. In the following PEST analysis step, the qualitative and quantitative performance indicators (PI) of each actor involved are clustered according to their political, economical, social or technological level. The PEST analysis for each actor forms the basis of the service impact evaluation as third step. Whenever one or more services would lead to a negative impact on an actor, service improvement strategies and guidelines are formulated in a last step.

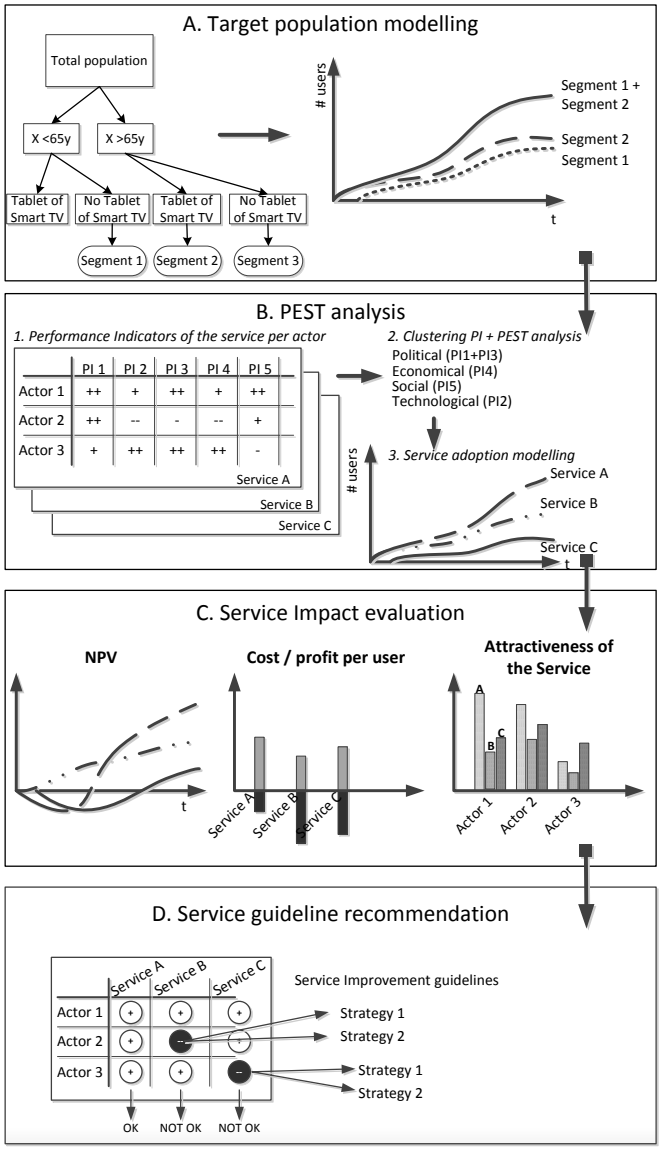

Figure 1. Schematic overview of the methodology

A. *Target population modelling*

Most eCare services address a particular group of users. Since it is a challenging task to estimate the size of this specific set of users, we started from the total projected demographic curve of Belgium [5]. Based on age, acceptance of technology, specific pathologies, service characteristics and other user requirements, potential user segments can be filtered from the entire population. For example: some services require a tablet or smart TV, other services require mental fitness or target users with hearing disorders, etc. Also time dependent variations of the user characteristics can be integrated (e.g. today 30% of the +65 population has internet access, within ten years this percentage could grow to >70%). To model this time evolution we rely on the adoption curve modeling theory of Bass or Gompertz [8] [22]. The results of these steps are time functions indicating the size and the evolution for each defined user segment. These segments can be allocated to one or more services. Figure 2 shows an example of a segmentation of the total starting population.

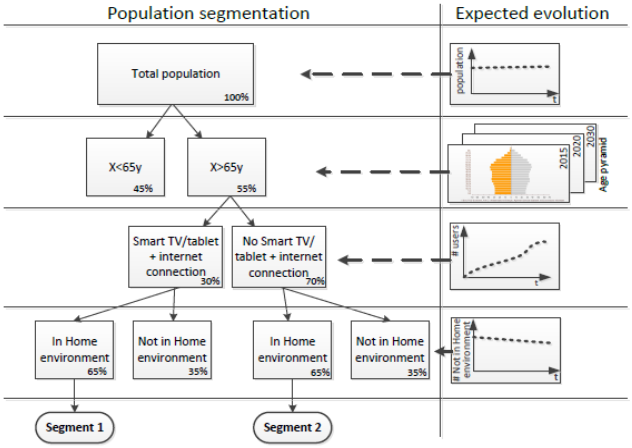

Figure 2. Population segmentation and customer segment defintion

B. *PEST analysis*

Whether an eCare service will succeed depends on several PEST (political, economical, technological and social) factors [17]. Examples of these factors are: existence of an elaborated legal framework, protection of privacy (political); reimbursement of the service, needed investment (economical); social acceptance of personal monitoring services, privacy issues (social); technology gap and device uptake (technological), etc. The combination of those parameters will play a very important role in the market adoption of services [14].

To be able to formulate and quantify the PEST factors, the model needs both qualitative and quantitative performance indicators (PI) as input from each actor. Quantitative PIs are defined as the impacts on actors that can be described, quantified and translated into monetary results in a straightforward way (e.g. gains in time, decrease of costs, decrease of number of transports, change in operational processes, etc.) Qualitative PIs on the other hand are defined as subjective and personal experiences or psychological effects (e.g. the value of perceived mobility increase, peace of mind of

a family member, decrease of anxiety of the care dependent, etc.) This type of PIs can be indicated on a measurement scale that is based on existing health utility indication systems as the visual analog scale (VAS), often used to determine quality of life (QALY) [4].

When all qualitative and quantitative PIs are formulated, the model clusters them according to the relevant predefined PEST parameters. PEST parameters on their turn influence the attractiveness, and therefore the adoption curve for a particular eCare service for a particular actor. If a service would lead to a positive impact for some actors, but to a worsening for just one particular actor, the overall uptake of the service will be highly impacted by this one actor. The latter could slow down or even block the adoption of the service. This approach allows modeling the overall adoption rate of a service based on 1) the time dependent evolution of the targeted user segment, 2) the attractiveness of the service and its expected impacts on all actors involved (See Figure 1 tab B).

C. *Service impact evaluation*

In this step, the model evaluates first the services individually and then makes a comparison with others when offered in a package. Several economic outcomes will be calculated e.g. the evolution of the net present value (NPV), the costs or profits per customer, the impact of the platform cost on the adoption of the services, etc. and will provide insights into the expected results of the service offers.

When providing an eCare platform that offers a complete service package consisting of various eCare services, one can expect that some costs can be shared and that economies of scale will lead to lower costs.

Therefore evaluating services packages is an important addition to a service individual approach. Some individual services could impact an actor in a negative way, but when offered in service package the overall impact of the total offer could be positive again through economies of scale, cost erosions, lower impact of platform cost and higher service adoption rate. The model allows calculating the impact of service packages and its service composition on its expected adoption.

D. *Service guideline recommendations*

Lastly, based on the evaluation results from the previous step, the model is able to offer viable strategies to improve a service. When the model detects that an offered service has a negative impact on a particular actor and therefore the adoption of the service is hindered (See Figure 1 tab D.), this sub model formulates some possible improvement strategies for making the service more attractive. The model indicates the value that needs to be compensated in order to obtain at least a neutral, non-negative impact. The model makes a suggestion for tweaking some parameters. For instance it could suggest that a higher subscription fee is required to compensate the actor for possible extra tasks; but also suggestions could be made for adding a certain service to the offered service package to improve the overall attractiveness of the service package.

IV. PRELIMINARY RESULTS

Since up to now focus of the research has been on the design of the methodology and model, fully validated results aren't there yet. Preliminary modeling results of the analyses of three different eCare services are already available. Due to the lack of validated data formulated by each modeled actor, the needed user input for the qualitative and quantitative performance indicators was formulated by field experts involved in the research project.

A. *Modeled services and actors:*

- PAS: Personal alarm system, a reimbursed alarm system that allows the user to alarm a local care center whenever the user is a danger situation. [7]
- Tele-Monitoring of the glucose level: Patients monitor their own glucose level and the results are sent to their care givers. Doing so, the care givers have always up to date data to diagnose on, without going to patient every day for obtaining the glucose level results. [10] [6]
- Fall Detection: A service that sends an alarm to the appropriate care giver (informal or formal) when a care dependent fell onto the ground. [16]

In the model following actors were distinct: patient/care dependent, informal caregiver (family, neighbors, friends, etc.), professional care providers (home nurses) and primary care actors such as general practitioners (GPs).

B. *Result indications*

Starting from the total Belgian 60 years+ population, eight different user segments were identified based on following criteria: age (>75y), technological requirement (Internet access), pathology or risk group (actual number of users of fall detection or PAS services). (See Figure 1 tab A for a segmentation tree). Using this methodology, each segment is mutually exclusive and therefore avoiding double counting of users.

This projected potential of users, combined with the impact of the qualitative and quantitative PIs, results in the total projected number of users per service (see Figure 3).

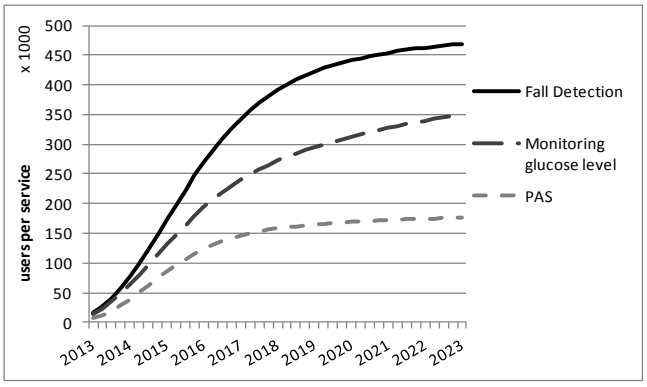

Figure 3. Expected evolution of users per service

Coupling and discounting the modelled costs (e.g. service upfront costs, platform cost, operational expenditures, etc.) and revenues (e.g. subscription fees, etc.) for each service to these adoption rates, leads to the projection of the Net Present Value (see Figure 4).

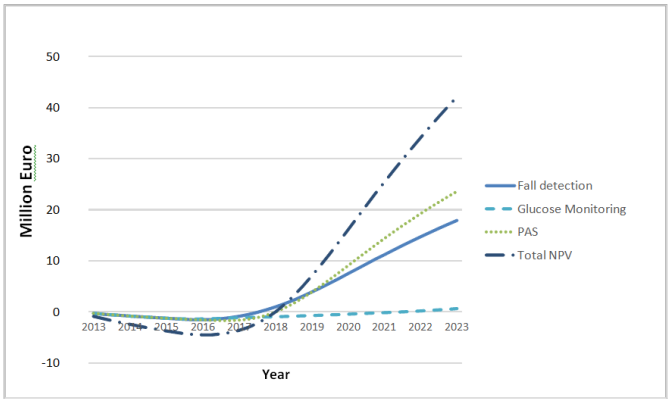

Figure 4. NPV analysis of the modelled service

Despite a significant market potential, one can see that from a service provider's perspective the service for monitoring the glucose level isn't interesting at all because of the long payback time and the low profits. But on the other hand, the PI analysis (combination of the qualitative and quantitative PIs) identified the glucose monitoring service as perceived the most valuable service by the informal caregiver and the care dependent (see Figure 5). Thus dropping the glucose level monitoring service would be a bad idea for an eCare service provider.

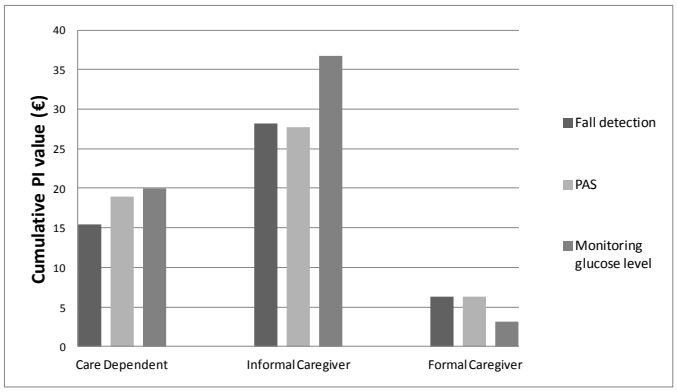

Figure 5. PI value per actor and per service

Looking to the cumulative PI impact of the glucose monitoring service on the different actors, the model indicates that formal primary care givers experience a much lower impact by using the service.

In a last step the model suggest decreasing the monthly service fee for the care dependent to compensate the extra burden that results from learning and using the service compared with a regular visit to the GP. Also previous research and literature [1] [21] showed that the lack of a legal and financial framework to compensate the GP seems to be a significant part of the problem. Today a GP isn't compensated to follow up the glucose monitoring results while investing time and losing direct contact hours and revenues. So without financial framework, this actor will only lose revenues by using this service. Today policymakers are looking to integrate these services into the existing care ecosystem [3]. This should make the service more attractive to use.

V. CONCLUSIONS

The methodology described in this paper allows to perform a multi-actor impact analysis on offering eCare services.

Through the categorization of actor individual quantitative and qualitative service performance indicators such as gains in time, decrease of costs and increase of peace of mind, etc. the model projects the expected adoption of the services.

Service and services package analyses (e.g. comparison of the economic profitability of the individual and combined service packages, the attractiveness of their added value and effects of economies of scale, etc.) provide meaningful insights in the overall impact of the service offer on the involved actors.

If a service isn't attractive for an actor and even could lead to a negative impact, the model formulates strategies for improving the service offer. Guidelines range from increasing the service subscription fee, other cost allocation strategies or increasing the overall added value of the service package by adding additional services to original package.

VI. FUTURE WORK

The methodological approach for evaluating eCare services may serve as a guideline to assess and justify the correctness and future perspectives for many systems which are now under development. An extensive validation of the methodology with direct input from the involved actors needs to be executed. Because the methodology derives the impact of quantitative PIs based on user input, it's important to have clear defined translation multipliers such as QALY [18], otherwise the qualitative impact could be overestimated.

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