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Digital Wellness Services: Key to Better Quality of Life for Young Elderly

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Abstract Digital wellness services for the "young elderly" (the 60-75 years old age group) will be interventions in their daily routines and if/when they are accepted and adopted they will help keep the young elderly in better shape for their senior years (75+). This will contribute to significant reductions in the estimated costs for health and social care for the ageing population. On an individual level, digital wellness services contribute to a better quality of life if designed to fit the needs of the young elderly. Platform tech- nology for digital services offers possible tools for intervention if the tools and services fit the requirements of the young elderly. We summarize several of our studies as a syn- thesis and work out a conceptual framework to facilitate the design and implementation of digital wellness services.

Keywords: • Young Elderly • Wellness • Digital Services • Conceptual Frame- work •

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1 Introduction

The socioeconomic impact of ageing citizens is already high in most EU countries as their proportion of the population is growing and there is growing political pressure to find long- term strategies for the ageing population (UN (2014)). The strategic thinking focuses 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. It would make more sense to find out if some proactive, preventive program could help reduce the annual cost in- creases expected for the ageing population (UN (2014)).

The logic we worked out is quite simple: get the young elderly [the 60-75 years old age group] to change their daily routines in ways, which will improve their probability to have a healthy life into advanced age [described as 90+].

There are some basic facts to build on. The young elderly represents 18-23 % of the population in most EU countries; this is a large segment, recent statistical estimates show that it will be about 97 million EU citizens by 2020 (EC (2014)). In the Nordic countries, there were close to 4 million citizens in the young elderly age group in 2016 (Nordic (2017)).

Rough estimates (worked out from Statistics Finland (2016)) 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. We can probably reduce this cost by 10-15% if we get young elderly physically more active. In a 5-year program with an enrolment of 15-20% of the age group we could get about 20 million young elderly to stay healthy which will save costs of at least 20-25 B€ annually. Staying healthy should be a long-term program which means that the effects move on to the senior [75 +] age group where the annual costs and the potential savings are much higher.

A proactive program to build 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 income levels and accumulated wealth).

The focus on the young elderly is a new approach for digital services, a market for which there has been no interest to develop mobile value services (Bouwman et al (2014), Carlsson and Walden (2012)). There is another, more important reason - society needs to have a strategy for the young elderly 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. Conse- quently, the various programs for the ageing population (EC (2014)) miss the young elderly and the possibilities to build proactive and preventive programs.

We collected first-hand knowledge and experience of the young elderly market in Finland through the Data to Intelligence (D2I) SHOK program (Tekes 340/12) and we have

continued work on the themes opened up in the program in several studies (Carlsson and Walden (2016, 2017a, 2017b)).

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, maintainers and distributors of the digital services to have enough resources available to service 100-200 000 users (first in Finland). This again, as a fourth result, requires an indus- try 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.

The aim with digital wellness services – as we could summarize it - is to find methods and tools to form and support interventions to introduce and sustain wellness routines. These rou- tines will improve the probability for better health in senior years and better quality of life for an ageing population.

The rest of the paper follows this storyline. In section 2, we will work out approaches to well- ness and some requirements on digital wellness services to contribute to and sustain wellness. In section 3, we summarize material from several empirical studies in order to get early verifi- cation of how the proposed storyline could work. In section 4, we work out a conceptual frame- work to serve as a basis for the design of digital wellness services. Section 5 is a summary with some conclusions.

2 Wellness 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 (WHO (2014)). "Well-being" is imprecise as it builds on anything from systematic action to random events. We decided on *wellness* as it fit our requirements for the design of digital wellness services. Wellness gets meanings from dif- ferent angles (Adams (2003), Rachele et al (2013)) in various contexts, and is an active research area (UCR (2013)). 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 of wellness follows insights we got from the young elderly themselves: "*it is nicer to get old if you are in good shape*" or a more serious version: "*to get good remaining years*".

Our early work built on an *ad* hoc assumption that wellness mostly comes from *physical* activ- ity. Literature studies show that there are many more aspects to wellness (Rachele et al (2013), UCR (2013)).

Physical wellness (to be in good shape) is easy to understand and to work out. Studies show (Jonasson (2017), Wallén et al (2014)) that physical exercise is a corner stone for sustaining a good quality of life in senior years. The young elderly themselves report (Carlsson and Walden (2016)) that as they turned 60 they noticed that their bodies start to impose functional limita- tions on them and realized that some active measures will be required to improve on things. Karolinska Institutet (Wallén et al (2014)) shows in a synthesis of several studies of physical wellness routines over several years for 2500 elderly Swedes (the age group 65-84), some in- teresting results. The findings are that 12% /14% female/male show no activity to improve their physical wellness. There are 69% / 64% female/male, who show regular physical wellness activity at low or medium intensity (recommendation: at least 150 minutes at medium intensity every week). The remaining about 20% show regular physical wellness activity at medium or high intensity. Only regular physical activity at high intensity will have long-term health ef- fects.

For young elderly the questions are *what* exercises and *how* to get health effects (and some- times *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 (Wallén et al (2014)). The *what, how* and *at what cost* is the arena for digital wellness services.

Intellectual wellness is more difficult, it is more demanding to work on building and sustaining intellectual wellness. Among the young elderly, we have registered concern for deteriorating cognitive capability and capacity, for memory loss and for the onset of Alzheimer disease. Work on physical wellness will reduce the probability for Alzheimer (Jonasson (2017)) and serious game theory, methods and technology (Birkenbush and Christ (2013)) will contribute to building and sustaining cognitive capability. Digital wellness services with serious games could contribute to cognitive capabilityand to sustaining memory functions.

Social wellness combines with both physical and intellectual wellness. Social media with many variations (Hanna et al (2011) offer viable platforms for connecting with other people. Physical exercise gets more effective in peer groups through challenges and cooperation (Walden et al (2017)). Group members can share insight and experience on effective wellness routines, social media links to innovative and good exercises and experience with health effects. Much in the same way, peer groups form around and with serious games (Birkenbush and Christ (2013)). Young elderly we worked with in focus groups (Sell et al (2017)) described that some ailments will prevent them from getting active on physical wellness, which then will close them out of the corresponding peer groups. Unless they find stimulation in intellectual wellness activities, which include cultural programs of various kinds, and the peer groups in these activities, they will be lonely. Loneliness is an often-reported malady in the ageing population (Walden et al (2017)) and will have a negative impact on *emotional wellness*. On the other hand, young el- derly of our focus groups (Sell et al (2017)) quite often stressed, "*being alone by choice is not being lonely*".

Emotional wellness is now the arena for studies with mindfulness tools, of which there are more than 200 apps for Android smartphones (van Emmerick et al (2018)). Mindfulness-based interventions induce improvements of positive affect and depression (van Emmerick et al (2018)).

We have focused the development of digital wellness services on physical, intellectual, social and emotional wellness and on sustaining this support for the time needed to gain and sustain positive health effects for the young elderly into advanced years (the age group 90 +) (Carlsson and Walden (2017a)).

A *first* observation is that we are going to need and use digital wellness services for 15-20 years. In the digital service market, where applications typically need to be improved and re- launched every 6-12 months, this means 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 the young elderly will adopt, pay for and use for 15-20 years. A *third* observation is that the young elderly is a demanding user group; digital wellness ser- vices need to be intuitive, easy to use (probably voice activated), user and context adaptive (probably omnivore), i.e. the services apply advanced and innovative technology. A *fourth* observation is that even with reasonable success the digital wellness services will have hun- dreds of thousands of users (even 1-1.5 million) in the Nordic countries only (the estimates upgraded in 2018). Distribution of the services need to build on cloud service platforms. The user interfaces are (families of) applications on smartphones that collect data and support wear- ables. Software should be advanced enough and adaptable to the users to fit the requirements of young elderly.

Statistics show that smartphones are becoming affordable general purpose instruments and will be even more so by the year 2020 (the mobile connection subscriptions are more than 100% of the population in most EU countries; the proportion of smart phones is closing on 70% in several EU countries (Ericsson (2017)). Statistics Finland (2017) shows that close to 80% of the age group 55-64 own and use smartphones. Thus, counting on smartphones as the platform is viable.

3 Early Empirical Findings

We have carried out a number of empirical studies with groups of young elderly in order to get first tests of the wellness concepts we are working with and to find out if the visions we have on digital wellness services make sense. We will briefly summarize the key findings from these studies; details in (Carlsson and Carlsson (2016), Carlsson and Walden (2016, 2017a, 2017b)). We carried out a survey of the young elderly in the Åland Islands and collected 101 usable answers with a 26.6 % response rate. There was a female majority among the respondents, and most of them belonged to the young elderly group (a few were seniors). A minority had only basic education (21%), the majority had second level technical/commercial degrees. In the sample, about 75% were retired (*fully retired* as some of them stated) but 25% were working full- or part-time or with voluntary work (*in order to stay active*). The most typical annual incomes before tax were < 30 000 € (about

50% of the sample), but the other half reported 30- 50 000 €, which is on the higher end of annual income for Finnish retirees (Staistics Finland (2016)). These profiles are typical and representative for the Åland group of young elderly.

We found that 73% of the respondents used smartphones; we also found that 73% of the re- spondents used mobile apps for navigation, weather forecasting, Internet search, etc. (which require smartphones).

We collected experience with and attitudes to mobile apps with a series of questions (Venkatesh et al. (2012)), in order to get some idea on how to build digital wellness services. The adoption of mobile apps scored high on a 5-grade Likert scale on several items; the following items scored between [4.32] and [3.75] for 70 respondents and show elements, we need to be aware of,

- mobile apps are useful in my daily life; I will continue to use mobile apps; mobile apps help me to carry out my tasks faster; using mobile apps helps me to carry out important tasks; I can use mobile apps without assistance; I have the necessary knowledge to use mobile apps; it is easy for me to learn to use mobile apps; I can use the mobile apps I need with the phone I have.

The results gave us some insight to build on: (i) daily routines is a good choice for focus; (ii) wellness routines should be important part of daily routines; (iii) digital wellness services should be usable without assistance; (iv) smartphone users have sufficient skills to learn digital services.

Then we moved on to get an understanding of what perceptions the young elderly have of physical and intellectual wellness. A number of proposals scored high on a 6-grade forced scale (101 respondents); the following items scored between [4.91] and [3.94]:

- intellectual challenges are important for my wellbeing; I get sufficient intellectual stimulation from my everyday life; my physical health has been good compared to people around me; my resistance to illness is good; the amount of information I have to process in my daily life is suitable for me (not too much, not too little); I expect my physical health to remain good; I expect my physical health to deteriorate with increasing age.

The results show that young elderly have a good understanding of what forms wellness (cf. Carlsson and Walden (2016, 2017a, 2017b) for details), which is encouraging for work on the design of digital wellness services. There is also understanding of interaction between physical and intellectual wellness.

Then we 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 Carlsson and Carlsson (2016), Carlsson and Walden (2016)).

After discussion and feedback on the earlier papers, we realized that this proposal could be tested with potential user groups. These could include early users of wellness services

(*early movers*, in the Rogers theory) who could trigger a growing demand for digital wellness services (Rogers (1962)). We will give a brief summary of the methods we used (Carlsson and Carlsson (2016), Carlsson and Walden (2017 a,b) for details).

The starting point was a factor analysis with 19 statements on mobile applications and 11 state- ments on wellness to find possible groupings. The results gave an indication for possible sum variables (cf. Table 1, first column) which we tested for reliability by calculating Cronbach's alpha coefficients; we reached the target value ($\alpha > 0.7$) for the constructed sum variables (cf. Table 1, the names show the groupings we found, for instance *mobile_ apps_ positive* is a grouping of respondents that are positive to the use of mobile apps).

Table 1: Mann-Whitney U-test on sum-variables.

Mann-Whitney U-test, □ = 0.05

	Age		Gender		Highest level of education		Marital status		Current work status		Annual income before tax €		Level of experience using mobile apps	
SUM VARIABLES	–69 yrs	70– yrs	male	female	– institute	higher vocational school –	single	in a relation-ship	in working life a/o volunteer	retired	-30000	30001–	routine	advanced
Mobile_apps_positive Mean rank	39.27	23.22	31.43	33.72	27.38	36.00	32.60	32.45	43.97	28.01	31.15	32.77	23.00	34.21
Asymp. Sig (2-tailed)	**0.001**		0.622		0.068		0.977		**0.002**		0.725		**0.036**	
Mobile_apps_experienced Mean rank	35.10	32.37	34.71	33.31	27.87	38.14	34.57	33.74	39.13	31.22	29.20	37.80	20.75	36.42
Asymp. Sig (2-tailed)	0.572		0.767		**0.034**		0.871		0.128		0.067		**0.003**	
Mobile_apps_social Mean rank	34.69	31.67	30.79	36.38	31.35	34.90	35.36	32.57	32.58	33.17	35.00	32.00	27.84	33.41
Asymp. Sig (2-tailed)	0.531		0.236		0.461		0.575		0.908		0.524		0.292	
Mobile apps value Mean rank	36.59	28.75	36.87	29.69	26.83	37.84	30.81	34.76	38.71	30.98	29.12	37.26	27.16	33.65
Asymp. Sig (2-tailed)	0.096		0.120		**0.019**		0.425		0.137		0.075		0.208	
Physical_wellness_positive Mean rank	48.88	45.79	57.27	40.00	44.48	50.16	48.41	47.78	54.16	45.47	40.84	54.45	40.13	33.45
Asymp. Sig (2-tailed)	0.580		**0.002**		0.309		0.915		0.186		**0.015**		0.237	
Intellectual_wellness_positive Mean rank	49.62	42.45	46.79	47.16	41.28	51.08	52.92	43.74	61.11	42.63	42.84	51.64	37.75	34.72
Asymp. Sig (2-tailed)	0.200		0.947		0.078		0.115		**0.005**		0.115		0.584	
Mobile_app_users Mean rank	36.01	26.29	32.25	31.74	26.38	35.46	31.63	32.17	38.69	28.56	29.58	33.30	16.50	34.93
Asymp. Sig (2-tailed)	**0.037**		0.912		0.055		0.912		**0.044**		0.416		**0.001**	
Wellness_positive Mean rank	48.23	42.09	50.09	42.65	42.30	48.30	46.66	45.64	51.93	43.54	41.22	50.17	39.84	32.86
Asymp. Sig (2-tailed)	0.266		0.180		0.275		0.861		0.197		0.104		0.215	
	N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95		N = 63 - 95	

We next run a non-parametric Mann-Whitney U-test to explore possible differences of the sum variables between gender, age, the highest level of education, marital status, current work sta- tus, annual income and level of experience of using mobile applications; the red "ovals" in Table 1 show significant differences.

In summary: we found significant differences in the positive attitudes to using mobile apps between the two age groups; the younger age group was more positive. The more educated group was experienced in using mobile apps. The more educated group was socially active in using mobile apps. The group with higher income gave more value to

mobile apps. Males with higher income had a positive perception of (their) physical wellness. The group with a more active work status had a positive perception of their intellectual wellness.

Now we have some insight of how 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

This insight needs, of course, testing with more groups of young elderly, but it is a starting point. It also makes sense – active people will be early movers (Rogers (1962)) and more edu- cated 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).

A survey of wellness literature (Walden et al (2017)) found that *younger age*, *better health*, *higher education* and not living alone is associated with higher likeliness to adopt and use technology among the elderly (the factors in italics are the same as those found with the Mann- Whitney). In addition, a positive and optimistic disposition gives a higher likeliness to adopt technology.

In (Walden et al (2017)) a market segmentation of the young elderly was done; *k-means* clus- tering of the Åland data identified two clusters labelled *secure* and *insecure* wellness. The young elderly in the *secure* cluster (i) were in *good health*, (ii) have an *optimistic* attitude to their *future health*, (iii) find *intellectual activities* important, and (iv) want to partake in *intel- lectually demanding pastimes*. These features add to those found with the Mann-Whitney and give a more complete view of what factors to focus on for intellectual wellness. Interestingly enough, the young elderly in the *insecure* cluster were (i) in *worse health* than people around them, (ii) *pessimistic* to their *future health*, (iii) *negative* to the importance of *intellectual ac- tivities* but (iv) *willing to partake* in them.

In semi-structured interviews with 34 young elderly, (Sell et al (2017), more potentially im- portant features were identified. There were attitudes of - what *will others think of me* - when the possibility to get active in physical wellness exercises was discussed. Another aspect - *what would I do there* – showed that the social context of wellness activities is new and somewhat problematic. Problems with - *how to act in social situations* – brought up aspects we had not thought about.

Separately we tested what would be a reasonable monthly cost for digital wellness services; we found that 19.95 € / month would be possible (cf. *mobile apps good value for the price*); the core issue is the value young elderly find with wellness interventions in their daily routines. The series of studies shows that it is meaningful to work out programs

for digital wellness services for young elderly. Given that, there are technology challenges to build services that will be effective wellness interventions in daily routines, that will be meaningful and sustain- able, that will be cost-effective and that can be tailored (over time) for individual user require- ments.

4 Conceptual Framework for Digital Wellness Services for Young Elderly

Work on digital wellness services started off as an ad hoc exercise on activities that we regarded as needed and wanted. We assumed that we could develop activities for the intended users with wearables and smartphone platforms, activities that we could design, develop and implement as simple and self-evident constructs and that the intended users would rush to get, to start using and would be willing to pay for. Work with groups of young elderly, both in semi-struc- tured interviews and with a survey, quickly showed the context and the task to be more com- plex.

Besides the technology platforms we will also need a conceptual framework for key constructs of the various types of digital wellness services.

The concept of *wellness* is a fundamental starting point; we should be able to show if paying users of digital wellness services are better off at $t+1$ than they were at t after having used the services. This is rather simple for individuals, but more demanding if the individual wants comparisons with peer, age, gender and health groups or against some accepted standard for wellness. Wellness is (for instance) graded in (Belohlavek et al (2017)) *poor, marginal, me- dium, acceptable, good, excellent* – for age, gender and health; maybe also for activity, income, intellectual activity, socio-economic status and attitude to life; factors that we found to have meaningful contributions to wellness.

We will use a standard approach and formulate *wellness* (W) with a 4-tuple,

$$W = < P, I, S, E > \quad (1)$$

where P, I, S and E are numerical or linguistic sets (Belohlavek et al (2017)) that represent physical, intellectual, social and emotional wellness. Physical wellness gets grades in several different ways as wearables and smartphone apps try to support changes and improvements through physical exercises; we have selected the following elements,

$$W_P = <P_{STEPS}, P_{STRENGTH}, P_{GROUP}, P_{HR}, P_{KCAL}, P_{SLEEP,}P_{MISC} > \quad (2)$$

where,

- P_{STEPS} covers walking, running & variations; 10 000 steps/day recommended
- $P_{STRENGTH}$ covers gym programs; varied targets; 60 min/program recommended
- P_{GROUP} covers exercise programs done in group; varied targets
- P_{HR} covers heart rate; intensity; combines with the three previous measures
- P_{KCAL} covers burn of calories; combines with the four previous measures
- P_{SLEEP} covers duration, quality of sleep
- P_{MISC} covers physical activities not planned as exercise (e.g. gardening)

Physical wellness, W_P, will be an index that combines the six elements measured in different dimensions and registered on wearables and smartphones; we notice that there is a data fusion problem (Wu and Crestani (2015)) as we need mappings between the various dimensions. Apps for physical exercises typically allow a user to set some targets and then report daily activity relative to target levels; there is typically no mapping the activities and no connection to any optimal target for the individual.

There are more challenges to follow and measure intellectual wellness, W_I,

$$W_I = <I_{GAMES}, I_{LITT}, I_{MUSIC}> \quad (3)$$

where,

- I_{GAMES} covers serious games, memory games, cross-words, Sudoku
- I_{LITT} covers literature, theatre
- I_{MUSIC} covers concerts, opera, choirs, classic ensembles, jazz bands

The extent and intensity of the intellectual activities will require some innovations on how to register and measure them.

On the other hand, social wellness, W_S, does not offer that many challenges,

$$W_S = <S_{FAM}, S_{VA}, S_{SM}, S_{P2P}, S_{ASSOC}> \quad (4)$$

where,

- S_{FAM} covers interactions with family, friends, colleagues, peers, hobby groups
- S_{VA} covers volunteer activities to help others
- S_{SM} covers interactions through social media
- S_{P2P} are person-to-person projects, joint activities
- S_{ASSOC} are (active) membership in associations with interesting activities

Typically, W_S activities are registered and measured in terms of frequency, duration and inten- sity for which it is possible to define target levels, objectives and goals.

Finally, emotional wellness, W_E, offers quite some challenges, as the substance is personal, individual and difficult to follow with digital devices. Here we have tried to capture some ele- ments,

$$W_E = <E_{MF}, E_{E\text{-}APP}> \quad (5)$$

where,

- E_{MF} covers work with mindfulness tools
- $E_{E\text{-}APP}$ is a collection of emotional well-being apps

It appears possible to register W_E and to measure the number and intensity of activities in the two entities based on personal reporting; there is a large number of mindfulness apps for smartphones and they may offer some measurement system, but there are challenges to find measures for adequate representation of emotional wellness.

The sets defined in (2)-(5) are numerical and linguistic, i.e. defined as fuzzy sets (Belohlavek et al (2017)). We can work out fusion functions (Wu and Crestani (2015)) so that the wellness measures W_P, W_I, W_S, and W_E are scalable as [0, 100] or as [0, 1], or as percentages of some ideal value vectors $\mathbf{W_P}$, $\mathbf{W_I}$, $\mathbf{W_S}$, and $\mathbf{W_E}$. The ideal values can first be some research-based targets (or even standards) but should become personalized and individual over time as well- ness is personal and individual. Then we can introduce context sensitive individual weight vectors that can be numerical or linguistic, to determine personal wellness status on a daily, weekly or monthly base:

$$W = w_1 \times W_P \ \Delta \ w_2 \times W_I \ \Delta \ w_3 \times W_S \ \Delta \ w_4 \times W_E \quad (6)$$

In (6) the Δ-operator can be additive or compensatory (Belohlavek et al (2017)) to allow for "lower status on physical wellness to compensate for higher status on intellectual wellness". Then a user can find daily or weekly (or monthly) satisfaction with her/his quality of life as reported on the smartphone.

5 Summary and Conclusions

We attempted a synthesis of several of our previous studies combined with supporting literature to get an improved knowledge base for building and implementing digital wellness services. We build on 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+].

We have argued that *wellness* is a viable approach to achieve this change by using digital well- ness services as interventions in daily routines. We worked this out with physical, intellectual, social and emotional wellness constructs that we have fitted into a conceptual framework. The framework is proposed to serve the development of numerical, digital technology platforms, that combine fuzzy linguistic representations of wellness with fuzzy logic operators to form digital wellness services.

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