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Christer Carlsson

Pirkko Walden

Tuomas Kari

Markus Makkonen

Lauri Frank

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Christer Carlsson,[1] Pirkko Walden,[1]
Tuomas Kari,[1,2] Markus Makkonen[1,2] &
Lauri Frank[2]

[1] Institute for Advanced Management Systems Research, Turku, Finland; e-mail: christer.carlsson@abo.fi, pirkko.walden@abo.fi, tuomas.t.kari@jyu.fi, markus.v.makkonen@jyu.fi
[2] University of Jyvaskyla, Faculty of Information Technology, Jyvaskyla, Finland; e-mail: lauri.frank@jyu.fi

Abstract There is consensus in health studies that regular physical activities of sufficient intensity and duration contribute to better health both in the short and long term. In an ongoing research program, we focus on getting the young elderly, the 60-75 years age group, to adopt and include physical activities as part of their daily routines. One reason for addressing young elderly is large numbers – in Finland health care costs for the elderly was 3.7 B€ in 2019 and will increase dramatically if the young elderly group is in bad shape when they reach the 75+ age group. We are finding out that systematic physical activities can serve as preventive health care for the young elderly. We are also learning that digital services can be instrumental for building sustainable physical activity programs.

Keywords: physical activity programs, digital service support, UTAUT, ELM, young elderly

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1 Introduction

There is a consensus (Bangsbo et al (2019)) that regular and systematic physical activities (PA) can serve as preventive health care (Jonasson (2017)). In the following we will refer to a set of systematic PA as a *PA program*, if the physical activities are carried out over a period of time and to reach some goal, The Copenhagen Consensus statement of 2019 (Bangsbo et al (2019)): (i) "being physically active is a key factor in maintaining health …" (ii) "physically active older adults, compared with older inactive adults, show benefits in terms of physical and cognitive function …" (iii) "physical inactivity in older adults is associated with a trajectory towards disease and increased risk of premature all-cause mortality …". Health recommendations agree on that PA at moderate intensity for at least 150 minutes per week will have health effects (Wallen et al (2014)). This standard applies to healthy adults; in practice there will be differences in the actual PA programs; the differences are in terms of female/male, age groups, level and history of PA capability, physical requirements for everyday activities, and to meet individual long- and short-term objectives. The Copenhagen Consensus also finds that less than 150 minutes could be sufficient for older adults (Bangsbo et al (2019)). Further study will, no doubt, show that a good variety of PA programs will give individually sufficient health effects.

Our focus is the young elderly – the 60-75 years age group – and we want to work out sustainable PA programs that could give preventive health effects for this group. We immediately found common ground with the pensioners' associations that have developed PA programs for their members. There was, however, a feeling among active pensioners that these activities (i) are not intensive enough, (ii) are not of sufficient duration, and (iii) are not regular enough to be sustainable habits; in short, they did not meet the perceived standards for preventive health care (Reyes-Mercado (2018), Hukkanen et al (2018)). The associations found that our proposed program – called *DigitalWells* (DW) – could be useful for them and agreed to work with us; they stated as a requirement that we also include the 75+ age group, who regard themselves as modern time young elderly.

DW is designed as an interactive research and development program aimed at building sustainable PA programs for young elderly.

There are a few central elements that define the program (cf. Carlsson and Walden (2018, 2019)); first, we use a synthesis of existing research results to develop PA programs for groups of young elderly; second, experience collected from field studies is used to validate and verify the theory constructs; third, we aim for PA programs which as such will give the participants short- and long-term health effects; fourth, the PA programs should be sustainable, i.e. the participants should stay with them for extended periods of time (months and years, more than weeks); fifth, we design and implement digital services to guide and support users to stay with and be active with their PA programs.

The participants are all volunteers, at the moment (May 2021) about 750 participants in 30 groups, they come from the local associations of three pensioners' federations which have more than 230 000 members.

DW works out contrasts between the users' own perceptions of their physical activities, intentions to spend (more) time with their PA programs and the time they have actually spent. The users are anonymous and identified only with individual 8-digit pseudonyms in both the surveys that cover perceptions and intentions, in the DW-app 2.5 (cf. section 2) and in the secure data cloud. This makes it possible to trace their activities and to test and validate theory frameworks for the adoption of PA programs.

With the user groups and the digital service tools developed in DW (cf. Kari et al (2020a, 2020b); Makkonen et al (2020a, 2020b)), we aim to tackle the following research questions:

- What drivers could get young elderly users to adopt and use PA programs?
- What factors or drivers could help support and sustain the adoption of PA programs?

The DW research program is running for several years and is ongoing; in this paper we formulate some initial, partial answers to the research questions, - i.e. in short, how to get young elderly to become users of PA programs and to stay with them.

In section 2, we will introduce the context and present the support tools we use for the young elderly users; in section 3 we work through the conceptual frameworks of ELM and UTAUT (introduced in detail in the section); section 4 offers answers to the research questions and adds details from previous research to the framework to offer roadmaps for further research.

2 Context and Tools for Young Elderly

Physical activity among Finnish adults is way too low. The 2010-2017 studies in the health and wellness of adults in Finland (THL, 2019a) shows that in the age group of 30-54 years, only 30% spent several hours per week at regular physical activities; in the 55-74 age group, it decreases to 15%; in the 75+ age group only 7% are regularly physically active. Moreover, the recent FinHealth2017 study (THL, 2019b) found that only 39% of men and 34% of women reach recommended levels of PA to get health effects. The FinHealth2017 study builds on a representative sample of the Finnish population.

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 of life. Studies (Jonasson, 2017; Wallén et al., 2014) show that systematic PA contributes to good quality of life in senior years.

The DW research program aims to meet the recommendations of Bangsbo et al (2019), Hukkanen et al (2018), Jonasson (2017) and Wallén et al (2014). In the following, we will work through some details.

DW has found (cf. Kari et al (2020a), (2020b), Makkonen et al (2020a, 2020b)) that typical PA forms for young elderly include walking, yard work, Nordic walking, cycling, cross-country skiing, golf, gym training, swimming and home gymnastics. The FinHealth2017 (THL, 2019b) study found that popular forms of PA mostly were the same; the study looks at physical activity during leisure time and registers activities that are carried out several times per week. What is interesting, there is no dramatic decrease in PA when moving to the older age group.

The FinHealth2017 study (THL, 2019b) offers a couple of challenges for the young elderly age group: (i) the proportion of young elderly that carries out PA according to health recommendations should be much higher; (ii) PA carried out several times per week should be of sufficient intensity and duration.

Over time, when PA programs developed in the DW research program have been adopted and taken into use, young elderly will start meeting the FinHelath2017 recommendations. The DW actually works out a list of proposed PA forms that will give sufficient PA intensity and duration ; some details on how this was worked out in the next few steps.

The 2011 Compendium of Physical Activity (CPA) (Ainsworth et al., 2011) offers advice and guidelines for the design of PA programs that will start giving health effects. CPA quantifies the energy cost of 821 specific activities in terms of the metabolic equivalent of task (MET) (cf. fig.1). This offers support for dealing with both challenges (i) and (ii). METs show the energy cost (effort) of a PA relative to sitting (Ainsworth et al., 2011). It is measured with groups in actual exercises and in lab experiments, which makes it verifiable and useful for goal setting, for registration of activities and for follow-up of PAs.

In the DW we adopted the CPA guidelines as a baseline for the PA programs (cf. fig.1). We work with 35 different activities that can be included in a PA program; we replaced the CPA MET levels with more “activity-describing” labels: low = light; medium = moderate; high = vigorous.

English	Finnish	Swedish	CPA MET		
			Low	Medium	High
Basketball	Koripallo	Basketboll	4.5	6.0	8.0
Soccer	Jalkapallo	Fotboll	4.9	7.0	10.0
Volleyball	Lentopallo	Volleyboll	3.0	4.0	6.0
Ice hockey	Jääkiekko	Ishockey	6.4	8.0	10.0
Baseball	Pesäpallo	Boboll	4.0	5.0	6.0
Floorball	Salibandy	Innebandy	6.2	7.8	9.8
Rowing or paddling	Soutu tai melonta	Rodd eller paddling	2.8	3.5	5.8
Rowing indoors	Soutu soutulaitteella	Rodd med roddmaskin	3.8	4.8	6.0
Swimming	Uinti	Simning	3.5	6.0	9.8
Aquajogging	Vesijuoksu	Vattenlöpning	2.5	4.5	6.8
Water aerobics	Vesivoimistelu	Vattengymnastik	3.2	5.5	9.0
Ice skating	Luistelu	Skridskoåkning	5.5	7.0	9.0
Cross-country skiing	Maastohiihto	Längdskidåkning	6.8	9.0	12.5
Aerobics	Aerobic	Aerobics	5.0	7.3	10.0
Jogging	Hölkkä	Joggning	6.0	7.0	8.0
Walking	Kävely	Gång	2.8	3.5	4.3
Yoga	Jooga	Yoga	2.0	2.5	4.0
Running	Juoksu	Löpning	6.0	8.0	9.8
Stretching	Venyttely	Töjning	1.8	2.3	3.0
Nordic walking	Sauvakävely	Stavgång	3.4	4.8	6.8
Home gymnastics	Kotivoimistelu	Hemgymnastik	2.8	3.8	8.0
Partner dance	Paritanssi	Pardans	3.0	4.5	5.5
Badminton	Sulkapallo	Badminton	4.3	5.5	7.0
Squash	Squash	Squash	4.4	7.3	12.0
Tennis	Tennis	Tennis	5.0	7.3	8.0
Boccia	Boccia	Boccia	2.6	3.3	4.2
Golf	Golf	Golf	3.5	4.8	5.3
Bowling	Keilailu	Bowling	3.0	3.8	4.8
Gym training	Kuntosaliharjoittelu	Gymträning	3.5	5.0	6.0
Circuit training	Kuntopiiri	Cirkelträning	2.3	4.3	8.0
Orienteering	Suunnistus	Orientering	6.8	9.0	11.0
Cycling	Pyöräily	Cykling	6.8	8.0	10.0
Cycling indoors	Pyöräily kuntopyörällä	Cykling med motionscykel	4.8	7.0	8.8
Household work	Kotityöt	Hushållsarbete	2.8	3.5	4.3
Yard work	Pihatyöt	Gårdsarbete	3.0	4.0	6.0
Other activity	Muu aktiviteetti	Annan aktivitet	4.1	5.6	7.5

Figure 1: List (subset) of physical activities, including CPA MET values

The names of the activities are standardized in English, Finnish and Swedish. The list of 35 activities is now a tool and a guide to find systematic and practical ways to build health-effective PA programs for young elderly. The health recommendations (THL, 2019a; Bangsbo et al., 2019) correspond to roughly 650 MET-minutes per week, which is a minimum to give short- and long-term health effects. A DW participant will simply work down the list and compose his/her weekly PA program for sufficient health effects.

In the DW we opted for composing and running weekly PA programs and the registration of the actual activities with digital support. For this purpose, we developed an application (cf.fig.2) for smart mobile phones (Android, iOS), now called the DW-app (2.5), which is still being developed with new and more advanced features.

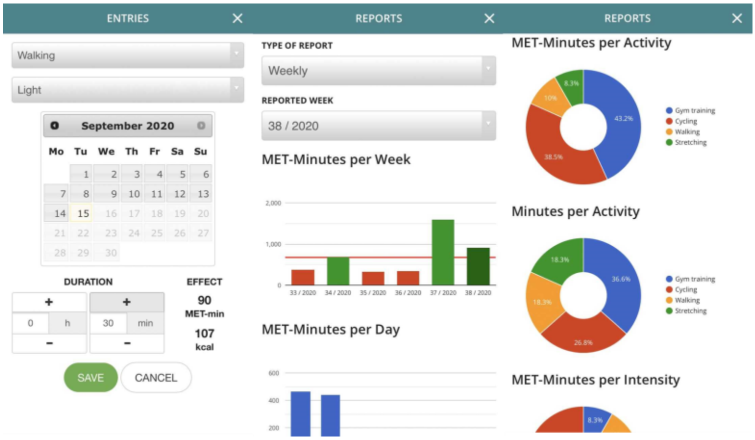

Figure 2: Logging and reporting of activities

The logging of activities on the smart phone is done in the left part of the screen (cf. fig.2): (i) the user selects the activity (*walking*), (ii) the intensity (*light*), (iii) the *date* from the calendar, (iv) the duration (*hours, minutes*) after which the app (v) calculates and shows the effect of the activity (*MET-min, kcal*).

The results of the activity are used to update a secure database where the user is registered with an individual 8-digit pseudonym. The data is used to produce reports on the smart phone for the user (the middle part): (i) the type of report is specified (*weekly*), then (ii) the reported week (*38/2020*), and (iii) the wanted report is shown (*MET-minutes per week*) and (iv) further specified (*MET-minutes per day*). Further graphical reports are shown in the right side that specify (for instance) MET-minutes per activity and Minutes per intensity.

A growing number of users have opted to get even more automated and use sports trackers and smart watches to collect and register their activities; the DW-app 2.5 now collects data from these devices, up-dates the secure database and produces the reports for the user on his/her smartphone.

There are quite a few research reports published on the use of the DW program and the DW-app 2.5 (cf. Carlsson et al (2020), Kari et al (2020b), Makkonen et al (2020b), Kettunen et al (2020)); here it suffices to give a snapshot of user comments selected from 265 respondents that have participated in the program for about 12 months (cf. Table 1). The comments have been selected with an aim to find both positive and negative experiences, but they also give a glimpse of the attitudes to exercise that can be found among the participants. The key to the quotes (translated from Finnish and Swedish) is: [participant #] M or F/age/BMI.

Table 1: Participant reactions to the WFR after about 12 months

The distance should be measured, in km or number of steps … there should be more measures for physical work [24] M/71/26.40
Summertime changes habits, we spend time at the summer cottage with no regular walking tours; fall is a better time for exercise [49] F/69/22.04
I regularly spend time with exercise; thus, the WFR has not changed my exercise routines [64] F/71/26.40
I spend as much time with exercise as feel good (quite much) [65] M/74/25.86
This program does not motivate to exercise as such; it is too simple and cumbersome; I am in favour of technology that automatically registers exercise and other activities; MET points are not calibrated to active exercise nor to health exercise [72] F/70/23.73
I left the WFR in mid-summer because my motivation was not sufficient to go on by myself [covid-19 restrictions closed group activities]; technology by itself is not enough as a motivation [75] F/68/33.25
Our WFR group was closed because of the covid-19 restrictions; all the indoor group events that I was attending every week were closed; I had to switch to walking and Nordic walking, which I increased quite a lot (to several times per day); now fall is coming but it seems as if the restrictions will continue [78] F/65/30.48
I follow up on my own exercise more than before and I have also been checking my results both from the tracker and from the [app on the] phone [83] M/71/26.01
I am not yet familiar with the WFR; I need to get guidance in person; I does not want to spend time to find out the functions for myself from the Internet [112] F/81/21.09
I increased exercise after I retired, because now I have more time for it; WFR and the need to reduce weight have increased exercise; yet I have not decided on any goals [120] M/63/34.48
[WFR] has improved the follow up of different forms of exercise [128] M/75/35.98
This [WFR] is good for people that have not been active on exercise; for me personally there is not much effect [134] F/66/23.59
The application has made me surer that my exercise activities are quite sufficient without any programs; I easily get 10 000 steps every day in my daily routine tasks [141] F/67/23.38

Before the covid-19 restrictions I worked out in gym programs 3 times/week and spent 3 times/week in water aerobics or aqua-jogging; now everything is closed which reduced my exercises to yoga and qigong once a week [164] F/71/27.83 A very good program that makes me follow my own activity program much better [174] M/66/28.78
For myself, joining the program did not "force" me to increase exercise [180] M/70/25.51

The DW-app 2.5 is a digital service, and we know something about digital services. Drivers for the adoption of digital services have been identified and studied with a basis in the UTAUT2 model. They include (Yuan et al., 2015):

- performance expectancy ("degree to which the use of a technology will help users to perform chosen activities")
- effort expectancy ("degree of ease in the use of a technology")
- social influence ("perception that important others support the use of technology")
- facilitating conditions ("factors that facilitate or impede adoption of technology")
- hedonic motivation ("fun or pleasure with using a technology")
- price value ("trade-off between perceived benefits of and monetary cost for using a technology")
- habit ("perception of automatically engaging in a certain behaviour").

Thus, we can find drivers that could make participants adopt and use the DW-app 2.5, but will that be sufficient to make them adopt and use a PA program? Then sustain the use of the adopted PA program. We will try out the proposal that UTAUT2 *will not be sufficient* as a conceptual framework for the adoption and use of PA programs; cf. Table 1 ["*This program does not motivate to exercise as such; it is too simple and cumbersome*" or "*I spend as much time with exercise as feel good (quite much)*"]. We propose to use the Elaboration Likelihood Model (ELM) to find drivers for the adoption and use of PA programs.

3 ELM and UTAUT and Variations

The ELM was introduced by Petty et al (1995), (i) to work out influence processes and their impacts on human perceptions and behaviour, and (ii) to explain why a given influence process may have varying outcomes across different users in each context. This is promising for our aim to find drivers that could get the DW program adopted for sustained use among young elderly.

Bhattacherjee and Sandford (2006) use the ELM as a theory framework to describe and explain IT usage intention. They state, following the Diffusion of Innovation theory (Rogers (1995)), that the acceptance of IT is fundamentally a problem of social influence. The ELM offers instruments for systematic studies of alternative influence processes and their effects, and the impact of moderating factors.

Bhattacherjee and Sandford (2006) make a distinction between argument quality as the key influence process and peripheral cues as moderating factors. They work out perceived usefulness as driven by argument quality to influence the intention to use IT (the perceived usefulness is one of the drivers in the TAM framework (Davis (1989)). They add source credibility and attitude as additional influences on perceptions of perceived usefulness. Finally, job relevance and user experience, are peripheral cues and moderating factors.

The key influence processes are surprisingly similar to the social influence processes we assume to describe and explain intentions for a sustained use of PA programs (cf. fig.3). The main influences come from perceived usefulness ("to get more good years"), which in turn is influenced by argument quality and source credibility (cf. the Copenhagen Consensus and verifiable medical research results); argument quality is at least partly influenced by source credibility; in some cases, argument quality can help decide source credibility.

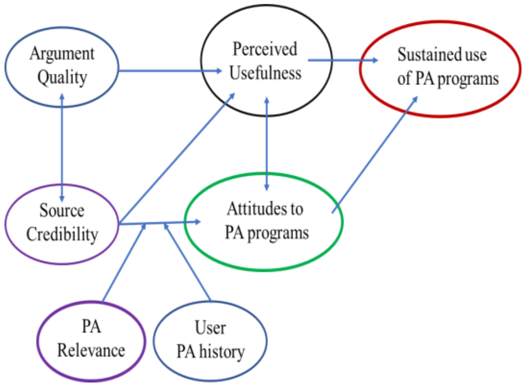

Figure 3: The ELM applied to the sustained use of PA programs

In the ELM framework, perceived usefulness influences attitudes, and we can find support for a proposed influence on attitudes to PA programs (typical comments from young elderly, cf. Table 1: "*A very good program that makes me follow my own activity program much better*" versus "*I left the DW in mid-summer because my motivation was not sufficient to go on by myself; technology by itself is not enough as a motivation*"). Attitudes to PA programs influence the perceptions of usefulness.

We also propose a couple of moderating effects (peripheral clues) that influence attitudes to PA programs: (i) user PA history – (cf. Kettunen et al (2019)) typically identifies (i.1) regular PA users who have been active for multiple years (even decades); (i.2) sporadic PA users in on-off mode for multiple years; (i.3) inactive PA users with on-off intentions to get active; (ii) PA relevance –typically lists different goals for being active with PA programs (Linke et al (2011)), (ii.1) to lose weight and get in (much) better shape; (ii.2) to stay in sufficient shape to be independent and able to carry out all daily tasks; (ii.3) to enjoy life and (social) pleasures of pensioners (with no stress for spending time on PA); (ii.4) a multitude of other goal variations.

The ELM framework will show the drivers that get users to adopt and use PA programs (and then – always/most of the time/sometimes/seldom - to stay with the programs). There are challenges to get the users to stay with their PA programs. Linke et al (2011) cite statistics that up to 50% of people who start an exercise program drop out within 6 months; Stiggelbout et al (2005) show a dropout incidence of 0.15 per 6 months in a large 12 month program for seniors with more than 2000 participants; Rossi et al (2018) studied the participants in a 10-year supervised physical exercise program for older adults and found that the main reasons for dropout were lack of time, disease and need to care for family members.

In section 2 we worked out the DW-app 2.5 as a digital service and noted that conceptual drivers for the adoption and use of digital services build on the Unified Theory of Acceptance and Use of Technology (UTAUT2) framework (cf. Venkatesh et al (2016)) that identifies seven drivers. We will use {DS} to denote a set of digital services that (following Venkatesh et al (2016)) will be specified by the context in which they are used.

The UTAUT2 framework will show the drivers that get users to adopt and use {DS} – which will then assist and support the sustained use of PA programs ({DS} includes DW-app 2.5 as an artefact).

We propose to combine the UTAUT2 with the ELM to work out how {DS} could contribute to the sustained use of PA programs when users are already using a program or have decided to start to use one.

If we assume that {DS} will contribute to a sustained use of PA programs we will only need three of the UTAUT2 drivers to trace the impact (ELM will cover the rest of the drivers, cf. fig.3): (i) perceived usefulness (≈ performance expectancy (PE)); (ii) perceived ease of use (≈ effort expectancy (EE)); and (iii) behavioural intention (≈ behavioural intention (BI)). The drivers are collected and described as perceived by the users (Davis (1989), Venkatesh et al (2012)). If we apply this to the {DS} we get the following constructs (cf. Table 2).

Table 2: Some selected UTAUT2 drivers for sustainable PA programs

- (PE1) I find {DS} useful in achieving my daily PA goals
- (PE2) Using {DS} helps me achieve my PA goals more quickly
- (PE3) Using {DS} increases my efficiency in achieving my PA goals
- (EE1) Learning how to use {DS} to achieve my PA goals is easy for me
- (EE2) I find using {DS} to achieve my PA goals easy
- (EE3) It is easy for me to become skilful at using {DS} to achieve my PA goals

- (BI1) I intend to continue using {DS} to achieve my PA goals
- (BI2) I will always try to use {DS} to achieve my PA goals
- (BI3) I plan to use {DS} regularly to achieve my PA goals

Perceived usefulness now appears in both the ELM and the UTAUT2 frameworks. In the ELM framework we have the perceived usefulness of PA programs and work this out from attitudes to systematic PA, and the relevance and history of PA (for a user), which then shows what {DS} features and functions would be helpful to gain sustained use of PA programs. In the UTAUT2 framework we work out what {DS} will be useful and easy to use for sustained use of PA programs. There may be facilitating conditions for the adoption and use of the {DS}; in the UTAUT2 framework we typically find digital experience, self-efficacy, and trust (cf. Venkatesh et al (2016)).

If we combine the ELM and UTAUT2 we get the following framework (cf. fig.4) that will show the conceptual drivers that describe and (partly) explain the sustained use of PA programs. This type of combination of conceptual frameworks was used in (e.g.) Brown et al (2010) and Lallmahomed et al (2013).

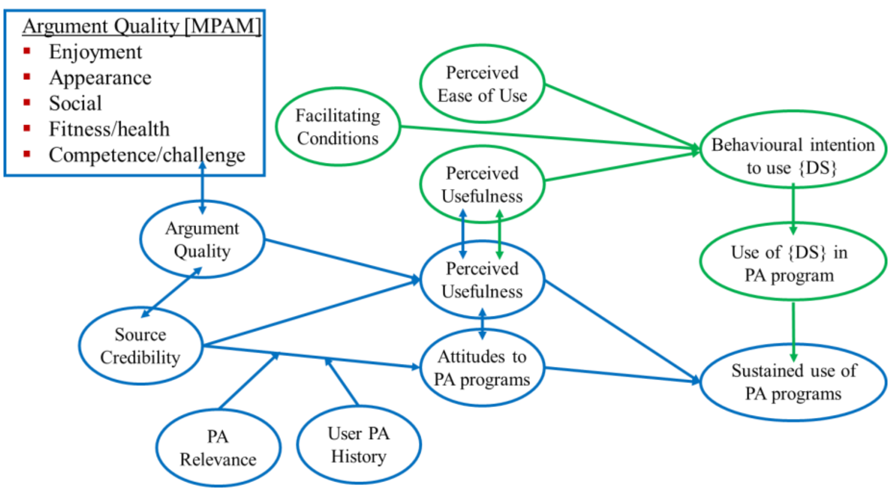

Figure 4: Combined ELM & UTAUT2 model

The framework has later been augmented with the *Motives for Physical Activity Measures* to add to the Argument Quality.

4 Preliminary Conclusion and Discussion

In section 1 we set out to tackle two research questions:

- What drivers could get young elderly users to adopt and use PA programs? Perceived usefulness & attitudes to PA programs combined with argument quality & source credibility (on the health effects of systematic PA) supported with user PA relevance and PA history will be drivers for the use of PA programs.
- What factors or drivers could help support and sustain the adoption of PA programs? Behavioural intention to use {DS} & use of {DS} in PA programs, which are supported by perceived usefulness & perceived ease of use with further support by facilitating conditions will be drivers to sustain the adoption and use of PA programs.

We realize that these answers are preliminary. Further studies are needed with the combined ELM & UTAUT2 model to find out what drivers are necessary for the sustained use of PA programs, and then what subset of drivers are sufficient to get sustained use of PA programs. We have seen in the DW research program (cf. Carlsson et al (2020)) that the {DS} will have an important (or even key) role for the sustained use of PA programs among the young elderly, but we have also seen that they will probably not be sufficient. Systematic empirical experiments and studies will give the answers.

We can use the UTAUT2 framework to enhance the proposed combined ELM & UTAUT2 model (cf. fig.5). There are *endogenous* motivations (cf. Venkatesh et al (2016)) that fit with argument quality and source credibility for sustained adoption of PA programs. There is the objective "*to get more good years*". There are facts, news, and media discussions about the effects of PA on health and the chance to avoid serious illness in senior years (Linke et al (2011)). Young elderly has short-term goals to continue with their everyday routines and longer-term goals for plans on activities that require good or better physical shape (Stiggelbout et al (2005)).

There are *exogenous* motivations (cf. Venkatesh et al (2016)) that support PA relevance in ELM; these include physicians' health recommendations for PA programs (Hukkanen et al (2018)). Potential public policy decisions on reduction in elderly care are dark drivers - "*better stay in shape, care may not be available when we need it*".

Social influence (cf. Venkatesh et al (2016)) is an exogenous factor for PA programs that supports attitudes to PA programs in ELM. The strongest influence, reasonably enough, comes from family and loved ones that want to contribute to the "*more good years*".

Aims for wellness & quality of life (cf. Venkatesh et al (2016)) also support attitudes to PA programs in ELM.

We found first validations of the constructs through empirical studies with young elderly in the DW research program (cf. Carlsson et al (2020b); Kari et al (2020a), (2020b); Makkonen et al (2020a), (2020b)) We have applied both cross-sectional (cf. Kari et al (2020a)) and longitudinal (cf. Makkonen et al (2020b)) studies of the actual use of PA programs (which fit the ELM mode), and the expected continued use of PA programs (in the UTAUT mode). The early results are interesting and growing sets of empirical data are collected in longitudinal test programs as the DW program progresses.

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