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Abstract New EU-level studies show that EU is "turning increasingly grey" and the old-age de-pendency ratio increases steadily during the next three decades. There is a growing, serious problem – people live longer lives but they are in worse shape during their final years and need growing support from health care resources. There is need for a new focus on prevention and on turning the development. The "young elderly" (the 60-75 years old age group) should adopt physical activity (PA) programs and make them part of their everyday routines. The learning processes get started through interventions with digital wellness services. DigitalWells is a research and development program to acti-vate 1000 young elderly to select and use PA programs. The goal is to keep the young elderly in better shape for their senior years (75+) and to contribute to significant reduc-tions in the growth of elderly health and social care costs.

Keywords: • Ageing • Physical Activity Programs • Digital Wellness Services • Multi-sensor Platforms • Smartphone Applications •

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1 Introduction

We have a growing awareness in many EU countries – to which we and the eBled conference may have contributed [6], [7], [8], [9], [10] – that something should be done to keep the ageing population in much better physical shape than now is the state of affairs in 2019.

This appears to be a simple insight and everybody agrees that it is in line with European values that elderly people should enjoy their lives after contributing to the wealth of their society during 30-40 years of work and paying their taxes. For some reason, this simple insight appears to be hard to turn into practical activity programs and to make real contributions to the wellness of the elderly. This despite the fact that the year 2012 was the "European Year for Active Ageing" and "Solidarity between Generations" [12].

One reason appears to be that the challenges are larger and more complex than the intuitive understanding of the slogans. The ageing population is large and growing for the next 20-30 years in most EU countries at the same time as the population of working age decreases both in absolute and relative terms. The elderly lives longer but they are in worse physical shape during their last few years, which requires a large and effective health care infrastructure to take care of them. This again translates to large and growing health care costs, which will start to be untenable for the working age population around 2030 [13].

In *The 2018 Ageing Report* [13] the European Commission projects a number of trends that will affect an EU that is "turning increasingly grey" in the words of the EC. The total population in EU will grow from 511 million in 2016 to 520 million in 2070, but the working age population will decrease from 333 million to 292 million in the same period. The old-age dependency ratio (people 65+ relative to working-age population (15-64)) will increase from 29.6% in 2016 to 51.2% in 2070; the EU will change from 3.3 working-age people for each 65+ person to only about 2.0. Much of the old-age dependency ratio change comes from people 80+ that will increase their impact on the ratio from 8.3% to 22.3% over the projected horizon.

The EC finds that the fiscal impact of ageing will be a significant challenge in almost all EU member states in 2020-2030. In the baseline scenario (there are two other scenarios with more challenges) the total cost of ageing is 25% of GDP in 2016 and will rise to 32-35% of GDP by 2070 [13].

There is growing political pressure to find long-term strategies for the ageing population [12] but decision makers have difficulties to agree on strategies and programs. The problems they should solve are complex and not separable from the infrastructure and value systems of a modern society [13], [23]. The macroeconomic theory and models that could offer understanding, the decision makers do not know nor understand sufficiently well. The strategic thinking appears to be more reactive than proactive, to focus more on handling the health and social care costs of ailing senior citizens than on preventive programs to keep ageing citizens in better health all the way to advanced years.

The ageing population will require annual budgeting for health and social care costs in several hundred billion euros. Rough estimates (worked out from Finnish statistics [29]) show that the annual benchmark cost for health and social care for the ageing population could be around 320-350 B€ in the EU countries, (there will be variations between countries). It makes sense to find out if some proactive, preventive program could help reduce the annual cost increases.

We have worked out a simple proposal for Finland: *get the young elderly [the 60-75 years old age group] involved in proactive programs to change their daily routines to improve their probability to have a healthy life into advanced age.*

A proactive program, which builds digital wellness services for the young elderly, is interesting for the digital services industry as the young elderly represent very large and growing markets (given the income levels and accumulated wealth of the young elderly in many EU countries).

The focus on the young elderly is a new approach for digital services, a market for which there has not been much interest to develop mobile value services ([5, 11]).

There is another, more important reason - society needs to have a strategy for the young elderly, which needs to be different from the health and social care strategy for the senior age group. A majority of the young elderly are reasonably healthy, active and socially interactive and do not require much intervention or support from the public health and social care systems. Consequently, the various programs for the ageing population ([12], [13]) do not focus on the young elderly and miss possibilities to build proactive and preventive programs. The reason is simple, they do not have diagnosed medical problems that require interventions. National health resources are not assigned to factors that could possibly generate health care issues after 15-20 years.

We have started a large, 2-year research and development program called *Digital Wellness Services for Young Elderly* (*DigitalWells*) that aims to get 1000 young elderly to build sustainable routines for including physical activity programs in their daily lives. *DigitalWells* cooperates with two unions of retired people's associations with a total of 100 000 members.

The program builds on a series of pilot studies [7], [8], [9] that served to produce first insight of what building sustainable routines for physical activity programs will require.

We developed a *storyline*: digital wellness services should build on methods and tools to form and support interventions in daily routines that introduce and sustain physical activity programs. Physical activity programs will improve the probability for better health in senior years. Better health for the senior population contributes to better quality of life – and to reduced and decreasing costs for senior health care. As the numbers are very large (the young elderly are 1.2 million in Finland), a significant improvement in health for the senior (75+) population – "*staying healthy for 5 more years*" – will significantly reduce the fiscal cost of the old-age dependency ratio [13].

The pilot studies produced a series of results. A first result we found was that wellness services are needed and useful – and wanted - for individual young elderly; a second result was that wellness services need to be digital to make them accessible efficiently and cost-effectively – the preferred way of distribution is through smartphones. A third result emphasized the need for an ecosystem of designers, developers, builders and maintainers of the digital services as there needs to be enough resources available to service 100 000 users that may be activated in Finland. This again, as a fourth result, requires an industry and university collaboration network. A fifth result is that there is potential for building a young elderly EU market, which may both grow very fast and be very large [7], [8], [9].

The *research problem* that drives *DigitalWells* and is the focus of this paper is *to identify design requirements and challenges for physical activity programs that will contribute to long-term physical wellness among young elderly*.

A reasonable way to tackle this research problem is through *action design research* [28] which we use to work out the *DigitalWells* and to structure the storyline of this paper. The *action design research (ADR)* method follows four stages [28]: (i) problem formulation, (ii) building, intervention and evaluation, (iii) reflection and learning and (iv) formalization of learning.

The rest of the paper works out the storyline. Section 2 addresses the designs of physical activity programs for young elderly. In section 3, we introduce digital wellness services and technology platforms to implement them. Section 4 introduces a research program to validate and verify that the activity programs, the technology and the digital wellness services get adopted for sustained use by the young elderly. Section 5 is a summary with some conclusions.

2 Physical Activity and Digital Wellness Services for Young Elderly

The WHO defines *wellness* as "the complete mental, physical as well as social well-being of a person or groups of persons in achieving the best satisfying or fulfilling life and not merely the absence of disease or any form of infirmity [33]. "Well-being" is imprecise as it builds on anything from systematic action to random events. We decided on *wellness* as the WHO definition builds on the physical and social elements we want to employ for the design of digital wellness services. In addition, *wellness* gets changing meanings from different angles [1], [25] in various contexts, and is an active research area [25], [30]. For work with young elderly user groups, we adopted a practical definition: *wellness – to be in sufficiently good shape of mind and body to be successful with all everyday requirements*.

The understanding and definition of wellness follow insights we have collected from the young elderly themselves: "*it is nicer to get old if you are in good shape*" or a more sober version: "*to get good remaining years*". These insights also neatly captures the strong motivation we have found among the young elderly to get in better physical shape [6]. *Physical wellness* comes from physical exercise to build stamina, muscle strength and balance and to ward off age-related serious illness; sustained physical exercise helps to meet everyday requirements and contributes to better quality of life.

Physical wellness is also the first wellness approach that comes to mind (*to be in good shape*) as it is easy to understand and to work out. Studies show [22], [31] that physical exercise is something of a corner stone for getting and sustaining a good quality of life in senior years. The young elderly themselves report that as they turned 60 they noticed that their bodies start to impose functional limitations on them and realized that some active measures will be required to improve on things. Karolinska Institutet [31] shows in a report, in which a synthesis of several studies over several years of physical wellness routines of 2500 elderly Swedes (the age group 65-84; there are 2 million people in this group), shows some interesting results. The findings are that 12% of the female and 14% of the male show no activity to improve their physical wellness. There are 69% of the female and 64% of the male, who show regular physical wellness activity at low or medium intensity (the minimum recommendation is 150 minutes at medium intensity per week). The remaining about 20% show regular physical wellness activity at medium or high intensity. The ATH 2010-2017 study in Finland [34] shows that in the 75+ age group, 31% have significant difficulties to walk 500 m and 41% report that they have challenges to cope with their everyday routines. Another worrying finding is that only 7% of the 75+ age group meet the recommendation of 150 minutes of physical activity every week; the 55-74 age group showed 15% that meet the recommendation, which health care professionals already should note and start active counter measures (not much happens as a matter of fact).

For young elderly the questions are *what* exercises and *how* to get health effects (and sometimes *at what cost* and even *why*). There are good answers to the *why* - research shows that work on physical wellness will have positive effects also on intellectual, emotional and social wellness and will reduce the probability to get serious (often age-related) illnesses [31]. The *what*, *how* and *at what cost* is the arena for digital wellness services.

So far, we have now covered ADR (i); we started with a research problem formulation, which helped us to identify a research opportunity (*proactive programs for digital wellness services for young elderly*) in a context of organizational commitment (*major, large organizations of retired people*).

In the *DigitalWells* program, we quickly realized that we are going to need a pragmatic approach to digital wellness services to change daily routines to include enough physical activity for health effects both in the short and long term.

We decided to select 28 activities that would fit young elderly and form meaningful weekly programs of physical activity. The programs need to be both manageable for young elderly and challenging enough to produce improved physical wellness that they could note and feel.

The 2011 Compendium of Physical Activity (CPA) [2] offers a standard for designing weekly programs. The CPA enhances the comparability of results across studies using self-report physical activity (PA) and quantifies the energy cost of 821 specific PA activities. There are other approaches to find the energy cost of PA activities [20] which are critical of the self-report results and want to build on measurements with multi-sensor systems. Then again, there is debate about what measurements are accurate enough to give meaningful guidance to the actual intensity and effects of different PA activities [4].

The MET is an objective measure of the intensity in carrying out a physical activity. MET is the metabolic equivalent and is measured as the ratio of the rate at which a person expends energy, relative to the mass of that person, while performing some specific physical activity compared to a reference, set by convention at 3.5 ml of oxygen per kilogram per minute, which is equivalent to the energy expended when sitting quietly [20].

The CPA offered a base standard for the following 28 physical activities [2]:

- Walking (individual, group), 5 km/h, 10 000 (12 000) steps, 3.5 (3.8) MET
- Nordic walking (individual, group), 6 km/h, 10 000 (12 000) steps, 4.8 (5.0) MET

- Jogging (individual, group), 7 km/h, 7.0 MET
- Running (individual, group), 10 km/h, 10.1 MET
- Treadmill running (1% angle), 10 km/h, 10.1 MET
- XC skiing (individual; classic, free style), 7 km/h, 10 (15) km, 7.0, (9.0) MET
- Aerobic (group, individual), 60 min, 7.3 MET
- Orienteering, 90 min, 9.0 MET
- Indoor ball sports (floor-, basket-, hand- and volleyball), 60 (90) min, 6.5 (8.0) MET
- Outdoor ball sports (football, Finnish baseball), 60 (90) min, 7.0 (8.5) MET
- Bicycle, 15 km/h, 7.5 MET
- Stationary bicycle, 15 km/h, 7.0 MET
- Senior dancing, 60 min, 5.0 MET
- Gymnastics (group, individual), 60 min, 3.8 MET
- Swimming (pool, open water; individual, group), 60 (90) min, 6.0 (7.5) MET
- Water running/walking, medium program, 4.5 MET
- Water gymnastics, medium program, 5.5 MET
- Rowing, normal stroke frequency, 3.5 MET
- Rowing machine, normal stroke frequency, medium load 4.8 MET
- Strength training (gym program 1), 60 min, 3.5 MET
- Strength training (gym program 2), 60 min, 5.0 MET
- Strength training (gym program 3), 60 min, 6.0 MET
- Group exercise, 60 min, 4.3 MET
- Stretching, light, 2.3 MET
- Yoga Hatha, light, 2.5 MET
- Functional training, 60 (90) min, 4.5 (6.0) MET
- Yard and forest work, 60 (90) (120) min, 3.8 (4.5) (5.5) MET
- Golf, 1 round, walking, 4.8 MET

The young elderly *DigitalWells* participants normally have two pointed questions ([7], [8]): "*what* exercises are good and useful for me and *how to* get health effects from these exercises". The recommendation offered from the CPA community "in one week spend at least 2.5 hours over 3 or more days at *medium* MET or 75 minutes at *vigorous* MET to get 495 MET minutes/week or 525 MET minutes/week". The colour codes classify the two lists of 28 activities (light MET is in black). They are also not absolute truths but average standards. The MET material comes from controlled experiments with adults 18-65 years old (only partially relevant for young elderly) [2]. We will at some point have to recalibrate the MET standards for our target population. In *DigitalWells* there will be 35 groups of 25-30 participants, a total sample of about 1000 participants, which will give us a basis for statistical analysis. Of course, there will be imprecision and variation as the participants will be in different physical shape. If we use the results in [30], 12-14% will have no previous history of physical activity programs, 64-69% will show regular physical wellness activity at light or medium intensity, and 20% will show regular physical activity at medium or vigorous intensity. Nevertheless, the process needs to get started.

If we want to get things correct, we should find the individual MET for each participant just before an activity program starts, again measure the MET before each moment of the activity and then get the MET-minutes at the end of the activity program. There will probably be some multi-sensor bracelet available in a few years to carry this out.

The *DigitalWells* needs a base and a standard that subsequently can be tested, verified and validated in actual use among the young elderly. We propose a simple approach, which is useful for fieldwork with existing technology.

> Activity/day = minutes a_i * light MET + minutes a_i * medium MET + minutes a_i * vigorous MET, i = 1, 27
> Activity/week = sum_j (activity/day), j = 1, 7

<u>Recommendation</u>: 3 or more days, ≥ 2.5 hours at medium MET or ≥ 75 minutes at vigorous MET to get 495 MET minutes/week or 525 MET minutes/week
<u>Norm I [*basic*]:</u> 5 or more days at medium MET and/or walking ≥ 30 minutes/day, 495 MET minutes/week
<u>Norm II [*active*]:</u> 5 or more days at medium MET (any combination of programs) or vigorous MET ≥ 45 minutes/day, 600 MET minutes/week
<u>Norm III [*senior athlete*]:</u> 3 or more days at vigorous MET ≥ 60 minutes/day, 1500 MET minutes/week

Then wse have to return to the reservation [2]: *CPA MET values are relevant for use in able-bodied adults who are 18–65 year old and do not reflect the energy cost of children and youth, older adults, and persons with disabilities*.

This initiated work to find corresponding CPA MET values for older adults [17], which produced the following formula:

> Men: BMR = 66.5 + (13.75 × weight in kg) + (5.003 × height in cm) – (6.755 × age in years)
> Women: BMR = 655.1 + (9.563 × weight in kg) + (1.850 × height in cm) – (4.676 × age in years)

We realized that the young elderly actually form five age groups, 60/65/70/75/75+, which also have different characteristics for males and females. This motivated us to introduce several levels of recommendations for the MET minutes/week:

Male [56-60]	576	Female [56-60]	468
Male [61-65]	540	Female [61-65]	432
Male [66-70]	498	Female [66-70]	390
Male [71-75]	450	Female [71-75]	348
Male [75+]	444	Female [75+]	342

These recommendations are only indicative – we will among our participants find 75+ aged marathon runners that easily train at 1200-1500 MET minutes/week and 55+ people who have never spent any time on physical activity programs and will find it challenging to reach 440 MET minutes/week [31].
The intensity at which an individual carries out an activity program is crucial but not well defined [2]. In laboratory based experiments a walking pace at 60 steps/minute for at least 10 minutes is *aerobic*, i.e. generates MET-minutes. Then, *light* would be < 60/steps/minute, *medium* 60-70 steps/minute and *vigorous* > 70 steps/minute. Another way to define the steps standard: *light*, aerobic steps for 10-30 minutes; *medium*, aerobic steps for 20-60 minutes; *vigorous*, aerobic steps for > 60 minutes.

Wew have now added to ADR (i) with contributing theoretical bases and an overview of possible contributions from existing measurement technology; next we will sketch some general requirements for the design and launch of digital wellness services.

The observation that (systematic) physical activity contributes to improved health and wellness starts to be verified and validated [22]. This supports a vision that physical activity programs and digital wellness services can produce sustainable health effects for young elderly. If large groups of young elderly (thousands, tens of thousand) adopt physical activity programs we can get sustainable health effects with an impact on national health care budgets.

The *first* observation is then that we are going to need and use digital wellness services for 10-15 years; macro-economic changes form slowly and reduced health care costs from improved health among young elderly need at least 5 years to materialize. In the digital service market, where applications typically need to be improved and relaunched every 6-12 months, this means that there will be dozens of generations of digital services. A *second* observation follows; an ecosystem of about 100 SMEs should develop, sustain and innovate the generations of digital services – it will be hard for any monolithic giant of the digital economy to build the flexible, renewable and adaptive services the young elderly will adopt, pay for and use for 10-15 years. A *third* observation is that the young elderly is a demanding user group; digital wellness services need to be intuitive, easy to use (probably voice activated), user and context adaptive (probably omnivore). The services will apply advanced technology that should incorporate technology innovations as they emerge. A *fourth* observation is that even with reasonable success the digital wellness services will have hundreds of thousands of users in the Nordic countries only. Software should be advanced enough and adaptable to the users to fit the requirements of young elderly [18], [19]. Development, maintenance and distribution of digital wellness services will need an ecosystem.

3 Digital Wellness Services and Technology Platforms

The technology should offer multi-purpose, viable platforms for multiple digital wellness services to support multiple activity programs of the type we worked out in section 2.

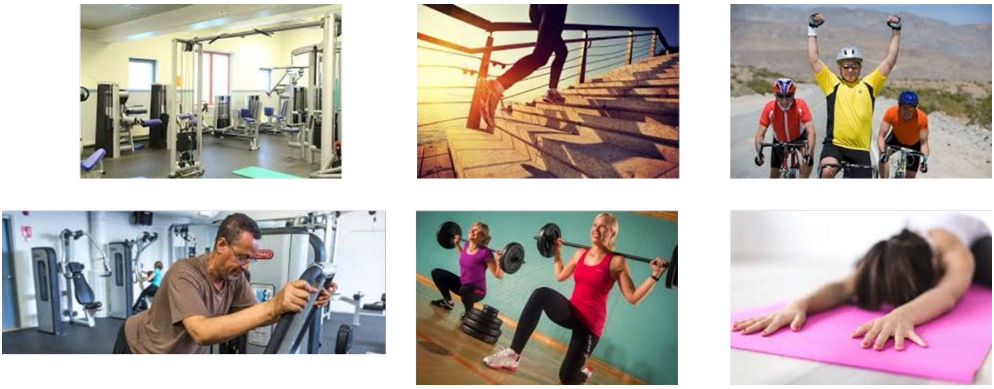

Fig.1 Multiple activity programs

There are dozens of wellness apps available for the leading brands of smart phones (Samsung, Apple, Huawei, Xiaomi, LG, etc. [35]). Tens of vendors offer fitness trackers that support wellness routines (Fitbit, Garmin, Xiaomi, Polar, Apple, etc. [36]). The fitness trackers normally come with supporting apps to summarize and interpret the data collected with sensors. Fitness trackers typically come with multiple sensors and the sensor technology shows fast and significant development.

In support of the activity programs to give participants individual feedback on the intensity and duration of their activities [24] a typical fitness tracker (Fitbit Charge 3 used as an example) collects data on and reports (i) 24/7 heart rate, (ii) VO2 Max, (iii) step tracking, (iv) SpO2 blood oxygen, (v) swim tracking and (vi) sleep stages (to collect data on sleep patterns). Another fitness tracker (Garmin Vivosmart 4) offers rep counting for gym sessions and crossfit, which probably will become a standard feature as the sensor combination becomes available for leading fitness trackers.

In the *DigitalWells* program, we decided to use available platforms and to build the DW-app(s) on top of existing apps for smartphones. This choice builds on the observation that members of the target group own and use fitness trackers and have wellness apps available on their smartphones. In tgerms of ADR (ii) we build the alpha and beta versions of the DW-app(s) on available platforms.

The preliminary choice is to use Wellmo and Exsed2 as platforms as they build on different sensor technologies (fig. 2).

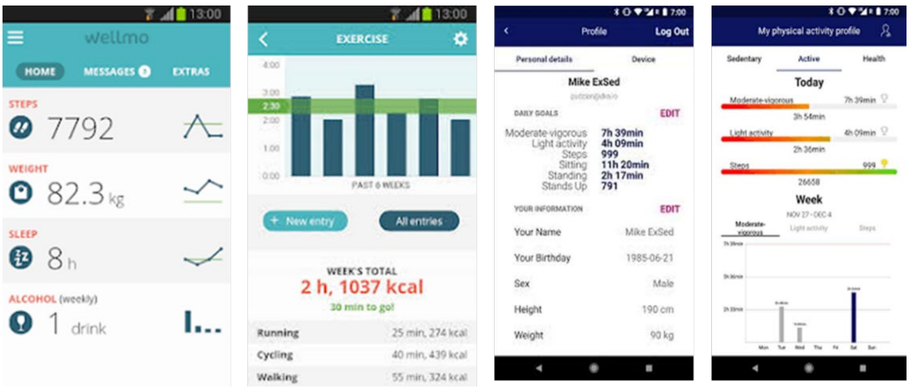

Fig. 2 Wellmo and Exsed2 wellness platforms

The differences between the two platforms come from the sensor technology used to measure the intensity and duration of the activities. The Exsed2 uses the Movesense (by Suunto) multisensory technology and Wellmo collects data from the most common fitness trackers (fig. 3).

Fig. 3 Movesense and Fitbit Charge 3

In the literature, there is some controversy about the correct way to measure and assess the medium to vigorous physical activity. In [20] hip-worn accelerometers collected data to find the threshold values for medium and vigorous activity. The technique builds on tri-axial acceleration data and the mean amplitude deviation (MAD) of the acceleration signal. The MAD values convert to metabolic equivalents (MET) through empirically derived and validated algorithms. The most frequently used method in fitness trackers measure VO2 max to trace intensity and duration of physical activity. Firstbeat [14] developed a series of algorithms that now gain growing acceptance among the fitness tracker vendors. Firstbeat claims to automatically detect the VO2max fitness levels during walking and running activities. This builds on proprietary software, which has been tested and validated in laboratory experiments and shown to give 95% accuracy. The hip-worn accelerometer supporters express scepticism about the accuracy and precision of the wrist-worn sensor measurements. Nevertheless, there is growing evidence [27] that the precision is sufficient for the intended use we have in the *DigitalWells* program. For the ADR (ii) technology artefacts we have singled out two main principles – the MAD and the VO2 max. The rest of the design needs to transform the measurements to meaningful expressions of light or medium or vigorous physical activity.

The beta design of the DigitalWells app (DW-app) introduces the following functionality (fig. 4)

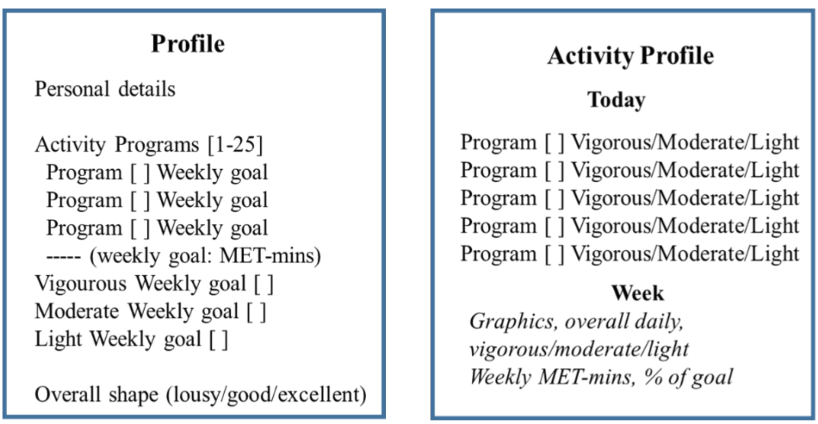

Fig. 4 DigitalWells app design

The user starts with background information to calculate an individual BMI, answers a questionnaire on personal history of physical activity and a subjective estimate of physical shape ("lousy/good/excellent"). He/she then selects 3-5 activity programs and defines weekly activity goals for each one and a weekly goal of MET minutes. The DW-app then follows up on the actual activity programs and the intensity (vigorous/medium/light) at which the user has carried them out. The activities summarize weekly as MET minutes relative to the goal set and as daily activity levels (with intensity levels) of each activity program. The DW-app protects user data with encryption and stores it under pseudonym on the *Kanta PHR* database, which the Social Insurance Institute operates over its cloud server. The user can select to use more features from the underlying platforms, for instance, to form peer groups that compare their activities and share best practices to get health effects.

The *DigitalWells* database will serve as a basis for cross-sectional and longitudinal studies of the effects of physical activity programs on wellness and health among the young elderly.

The crucial part is how easily the intended users will adopt the DW-app and the activity programs. This enters the ADR (iii) reflection and learning stage. We apply iterative design processes as part of guided emergence [28].

We carried out a number of pilot studies, which gave some insight to build on [7], [9]: (i) daily routines are a good choice for focus; (ii) wellness routines should be important parts of daily routines; (iii) digital wellness services should be usable without assistance; and (iv) smartphone users have sufficient skills to learn digital services. We have also tested the idea that relations between socio-economic characteristics, attitudes toward the use of mobile applications and perceptions about wellness could help identify potential users (see details in [8], [9], [10]). To introduce digital wellness services for young elderly, we should start with young elderly, who are,

- Active in full time/part time/volunteer work & advanced users of mobile apps & < 70 years
- Experienced users of mobile apps & more educated
- Males with good physical health & income > 30 k€ per year

- More educated & find mobile apps good value for the price

The findings make sense – active people will be early movers [26] and more educated people younger than 70 are experienced users of smartphones and mobile apps. Males, who are more educated and have good income, find mobile apps good value for the price (and would be willing to pay for digital wellness services).

4 The DigitalWells Research Program

Then we enter the ADR (iv), formalization of learning. The conceptual basis for building and sustaining physical wellness among the young elderly is *gerontologic prevention* [16] but we use the design and intervention of digital wellness services as tools (artefacts) to operationalize the insight and understanding gerontologists have of physical activity programs for ageing people.

We expect to get rich data collected from the 1000 young elderly recruited for and active in the program: (i) daily physical activities with a selection of activity programs on a variety of intensity levels, (ii) follow up on subjective wellness and (iii) how well they are doing in relation to individual goals. The data should help us to find, verify and validate answers to the following specifications of the research problem:

- What are the best activity programs for young elderly? What activity programs give the most effective, sustainable health effects? Will there be significant differences between young elderly – in terms of M/F, age groups (60, 65, 70, 75, 75+), history of physical activity, work history?
- What are the "correct" MET minutes/week levels for young elderly?
- What MET values are (more) correct for young elderly – hip- or wrist measured? Can we show systematic differences in multi-sensor system measurements in the set of physical activity programs?
- We have 35 groups – will there be significant differences between the groups in adoption of physical activity programs? Can we find reasonable explanations for the differences? Can we explain differences with digital services adoption theory or models?

- We will determine the base level of physical activity prowess and experience with the IPAQ Short form [21]. Can we find similarities or differences for the groups in international comparison?
- The groups will work with the physical activity programs and the DW-app for 4-5 months. Using the UTAUT2 framework [32], can we find similarities or differences in how the groups adopt the digital wellness services in international comparison?

The *DigitalWells* findings and results describe and start to explain *general trends of exercise and health*, which are relevant for the themes of the EU *2018 Ageing Report* [13]. The results will also show possibilities to validation and generalization with different theoretical frameworks (cf. ADR (iv) general outcomes [28]).

The field work with 35 groups of young elderly (each one with 25-30 participants) builds on research on *group work to develop activity programs for young elderly*, which develops and enhances living labs methods [3].

The work with young elderly to select physical activity programs and to compose a weekly portfolio of programs contributes to *co-creation of digital wellness services*, which develops and enhances the pioneer work of Grönroos [15].

It is probably unavoidable that after the first year with the digital services users (probably a majority) start to ask for a higher level of automation and more intelligent support to get advice on how to build effective combinations of activity programs. The answers are in three interrelated research themes, (i) *digital coaching principles adapted to activity programs for young elderly*, (ii) *multi-agent systems for digital coaching of digital wellness services* and (iii) *key activities to make digital coaching work with young elderly*. There are some preliminary results to build on [6], [8] but digital coaching offers a number of challenges that need to be worked out.

We made an initial observation that large-scale health effects will require large numbers of *DigitalWells* participants and/or users of physical activity programs. The relevant research themes will address *ecosystems of digital service stakeholders to build activity programs for thousands of users*. It is almost a truism that large structural changes require large ecosystems of stakeholders to get real change in reasonable time.

SME:s are a crucial part of the ecosystem to build, change, enhance and improve digital wellness services both as part of smartphone applications and as designers and developers of platforms for multisensory systems. For the SME:s, the ADR research themes include *business models for digital wellness services* and *business models for remote digital rehabilitation services*. The foundations and conceptual frameworks for these research themes are in the H2020 ENVISION research and development program [37].

5 Summary and Conclusions

The *DigitalWells* implements a simple logic: get the young elderly to change their daily routines in ways, which will improve their probability to have a healthy life into advanced age [90+]. This focus on *prevention* will help to reduce significantly the need to react to with advanced health care services to the needs of large, growing numbers of ageing people. Services that [13] shows will require resources that most EU countries cannot afford beyond 2030.

We have argued that *physical activity programs* is a viable approach to achieve changes towards better health scenarios by using digital wellness services as interventions in daily routines. We worked this out with a selection of 28 physical activity programs that we will support with smartphone apps and multi-sensor platforms.
The data *DigitalWells* collects from about 1000 users of the digital wellness services and the technology offers material for several research themes, which will have significant impact on methods and theory development for digital services in general and digital wellness services in particular.

The *DigitalWells* program aims at several contributions. First, it addresses a user group – the young elderly – that does not get much attention in research on digital services. Second, it develops digital services in an area where the macroeconomic impact of the services will be significant. Third, young elderly has other and new requirements on digital services than the young adults and the teenagers (the standard target groups). The young elderly wants and needs are new requirements for developers of digital technology and services, but young elderly is also a potentially very large market (about 97 million EU citizens are young elderly) that has so far been ignored.

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