Measuring the uptaking of digital health platforms on AAL/AHA domain

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Abstract. This paper presents a method to determine the metrics to assess the uptake of Ambient Assisted Living (AAL) platforms. The different platforms are offering various resources to construct digital health products oriented to Active and Healthy Ageing (AHA) and social health care. This research work is addressed to identify and define which metrics could be Key Performance Indicators (KPIs) to be tracked for successful uptake, interoperability, synergies, and cost-benefit analysis of open platforms.

Keywords: Uptaking, Digital Health Platforms, AAL, AHA KPIs.

1 Introduction

Aging presents one of the greatest socio-economic challenges in the 21st century. Our research project aims at analyzing open service platforms in the AHA and AAL fields and the measurement of their performance. To do this, a set of KPIs needs to be defined to perform effective analysis of the platforms' success. As the platforms' success involves more than one factor for more than one stakeholder group to make it measurable in detail, a set of KPIs is defined and analyzed according to a specific methodology.

Key European domain-related platforms are relevant, such as universAAL IoT [1] and FIWARE [2]. Besides the two mentioned platforms, a considerable number of platforms have been created and are operational on similar services within the similar domain, either competing or complementing each other, which would urge for more in-

teroperability among them. Responding to the numerous critical voices, lack of interoperability of the various solutions deployed, or difficulties with the large-scale uptake of the platforms by their targeted users, the main objective of this research is to determine the platforms' uptake by their user communities as well as their continuous improvement and possibility of market expansion. Consequently, the research question of this work attempt to answer is how this platform uptake can be measured and quantified? The response to this question should serve to measure the uptake in current and future AAL platforms.

2 State of the Art

We collect the existing open-source platforms that belong to the bigger ecosystem together with universAAL IoT, FIWARE, and include those that are partly open or fully proprietary. The selection concerned three types of projects; those aimed specifically at AAL/AHA issues, projects for general purposes but application guaranteed by the AAL/AHA environment, and projects that brought specific integrated development and innovation in the sector. These projects are: ACTIVAGE/AIOTES, VAALID, UNCAP, ReAAL, BEYOND SILOS, unversAAL, PERSONA, GIRAFF+, eWALL, FI-STAR, m-power, HAH, ACCOMPANY, HDIM, FIWARE, AmIVital, CareWell, ehcoBUTLER, INNOVAGE, SOPRANO, AMIGO, Mario, Reach2020, SmartCare, CARER+ and EkoSmart. In this research work, we focus on universAAL IoT and FIWARE as reference platforms due to their popularity.

3 Problem Statement

A Key Performance Indicator (KPI) is a measurable value that represents the possibility of a process or action of a company or organization, to achieve a specific objective (mainly strategic).While a metric measures a raw value on a process, a KPI is directly associated with a goal set by the organization and allows to assess whether the strategies followed to achieve it are working. Since this work aims to analyze the uptake of the existing platforms in the AHA/AAL field, a set of KPIs needs to be defined to perform an effective analysis of the platforms' success.

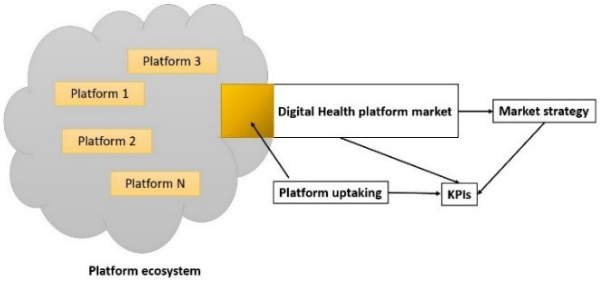

Fig. 1. Overview of problem statement.

Thus, it seems that the number of users of these platforms may partially define the platform uptake. However, considering the market strategy and the use of the platforms, a set of KPIs can be defined to determine the platforms' uptake (see Figure 1).

4 Methodology for the definition of potential KPIs

In our research, we propose different stakeholders types around any platform, such as: Primary end-users (the single individual intended as the main beneficiary of a service or set of services provided by the considered platform), End-user customer (the person or organization in direct contact with a primary end-user, such as formal and informal care persons, family members, care organizations, and their representatives), Technology providers (typically hired by customer end-users that follow and implement the entire life cycle of the applications), and Government (the public sector service organizers, social security systems, insurance companies). In this work, we propose a methodology to determine the platforms' uptake. This methodology is divided into four steps, and it aims to obtain a list of representative KPIs for platform uptake:

1. The first step regards the ecosystem observation by reviewing whether some platform is publicly showing a set of metrics and/or even KPIs of its uptake. This direct information should be crawled in the sites of the different platforms. This first step also includes indirect information coming from research papers related to this uptake. Thus, a literature review is necessary. In any case, if positive, recapture all these metrics or KPIs from reviews and jump to step 3.
2. In case of not having metrics or KPIs from step 1, proceed with different benchmarking procedures with other platform sectors as the software platforms or e-commerce platforms to determine potential metrics or KPIs. Any potential metric or KPIs should be translated to the AHA/AAL domain. Additionally, the authors as researchers in the domain add other potential metrics or KPIs not provided by benchmarking.
3. Make a proposal of KPIs (classified by stakeholder types and pointing out which are generic vs. AHA/AAL specialized).
4. Propose the potential list of KPIs and metrics to stakeholders through different instruments. Then, considering the platform's stakeholders' experience and intention, the list of uptake KPIs shall be obtained as a result of the application of the proposed methodology.

4.1 Platform review and literature review

After the review of the complete list of platforms above, we did not find any metric or KPI to assist with the platform uptake assessment. Thus, we proceeded with a partial systematic literature review. To determine the platforms' uptake, a revision of out-

comes from the literature was performed for the two more popular platforms (one generic and one specialized), aiming to get information on potential KPIs that will nurture our analysis. Some keywords were identified to perform a Google Scholar search (i.e. “KPI”, “Key performance indicator”, “metric”, “measure”, “benchmarking”, “AHA”, “AAL” and “platform”). Then, these logical expressions (LE) were used for the search:

- LE1: “FIWARE” AND ((“KPI” OR “Key performance indicator” OR “metric” OR “measure” OR “benchmarking”) AND (“AHA” OR “AAL” OR “platform”))
- LE2: “UNIVERSAAL” AND ((“KPI” OR “Key performance indicator” OR “metric” OR “measure” OR “benchmarking”) AND (“AHA” OR “AAL” OR “platform”))

Taking into account the whole metadata from Google Scholar and with any timeline restrictions, we obtained 983 results from LE1 and 293 from LE2. In a second stage, we obtained from the abstract information that the platform’s performance is the main aim of the current literature. Therefore, we modified the LE1 and LE2 to go in-depth on the performance study, evaluating the modified logical expressions in the same previous conditions:

- LE1.1: “FIWARE” AND ((“KPI” OR “Key performance indicator” OR “metric” OR “measure” OR “benchmarking”) AND (“AHA” OR “AAL” OR “platform”) AND “performance”)
- LE2.1: “universAAL” AND ((“KPI” OR “Key performance indicator” OR “metric” OR “measure” OR “benchmarking”) AND (“AHA” OR “AAL” OR “platform”) AND “performance”)

From LE1.1 we obtained 833 results and 205 from LE2.1. From this literature review and our knowledge, there is no paper about metrics of uptaking in AHA/AAL domains. Then we proceeded with reviewing the whole list of platforms. However, we were not able to establish any consequent and consistent list of metrics or KPIs for any platform publishing its uptake measurements as there is no research paper about this. To solve this problem, we proceed with step two of our methodology.

4.2 Benchmarking

As we denoted in the previous section, it is necessary to proceed with the benchmarking process to obtain a potential list of metrics and KPIs for uptake. We followed the benchmarking methodology proposed by Kaiser Associates [3]. The obtained list of metrics and KPI is not specialized in AAL/AHA domain, and we should adapt it to our domain.

5 Proposal of metrics and KPIs (results)

In the following, we present a set of KPIs from different stakeholders’ perspectives to determine the degree of platform uptake. There are 12 KPIs that can be specialized for the digital health domain marked with (S).

5.1 KPIs for primary end-users

- Reaching user goals, needs, and preferences: The platform matches the user's goals, needs, and preferences, which may be specific to the context of use and are subject to change.
- Accessibility: The platform is accessible for persons with disabilities and older persons is a prerequisite for personal user experience.
- User-driven design: The platform has been developed with user involvement.
- User empowerment: The platform significantly contributes to the individual user's empowerment, by supporting and training the individual user to better understand and express their current and future wishes, needs, and preferences.
- Adaptability: The user should be able to adjust the look & feel of the platform and overwrite the system's choices and interface settings.
- Non-stigmatization: The platform looks attractive and is meaningful to everyone. It does not exclude any sub-group of users.
- Easy-to-use: The platform is easy-to-use.
- Responsive: The platform adapts itself to the user's selected preferences, behavior, and devices.
- Modular: It allows the user to extend the solution by adding additional modules, if needed.
- Privacy and data governance: The platform provides information on data collection, access, usage, control, sharing, and benefit to the user.
- Ethics compliance: The platform ensures that complies with de facto ethical issues such as the Declaration of Helsinki.
- Autonomy: The level of autonomy of users reached using the platform.
- Hospitalizations (S): The percentage of hospitalizations of end-users using the platform compared with current clinical practices without the usage of the platform.
- Quality of Life: Quality of Life: impact on QoL of the platform services.
- Learnability: The platform and its functions are learnable for both older persons, relatives, and staff
- Interest and enjoyment: The platform is interesting and enjoyable to end-users; older adults, relatives, and staff.
- Costs for informal care (S): The costs decrease/increase of informal care for end-user using the platform.
- K-factor for attracting other end-users: used to describe the growth rate of platform users, the platform-developed apps, or membership of the platform.
- Adherence-health+app/solution (S): The end-users are improving due to the app/solution developed based on platform contents.
- Affordability-treatment+app/solution (S): Treatment became more affordable end-users because of the developed app/solution based on platform contents.
- Efficiency-treatment+app/solution (S): Treatment is more efficient because the developed app/solution based on platform contents was used/solution.

- Effectiveness-treatment+app/solution (S): Treatment process is more effective because the developed app/solution based on platform contents was used (except for clinical effectiveness).
- Empowerment-app/solution (S): The app/solution developed based on platform contents empowers the end-users and health professionals to know more about their conditions or perform their tasks better.
- Safety-app/solution: The developed app/solution based on platform contents itself is safe or makes the treatment process safer.
- Trustability-treatment+app/solution (S): The developed app/solution based on platform contents improves the trust of the end-user in the treatment.
- Customer Success Stories Submitted: The amount of Customer Success Stories Submitted.

5.2 KPIs for secondary end-users

- Compliance/Adherence to standards: These would make the platform directly compatible with hardware (e.g., medical or other IoT devices), software (e.g., services or tools), or another kind of protocols (e.g. compliance to legal/ethics/security requirements via standards).
- The wideness of adoption of the platform: Number of users of the platform.
- Availability/Level of support: Number of available support channels.
- Maintenance difficulty level: How easy or difficult is it to locate and fix problems with the platform.
- Mean frequency of updates: How often are existing problems tackled.
- Monitoring capabilities (or other capabilities of high importance for IoT): Performance issues can be quickly understood and resolved.
- Compliance/ Adherence to standards: These would make the platform directly compatible with hardware (e.g., medical or other IoT devices), software (e.g., services or tools), or another kind of protocols (e.g. compliance to legal/ethics/security requirements via standards).
- Minimal fixed cost: Initial cost for purchasing the required platform components.
- Readability of platform documentation: How much time did it take to go through all platform documentation.
- Platform deployment: How much time did it take to deploy the platform.
- Platform configuration: How much time did it take to configure the different tools/components of the platform.
- Platform support documentation: How good are the platform installation and configuration documentation.
- Platform support services: How good are the provided support services (e.g. phone/email/chat support) for the platform.
- Awareness (TOMA) (S): Top of mind: The first platform that comes to mind when a stakeholder is asked an unprompted question about AHA/AAL.
- Acquisition (registration/membership…): registration on the platform.

- Revenue (gross receipts, support, contributions, etc., gains, gross income…): Economic revenue of platform.
- Average producer/developer/... lifespan: It is the average number of years that a service producer/developer continues to produce through the platform's components/items/...
- Retention (active producers/developers/…): It is the percentage of active producers/developers from total (registered, known).
- K-factor for attracting other producers/developers/registrations/donations/…: the K-factor can be used to describe the growth rate of platform users, the platform-developed apps, or membership of the platform.
- Productivity: The number of solutions based on platform contents over time.
- Robustness: The number of use-cases based on platform contents over time.
- Certifications of apps/solutions: The number of Certifications of apps/solutions based on platform contents.

5.3 KPIs for platform developers

- Initial investment: The costs related to the setup of the platform (e.g. hardware, software royalties, installation, and configuration).
- Cost per year: The costs to maintain the platform actively.
- Cost per user: The mean costs for each user.
- Reduction of home care costs (S): The decrease of hospitalization of end-user using the platform.

5.4 KPIs for customer end-users

- The efficiency of service providers (S): The service providers (including caregivers) find it easy to use the platform, and make fewer errors.
- One Business Model (BM) per user group: The platform offers a BM for each of the user groups addressed.
- Purchasing and usage expectations: The platform considers all stakeholders, including buyer, payer, user, prescriber, and service provider, and their expectations in the purchase and later also in the usage processes.
- Affordability (S): The platform considers its affordability for each of the user groups (who may not be able to pay for it) and supports them in the application of some financial support.
- Sustainability: The platform uses mainstream technologies as much as possible for economic sustainability and easy replacement and updates
- Usability and acceptance: The usability and acceptance of the services offered by the platform by stakeholders.
- Integration: The platform permits the integration of different devices and integrate / can be integrated with other systems.
- Scalability: The platform can be adapted according to the number of services/users.
- Solve real needs: The platform solves the real needs of end-users.

- Openness: The platform is openly accessible for everyone.
- Churn rate (contributors/members/registrations/…): It is the proportion of subscribers/members/registered/ who leave a platform during a given period.
- Engagement per visit (downloads): the visits to the website platforms and the number of downloads of items on the platform.
- Engagement per visit (time spent): the time visiting the website platforms.
- Net Promoter Score (NPS): Scoring of the platform from any stakeholder.
- Literature rate: The number of papers or projects reporting platform usage.

6 Discussion, conclusion and open problems

The work started with an analysis of current literature with a focus on two widely-used reference platforms (i.e. FIWARE and universAAL), where we did not find any relevant KPI that serves to measure the uptake and success of these platforms. According to the authors' knowledge, there is a clear absence of KPIs that help to assess open service platforms aiming to support its success and uptake. This could mean that there is an apparent lack of strategy for platform uptake. KPIs have been analyzed, clustered, and prioritized according to four different perspectives defined by 4 groups of stakeholders. However, having a KPI does not mean that the stakeholder of this group must provide the necessary information to calculate such KPI. As shown on the measurement instrument and unit fields, in most of the cases, information to measure the KPIs will be provided by others (e.g. platform owners according to the characteristics of the platform or technical features, service providers, etc.). From this research outcome, we cluster the most important KPIs for the different stakeholders. The list of KPIs was developed with a holistic perspective to be applicable for any platform. Moreover, we will consider other commercial platforms different from European projects.

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