Spring 6-20-2012

Examining the Usage Intentions of Exercise Monitoring Devices: The Usage of Pedometers and Route Trackers in Finland

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25th Bled eConference
eDependability:
Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future
June 17, 2012 – June 20, 2012; Bled, Slovenia

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Abstract
In the past years, an increasing number of people have begun to use different types of exercise monitoring devices to measure their physical exercise activities. However, the underlying reasons why people use these devices remain very vaguely understood. This study aims at addressing this shortcoming by first proposing a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically testing it in the case of two common types of these devices: pedometers and route trackers. The model is based on a synthesis of three distinct theoretical domains – the theory of planned behaviour, the innovation diffusion theory, and the typology of consumer value – and it is tested by analysing an online survey sample of 3,036 Finnish consumers, or more specifically sub-samples of 293 pedometer owners and 359 route tracker owners, through structural equation modelling. The results of the analysis are also used to draw implications for the design and marketing of the devices.

Keywords: Usage intentions, exercise monitoring devices, pedometers, route trackers, theory of planned behaviour, innovation diffusion theory, typology of consumer value

1 Introduction

In the past years, an increasing number of people have begun to use different types of information and communication technology (ICT) based self-monitoring devices to measure various aspects of their lives (e.g., Li, 2011). One common type of these devices are exercise monitoring devices that people use to measure their physical exercise activities. For example, many of us carry a pedometer in our pocket to count our daily steps or wear a heart rate monitor around our chest and wrist when we go out jogging. However, although commonly used, there seems to be considerable differences in the reasons why people use these devices. For some, the reasons may be related to general physical health and well-being, whereas others may reach for some much more specific goals, such as improving their physical performance in a particular sport or shaping their physical appearance by losing weight or gaining muscles. Yet for others, the reasons may be related to the ability of the devices to make exercise more fun or to the social advantages resulting from just wearing them. For example, some people may wear a heart rate monitor around their wrist in order to give an active impression of themselves to other people. Or less egoistically, a caring parent may do the same in order to altruistically encourage his or her children to adopt an active lifestyle.

So far, most prior studies on exercise monitoring devices have adhered to a rather device-centric perspective and examined topics like their measurement accuracy, reliability, and validity as well as their ability to promote physical activity (e.g., Eston, Rowlands & Ingledew, 1998; Terbizan, Dolezal & Albano, 2002; Crouter et al., 2003; Schneider et al., 2003; Crouter, Albright & Bassett, 2004; Bravata et al., 2007; Nunan et al., 2009). In contrast, few prior studies have adhered to a more user-centric perspective and examined topics like the aforementioned reasons for using the devices. This can be seen as a significant shortcoming because an understanding of these reasons can be considered a critical prerequisite, among others, for the analytical promotion of their adoption and diffusion with appropriate design and marketing decisions. The present study aims at addressing this shortcoming by first proposing a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically testing it in the case of two common types of these devices: pedometers and route trackers. Methodologically, the testing is done by analysing an online survey sample of 3,036 Finnish consumers, or more specifically sub-samples of 293 pedometer owners and 359 route tracker owners, through structural equation modelling (SEM).

By *pedometers* (PMs), we refer to mobile devices that measure the steps taken by their users. The measurements can be done either mechanically or electromechanically by using a pendulum or electronically by using an accelerometer. In fact, based on this, some studies (e.g., Eston, Rowlands & Ingledew, 1998) differentiate pedometers and accelerometers as two distinct types of devices, of which accelerometers are also commonly referred to as “activity monitors” (e.g., Polar FA20 and Active). However, in this study, we make no such differentiation. Physically, PMs may be separate special purpose devices that are worn on the body or on the clothes, or they may be additional features of other mobile devices, such as mobile phones or heart rate monitors, which are equipped with either an internal or an external stride sensor. As the external sensors are commonly worn on the foot, they are also often referred to as “foot pods”.

By *route trackers* (RTs), we refer to mobile devices that measure the route travelled by their users, typically by using the Global Positioning System (GPS). Physically, once again, RTs may be separate special purpose devices that are worn on the body or on the clothes, but more commonly they are additional features of other mobile devices, such as mobile phones or heart rate monitors, which are equipped with either an internal or an external positioning sensor. As GPS is the most commonly used positioning technology, the external sensors are also often referred to as “GPS pods”.

This paper consists of six sections. After this introductory section, we propose our theoretical model for explaining the usage intentions of exercise monitoring devices in Section 2. Sections 3 and 4 present the methodology and results of the study. The results are discussed in more detail in Section 5, which also uses them to draw implications for the design and marketing of PMs and RTs. Finally, Section 6 considers the limitations of the study and potential paths of future research.

2 Theoretical Model

Our theoretical model for explaining the usage intentions of exercise monitoring devices is based on a synthesis of three distinct theoretical domains: the theory of planned behaviour (TPB) by Ajzen (1985, 1991), the innovation diffusion theory (IDT) by Rogers (2003), and the typology of consumer value (TCV) by Holbrook (1996, 1999). TPB, which is an extension of the theory of reasoned action (TRA) by Fishbein and Ajzen (1975, 1980) and one of the most commonly used theories for explaining human behaviour, was used as the backbone of the model. A schematic illustration of TPB is presented in Figure 1 (the dashed elements are omitted in this study). In accordance with TPB, we hypothesised that the usage intentions of exercise monitoring devices could be explained by three factors: the attitude towards their usage, the subjective norm towards their usage, and the perceived behavioural control over their usage. Here, *attitude* refers to an individual’s positive or negative evaluations of performing a behaviour, whereas *subjective norm* refers to an individual’s perception of social pressure to perform or not to perform it. *Perceived behavioural control*, in turn, refers to an individual’s perception of capacity, autonomy, and self-efficacy to perform it. Each of these three factors was hypothesised to have a positive effect on the usage intentions, meaning that the more positive the attitude towards the usage and the stronger the subjective norm towards and the perceived behavioural control over it, the stronger the usage intentions should be.

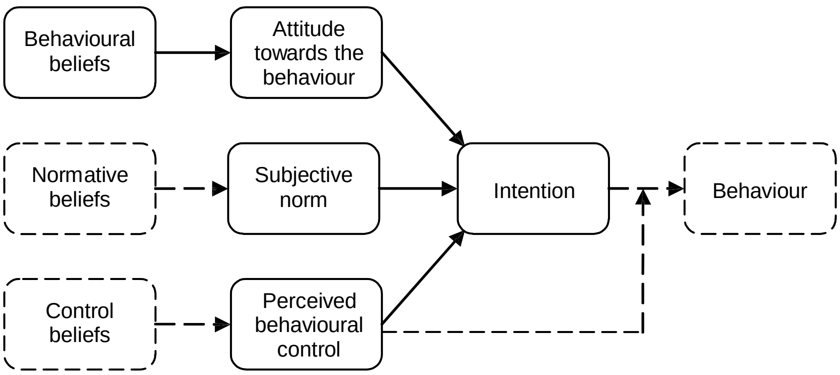

Figure 1: The theory of planned behaviour (Ajzen, 1985, 1991)

In addition to explaining the usage intentions of exercise monitoring devices with the three aforementioned factors, we also aimed at explaining the attitude towards their usage with behavioural beliefs on the outcomes of the usage. This, of course, could also have been done for subjective norm and perceived behavioural control with normative beliefs and control beliefs. However, in this study, we decided to concentrate only on attitude, which most prior studies have identified as the most important explanatory factor for intentions (Fishbein & Ajzen, 2010). In accordance with the decomposed theory of planned behaviour (DTPB) by Taylor and Todd (1995), we decomposed the behavioural beliefs into three distinct belief dimensions derived from IDT by Rogers (2003), which, in addition to perceived trialability and perceived observability, are hypothesised to be the most important explanatory factors for the rate of adoption of an innovation: perceived relative advantage, perceived complexity, and perceived compatibility. However, we differed from the original DTPB in three respects. First, we replaced the concept of *perceived complexity*, which in IDT is defined as the degree to which an innovation is perceived as relatively difficult to understand and use, with the contrary concept of *perceived ease of use* from the technology acceptance model (TAM) by Davis, Bagozzi, and Warshaw (1989), in which it is defined as the degree to which a person believes that using a particular system would be free from effort. To differentiate it from the concept of perceived behavioural control, we also defined it more specifically as the freedom from cognitive effort. In accordance with the original TAM, this concept was hypothesised to have a positive effect on attitude. Second, in addition to *perceived compatibility*, which in IDT is defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters, we included in the model the concept of *perceived discomfort*, which we defined more specifically as the degree to which the usage of an innovation is perceived as causing physical discomfort, inconvenience, or distraction to its users. We consider this concept extremely important in the case of exercise monitoring devices as even a minor degree of perceived discomfort may have a major adverse effect on the overall exercise experience and, consequently, on the attitude towards using the devices. Thus, contrary to the concept of perceived compatibility, this concept was hypothesised to have a negative effect on attitude.

Third, we replaced the concept of *perceived relative advantage*, which in IDT is defined as the degree to which an innovation is perceived as being better than the idea it supersedes, with the more comprehensive concept of *perceived value*, which more explicitly captures not only utilitarian but also hedonic and social perceptions of an innovation. More specifically, we included in the model four types of active value (efficiency, play, status, and ethics) that are defined in TCV by Holbrook (1996, 1999). In addition to these, TCV defines four types of reactive value (excellence, aesthetics, esteem, and spirituality). However, these were excluded from the model because we wanted to concentrate specifically on the value that derives from the active usage of the devices. A schematic illustration of TCV is presented in Figure 2 (the value dimensions and value types in parentheses are omitted in this study).

		Extrinsic	**Intrinsic**
Self-oriented	**Active**	Efficiency	Play
	(Reactive)	(Excellence)	(Aesthetics)
Other-oriented	**Active**	Status	Ethics
	(Reactive)	(Esteem)	(Spirituality)

Figure 2: The typology of consumer value (Holbrook, 1996, 1999)

In the context of exercise monitoring devices, we conceptualised the extrinsic and self-oriented *efficiency value* as the value deriving from the perceived ability of the devices to support the achievement of different types of utilitarian exercise goals more efficiently. We identified three types of these goals: physical health and well-being goals (e.g., maintaining one's physical health and well-being), physical performance goals (e.g., improving one's physical endurance, strength, speed, or agility), and physical appearance goals (e.g., losing weight, gaining muscles, or toning one's body). These were all included in the model as individual concepts, each of which was hypothesised to have a positive effect on attitude. The goals were derived from the revised motivation for physical activity measure (MPAM-R) scale by Ryan et al. (1997), which defines five motivational dimensions for physical activity: fitness and health, competence and challenge, appearance, social, and enjoyment. The first three dimensions correspond to the aforementioned health and well-being, performance, and appearance goals. The fourth dimension, social, can also be considered a utilitarian goal, but it was excluded from the model because few exercise monitoring devices have an ability to strongly support its achievement. In contrast, the fifth dimension, enjoyment, is a hedonic goal, and, therefore, it associates better with the intrinsic and self-oriented *play value*, which we conceptualised as the value deriving from the perceived ability of the devices to support the achievement of different types of hedonic exercise goals (e.g., making exercise more fun, enjoyable, or pleasurable). This concept (included in the model as "enjoyment perceptions" in accordance with MPAM-R) was also hypothesised to have a positive effect on attitude. The extrinsic and other-oriented *status value* was conceptualised as the value deriving from the perceived ability of the devices to the give a more positive impression of their users to others. In this context, we defined this more specifically as giving others a more active impression of oneself. Finally, the intrinsic and other-oriented *ethics value* was conceptualised as the value deriving from the perceived ability of the devices to do something for the sake of others. In this context, we defined this more specifically as motivating or inspiring others to exercise in order for them to adopt an active lifestyle. Both status and ethics perceptions were hypothesised to have a positive effect on attitude. The final form of the theoretical model is illustrated in Figure 3.

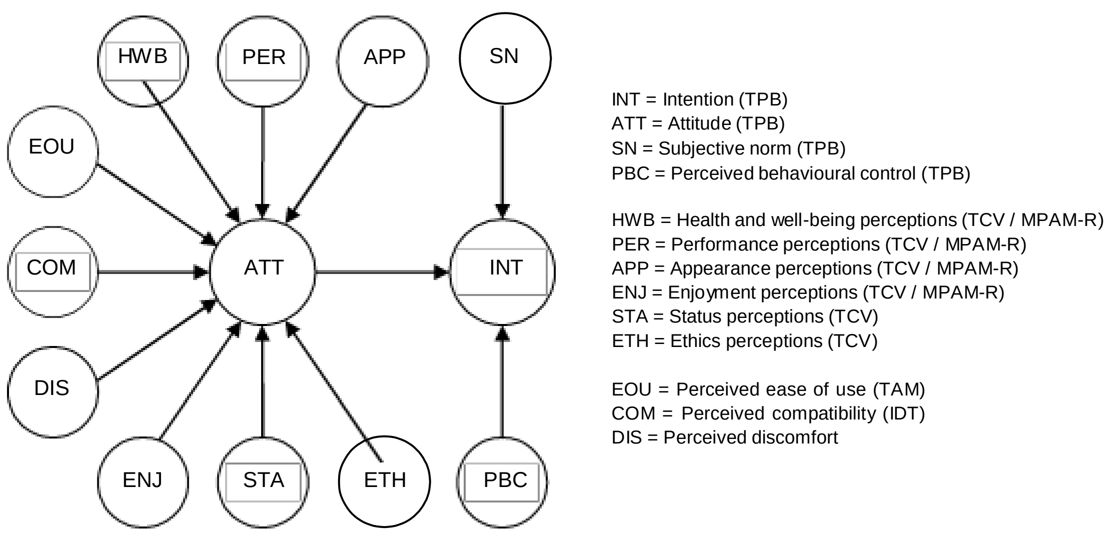

Figure 3: The model for explaining the usage intentions of exercise monitoring devices

3 Methodology

To test the theoretical model, we conducted an online survey among Finnish consumers. The survey was created by using the LimeSurvey 1.91+ software, and before launching it online, we pre-tested it qualitatively with two postgraduate students and quantitatively with 56 undergraduate students. The survey was online for about one and a half months from 14 December, 2011 to 31 January, 2012. During this time, we actively promoted the survey link by posting it to several Finnish discussion forums focusing on a variety of topics as well as by sending several invitation e-mails through the internal communication channels of our university and an e-mail list provided by a Finnish company specialising in the testing of exercise devices. This e-mail list contained both active and inactive users of various exercise devices. To raise the response rate, we also raffled 26 gift cards with a total worth of 750 € among the respondents.

The survey questionnaire consisted of several sections, one of which was used to collect the data for testing the theoretical model. The other sections concentrated, among others, on the exercise habits of the respondents and their usage of three different types of exercise monitoring devices: PMs, RTs, and heart rate monitors. Some of the sections and the items in them were conditional. For example, the data for testing the theoretical model was collected only from the respondents who owned a PM, a RT, or a heart rate monitor. This was to ensure that they all had an about equal chance to use the devices and at least a little experience with them. If a respondent owned multiple devices, he or she was first asked to select his or her most commonly used device and was then surveyed only on it. This was to avoid respondent fatigue, which was a potential problem as the number of items presented to each respondent varied from 46 to 130.

Each of the 13 constructs in the theoretical model was operationalised to be measured by three reflective indicators. The wordings of these 39 indicators, translated from Finnish to English, are presented in Appendix A. The operationalisations of the intention, attitude, subjective norm, and perceived behavioural control constructs followed the guidelines given by Fishbein and Ajzen (2010) as well as the examples by Taylor and Todd (1995). The intention, subjective norm, and perceived behavioural control constructs were each measured by using a seven-point Likert scale. As suggested by Fishbein and Ajzen (2010), the normative indicators were designed to capture both the descriptive (SN1 and SN2) and the injunctive (SN3 and SN2) aspects of normative evaluations, whereas the control indicators were designed to capture both the capacity (PBC1 and PBC2) and the autonomy (PBC3 and PBC2) aspects of control evaluations. The time horizon of the intention indicators was set to six months to cover both winter and summer sports. The attitude construct was measured by using a seven-point semantic differential scale. As suggested by Fishbein and Ajzen (2010), its indicators were designed to capture both the experiential (ATT2) and the instrumental (ATT3) aspects of attitudinal evaluations as well as overall attitude (ATT1).

The nine behavioural belief constructs were also measured by using a seven-point Likert scale. The operationalisations of the health and well-being, performance, appearance, and enjoyment perceptions constructs were based on the MPAM-R scale by Ryan et al. (1997). The operationalisation of the status perceptions construct was based on the study by Sweeny and Soutar (2001). The operationalisations of the perceived ease of use and compatibility constructs were based on the studies by Davis (1989) as well as Karahanna, Agarwal, and Angst (2006), and they concentrated specifically on cognitive ease of use and on compatibility with existing habits. For the operationalisations of the perceived discomfort and ethics perceptions constructs, no suitable examples were found in prior studies.

The analysis of the collected data was done by using the IBM SPSS Statistics 19 and the Mplus 6 software. SPSS was mainly used for data preparation and preliminary analysis, whereas Mplus was used for the actual SEM analysis.

4 Results

In total, we received 3,036 valid responses to our online survey. Of the respondents, 295 owned only a PM or owned multiple devices and selected the PM as their most commonly used exercise monitoring device. Respectively, 362 owned only a RT or owned multiple devices and selected the RT as their most commonly used exercise monitoring device. After excluding five responses with missing values in all the indicator variables, two in the case of PMs and three in the case of RTs, this resulted in sub-samples of 293 and 359 responses for testing the theoretical model in the case of PMs and RTs, respectively. The average response times for the entire survey were about 18 minutes in the PM sub-sample and about 21 minutes in the RT sub-sample.

	Entire sample (N = 3,036)		PM sub-sample (N = 293)		RT sub-sample (N = 359)	
	N	%	N	%	N	%
Gender						
Male	1,082	35.6	49	16.7	244	68.0
Female	1,954	64.4	244	83.3	115	32.0
Age						
–29 yrs.	1,204	39.7	62	21.2	118	32.9
30–39 yrs.	789	26.0	69	23.5	124	34.5
40–49 yrs.	593	19.5	81	27.6	71	19.8
50– yrs.	450	14.8	81	27.6	46	12.8
Yearly income						
–14,999 €	908	34.1	66	27.8	80	24.5
15,000–29,999 €	668	25.1	69	29.1	55	16.9
30,000–44,999 €	678	25.5	74	31.2	103	31.6
45,000– €	407	15.3	28	11.8	88	27.0
N/A	375	–	56	–	33	–
Socioeconomic group						
Student	768	25.3	47	16.0	73	20.3
Employed	1,797	59.2	188	64.2	249	69.4
Unemployed	210	6.9	29	9.9	17	4.7
Pensioner	121	4.0	14	4.8	12	3.3
Other	140	4.6	15	5.1	8	2.2
Actively does some sport						
Yes	2,150	74.7	172	62.5	298	86.4
No	728	25.3	103	37.5	47	13.6
N/A	158	–	18	–	14	–

Table 1: Descriptive statistics of the entire sample and the two sub-samples

Descriptive statistics of the entire sample as well as the PM and RT sub-samples are presented in Table 1. Overall, the gender, age, and income distributions of the entire sample corresponded very well with the gender and age distributions of the Finnish Internet population as well as the income distribution of the Finnish income recipients in 2010 (Statistics Finland, 2012). Women and the youngest age group were slightly overrepresented, whereas men and the two oldest age groups were slightly underrepresented. However, there were no indications of severe non-response bias in terms of these three variables. The gender, age, and income distributions of two sub-samples differed somewhat from each other and from those of the entire sample. For example, the PM sub-sample was more dominated by women and older respondents, whereas the RT sub-sample was more dominated by men and younger respondents. Both the entire sample and the two sub-samples could also be characterised as very heterogeneous in terms of the socioeconomic group of the respondents and the percentage of the respondents who actively did or did not do some sport.

4.1 Estimation Results

The model estimations were done by using the robust maximum likelihood (MLR) estimator, and the estimation results are presented in Figure 4. As can be seen, the model performed very well in explaining the usage intentions of and the attitudes towards using exercise monitoring devices, especially in the case of PMs. In the case of PMs, health and well-being perceptions, perceived compatibility, ethics perceptions, and perceived discomfort had a statistically significant effect on attitudes, and together they explained 62.0 % of the variance in them. As hypothesised, the first three factors had a positive effect, whereas perceived discomfort had a negative effect on attitudes. Attitudes, in turn, had a statistically significant and positive effect on usage intentions and explained 60.9 % of the variance in them. In contrast, neither subjective norm nor perceived behavioural control had a statistically significant effect on usage intentions. In the case of RTs, only perceived compatibility had a statistically significant and positive effect on attitudes, and it explained 34.5 % of the variance in them. Attitudes, in turn, together with perceived behavioural control, had a statistically significant and positive effect on usage intentions, and they explained 54.7 % of the variance in them. In contrast, as in the previous case, subjective norm had no statistically significant effect on usage intentions.

In the next three sub-sections, the goodness of fit, reliability, and validity of the estimated models are evaluated on model, construct, and indicator levels.

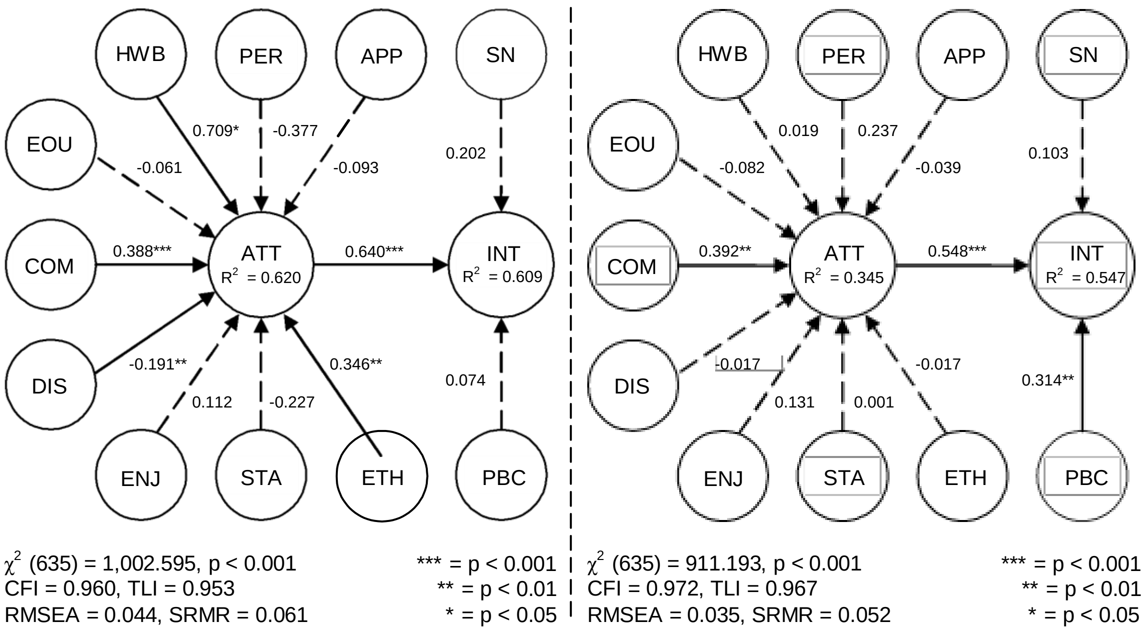

Figure 4: Estimation results for PMs (left) and RTs (right)

4.2 Model Goodness of Fit

Model goodness of fit was evaluated by using the χ^2 test of model fit and four fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). Their values are presented in Figure 4. In the case of both the models, the χ^2 test rejected the null hypothesis of the model fitting the data. However, this may have been due to the tendency of the χ^2 test to underestimate the fit in the case of large samples and complex models (Bentler & Bonett, 1980). In contrast, the values of the four fit indices clearly met the commonly accepted cut-off criteria for a satisfactory fit (CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08 – Hu & Bentler, 1999). Thus, overall, both the models can be seen as exhibiting a satisfactory fit with the data.

4.3 Construct Reliabilities and Validities

Construct reliabilities were evaluated by using composite reliabilities (CR – Fornell & Larcker, 1981). It is commonly expected that the CR of each construct should be greater than or equal to 0.7 in order for it to exhibit satisfactory reliability (Nunnally & Bernstein, 1994). The CR of each construct is listed in the first column of Tables 2 (PMs) and 3 (RTs). As can be seen, all the constructs met this criterion.

Construct	CR	AVE	INT	ATT	SN	PBC	HWB	PER	APP	ENJ	STA	ETH	EOU	COM	DIS
INT	0.976	0.930	**0.964**												
ATT	0.893	0.735	0.749	**0.857**											
SN	0.750	0.507	0.520	0.445	**0.712**										
PBC	0.871	0.693	0.329	0.257	0.449	**0.833**									
HWB	0.956	0.878	0.519	0.616	0.554	0.174	**0.937**								
PER	0.943	0.846	0.462	0.541	0.517	0.151	0.964	**0.920**							
APP	0.944	0.848	0.420	0.493	0.484	0.080	0.873	0.872	**0.921**						
ENJ	0.969	0.911	0.515	0.635	0.482	0.151	0.828	0.802	0.758	**0.955**					
STA	0.956	0.880	0.300	0.342	0.411	-0.029	0.587	0.566	0.683	0.610	**0.938**				
ETH	0.960	0.889	0.375	0.452	0.421	0.013	0.614	0.575	0.655	0.656	0.870	**0.943**			
EOU	0.920	0.794	0.327	0.380	0.277	0.382	0.214	0.182	0.159	0.276	0.093	0.113	**0.891**		
COM	0.786	0.560	0.512	0.615	0.443	0.392	0.431	0.395	0.371	0.501	0.207	0.244	0.671	**0.748**	
DIS	0.922	0.799	-0.278	-0.360	-0.159	-0.214	-0.137	-0.075	-0.033	-0.230	0.068	0.075	-0.325	-0.276	**0.894**

Table 2: CRs, AVEs, square roots of AVEs, and correlations of the constructs (PMs)

Construct	CR	AVE	INT	ATT	SN	PBC	HWB	PER	APP	ENJ	STA	ETH	EOU	COM	DIS
INT	0.973	0.922	**0.960**												
ATT	0.846	0.647	0.644	**0.805**											
SN	0.803	0.589	0.403	0.264	**0.768**										
PBC	0.842	0.642	0.485	0.218	0.495	**0.801**									
HWB	0.958	0.884	0.311	0.418	0.347	0.149	**0.940**								
PER	0.947	0.857	0.349	0.451	0.400	0.193	0.913	**0.926**							
APP	0.953	0.872	0.183	0.279	0.248	0.014	0.794	0.775	**0.934**						
ENJ	0.939	0.837	0.376	0.453	0.370	0.284	0.703	0.717	0.506	**0.915**					
STA	0.963	0.897	0.110	0.160	0.211	0.001	0.528	0.483	0.625	0.381	**0.947**				
ETH	0.962	0.895	0.145	0.232	0.262	-0.030	0.584	0.573	0.653	0.476	0.840	**0.946**			
EOU	0.889	0.728	0.351	0.224	0.370	0.604	0.170	0.223	0.095	0.268	0.058	0.075	**0.853**		
COM	0.792	0.562	0.460	0.508	0.393	0.450	0.361	0.400	0.181	0.467	0.076	0.181	0.549	**0.750**	
DIS	0.945	0.850	-0.270	-0.257	-0.244	-0.331	-0.154	-0.183	-0.014	-0.298	0.105	0.025	-0.280	-0.455	**0.922**

Table 3: CRs, AVEs, square roots of AVEs, and correlations of the constructs (RTs)

Construct validities were evaluated by concentrating on the convergent and discriminant validity of the constructs. These were evaluated by using the two criteria proposed by Fornell and Larcker (1981). They both are based on the average variance extracted (AVE) of a construct, which refers to the average proportion of variance that a construct explains in its indicators. In order to exhibit satisfactory convergent validity, the first criterion requires that each construct should have an AVE greater than or equal to 0.5, meaning that, on average, each construct should explain at least half of the variance in its indicators. The AVE of each construct is listed in the second column of Tables 2 (PMs) and 3 (RTs). As can be seen, all the constructs met this criterion. In order to exhibit satisfactory discriminant validity, the second criterion requires that each construct should have a square root of AVE greater than or equal to its absolute correlation with the other constructs, meaning that, on average, each construct should share at least an equal proportion of variance with its indicators than it shares with the other constructs. The square root of AVE of each construct (on-diagonal cells) and the correlations between the constructs (off-diagonal cells) are listed in the remaining columns of Tables 2 (PMs) and 3 (RTs). As can be seen, this criterion was met by all the constructs except for the health and well-being perceptions and performance perceptions constructs in the case of PMs, which correlated very strongly (0.964). Also in the case of RTs, these two constructs correlated strongly (0.913). Thus, we decided to unify them into one health, well-being, and performance perceptions construct, which was measured by the original six indicators, and to re-estimate the models. Of course, an alternative approach would have been to model them as first-order constructs of a second-order construct. The re-estimation results are presented in Section 4.5.

4.4 Indicator Reliabilities and Validities

Indicator reliabilities and validities were evaluated by using the standardised loadings and residuals of the indicators, which are listed in Appendix B. In a typical case where each indicator loads on only one construct, it is commonly expected that the standardised loading (λ) of each indicator should be statistically significant and greater than or equal to 0.707 (Fornell & Larcker, 1981). This is equal to the standardised residual ($1 - \lambda^2$) of each indicator being less than or equal to 0.5, meaning that at least half of the variance in each indicator is explained by the construct on which it loads. As can be seen, in the case of both PMs and RTs, the only indicators that did not meet this criterion were SN1 and COM3. Thus, after assessing that there would be no adverse effects on the content validity of the subjective norm and perceived compatibility constructs, we decided to eliminate them and to re-estimate the models. The re-estimation results are presented in Section 4.5.

4.5 Re-Estimation Results

The re-estimation results after unifying the health and well-being perceptions and performance perceptions constructs into one health, well-being, and performance perceptions construct (HWP) and eliminating the indicators SN1 and COM3 are presented in Figure 5. The model goodness of fit, construct reliabilities and validities, and indicator reliabilities and validities of both the models were all at a satisfactory level. There were no considerable changes in the regression estimates except for the new health, well-being, and performance perceptions construct, which now had a statistically significant and positive effect on attitudes in the case of both PMs and RTs.

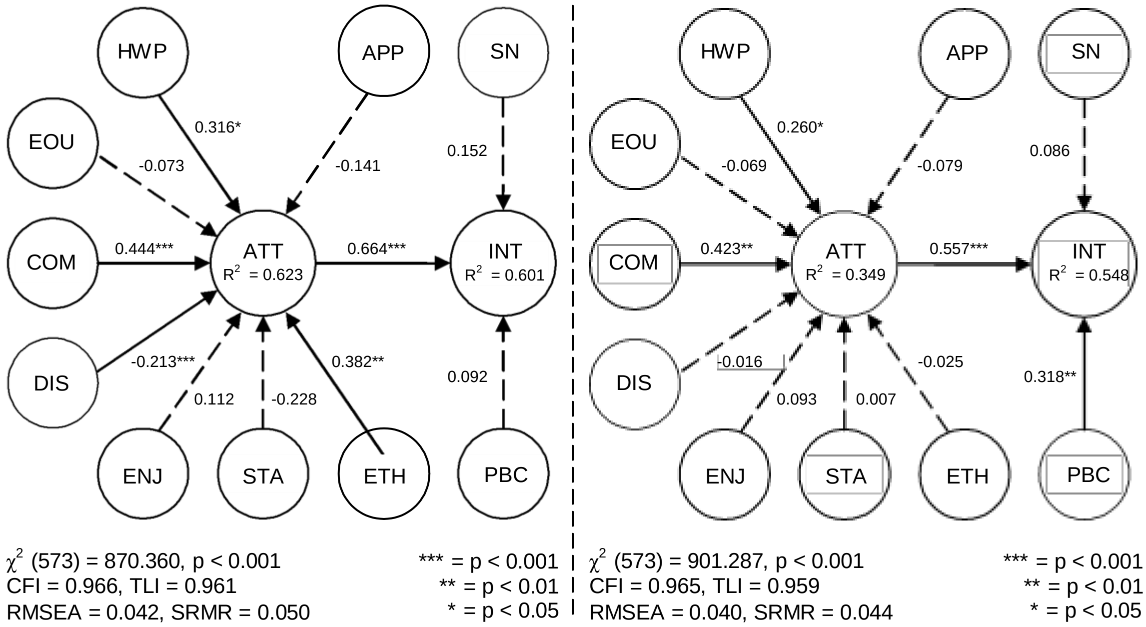

Figure 5: Re-estimation results for PMs (left) and RTs (right)

5 Discussion and Conclusions

In this study, we first proposed a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically tested it in the case of Finnish PM and RT owners. This model can be considered the main theoretical contribution of the study as it not only promotes our theoretical understanding of the reasons behind the usage of exercise monitoring devices but also synthesises three distinct theoretical domains for explaining human behaviour – TPB, IDT, and TCV – into a new unified model, thus narrowing the theoretical gap between them. Although a similar synthesis has previously been done between TPB and IDT (e.g., Taylor & Todd, 1995), we are not aware of it having been done between TPB and TCV or all three of the theories.

The main practical contribution of the study are the estimation results of the model in the case of Finnish PM and RT owners, which can be used to draw some interesting implications for the design and marketing of these devices. First, at least in Finland, it seems that the attitudes towards using both PMs and RTs are driven more by the utilitarian perceptions on their ability to support the achievement of different types of health, well-being, and performance goals than by the hedonic perceptions on their ability to make exercise more fun. Thus, the promotion of these utilitarian perceptions should also be the primary goal in the design and marketing of PMs and RTs.

Second, in the case of both PMs and RTs, also perceived compatibility was found to be a significant driver of the attitudes towards using the devices. Thus, it is important for the designers of PMs and RTs to thoroughly study the exercise habits of the present and potential users of the devices so that they can promote the perceived compatibility of the devices with them through proper design decisions. In the case of PMs, these design decisions should also promote the perceived comfort of using the devices among the users as perceived discomfort was found to have a negative effect on the attitudes towards their usage. Respectively, in the case of RTs, they should also promote the perceptions of capacity, autonomy, and self-efficacy among the users as perceived behavioural control was found to have a positive effect on their usage intentions. In this, also perceived ease of use is likely to indirectly play an important part, although it was not found to have a direct effect on the attitudes towards using PMs and RTs.

Third, in the case of both PMs and RTs, social perceptions were found to be relatively insignificant drivers of the usage of the devices. For example, subjective norm and status perceptions were not found to have an effect on their usage intentions and the attitudes towards their usage, respectively. In contrast, in the case of PMs, ethics perceptions were found to have a positive effect on the attitudes towards their usage, meaning that people who perceived themselves as being able to better encourage also others to exercise by using the devices reacted more positively towards their usage. This finding could perhaps be utilised in the marketing of PMs by more explicitly appealing to the altruistic motivations of the potential users.

6 Limitations and Future Research

We consider this study having five main limitations. First, we empirically tested the theoretical model for explaining the usage intentions of exercise monitoring devices only in the case of Finland and two devices: PMs and RTs. Therefore, future research should aim at replicating this study in other countries and in the case of other types of exercise monitoring devices. This is actually already work in progress as the same online survey that was used to collect the data for this study was also used to collect similar data on heart rate monitors. However, the analysis of this data was omitted from this study due to space restrictions.

Second, in this study, we only concentrated on examining the regression relationships between the constructs and not, for example, the construct scores and means. Third, of these regression relationships, we only examined the indirect effects of behavioural beliefs on usage intentions through attitudes and not the potential direct effects, which have been hypothesised to exist in models like TAM. Fourth, in order to conduct more rigorous comparisons between different types of exercise monitoring devices, measurement invariance would have to be established between the estimated models. This was not done in this study, although an overview of the indicator loadings seems to suggest that at least configural and metric invariance are likely to hold in the case of most of the constructs. Fifth, based on the commonly suggested heuristics for minimum sample size (e.g., Nunnally & Bernstein, 1994), the sample sizes of 293 and 359 respondents that were used to estimate the models in this study can be considered quite small for estimating models with this level of complexity. However, we do not believe the sample sizes having had adverse effects on the estimation results as we also redid the model estimations by using the partial least squares (PLS) estimator, which has less strict requirements for minimum sample size, and received almost identical results.

We consider the most potential paths of future research relating to addressing the aforementioned limitations through a more thorough analysis of the already collected data as well as through replicating the study in other countries and in the case of other types of exercise monitoring devices. Also our theoretical model seems to require some refinements, especially in the case of RTs, as it was able to explain a rather modest proportion of the variance in the attitudes towards their usage. In addition, it would be interesting to extend the theoretical model to cover not only the usage intentions but also the actual usage of exercise monitoring devices.

Acknowledgements

The authors wish to acknowledge the Tourism and Leisure Services Programme of Tekes, the Finnish Funding Agency for Technology and Innovation, and the companies participating in the Sedospo project for their funding of this study.

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Appendix A: Indicators

INT1 I intend to use a PM / RT to monitor my exercise activities in the next six months.
INT2 I plan to use a PM / RT to monitor my exercise activities in the next six months.
INT3 I am likely to use a PM / RT to monitor my exercise activities in the next six months.
ATT1 I think that the idea of me using a PM / RT to monitor my exercise activities in the next six months is bad … good.
ATT2 I think that the idea of me using a PM / RT to monitor my exercise activities in the next six months is unpleasant … pleasant.
ATT3 I think that the idea of me using a PM / RT to monitor my exercise activities in the next six months is useless … useful.
SN1 Many people who are important to me use a PM / RT to monitor their exercise activities.
SN2 Many people who are important to me think that it is a good idea to use a PM / RT to monitor one’s exercise activities.

SN3 Many people who are important to me think that it is a good idea for me to use a PM / RT to monitor my exercise activities in the next six months.
PBC1 If I wanted to, I would be able to use a PM / RT to monitor my exercise activities in the next six months.
PBC2 If I wanted to, it would be possible for me to use a PM / RT to monitor my exercise activities in the next six months.
PBC3 It is up to me whether or not I use a PM / RT to monitor my exercise activities in the next six months.

I believe that by using a PM / RT to monitor my exercise activities in the next six months I can or could…
HWB1 …better maintain my physical health.
HWB2 …better maintain my physical ability to function.
HWB3 …better maintain my physical well-being.
PER1 …more efficiently improve my physical capacity.
PER2 …more efficiently improve my physical performances.
PER3 …more efficiently improve my physical capabilities (e.g., endurance, strength, speed, or agility).
APP1 …more efficiently improve my physical appearance.
APP2 …more efficiently shape my body.
APP3 …more efficiently lose weight, gain muscles, or tone my body.
ENJ1 …make my exercise more fun.
ENJ2 …make my exercise more enjoyable.
ENJ3 …make my exercise more pleasant.
STA1 …be perceived as a more active person by other people.
STA2 …give a more active impression of myself to other people.
STA3 …create a more active image for myself.
ETH1 … better motivate also other people to exercise.
ETH2 … better inspire also other people to exercise.
ETH3 … better encourage also other people to exercise.

I believe that using a PM / RT to monitor my exercise activities in the next six months…
EOU1 …would be clear and comprehensible to me.
EOU2 …would be easy for me to understand.
EOU3 …would be easy for me to learn.
COM1 …would be compatible with my current exercise habits.
COM2 …would not run counter to my current exercise habits.
COM3 …would not require changes in my current exercise habits.
DIS1 …would physically disturb me.
DIS2 …would feel to me physically uncomfortable.
DIS3 …would feel to me physically inconvenient.

Appendix B: Indicator Loadings and Residuals

	PMs		RTs	
Indicator	**Loading**	**Residual**	**Loading**	**Residual**
INT1	0.975***	0.050***	0.964***	0.070*
INT2	0.962***	0.074***	0.945***	0.107***
INT3	0.956***	0.086***	0.972***	0.056*
ATT1	0.866***	0.250***	0.749***	0.439***
ATT2	0.849***	0.279***	0.805***	0.352***
ATT3	0.857***	0.266***	0.856***	0.267***
SN1	0.530***	0.719***	0.507***	0.743***
SN2	0.766***	0.413***	0.901***	0.188**
SN3	0.808***	0.347***	0.836***	0.302***
PBC1	0.852***	0.273***	0.893***	0.202*
PBC2	0.904***	0.183**	0.790***	0.377**
PBC3	0.732***	0.464***	0.711***	0.495***
HWB1	0.945***	0.107***	0.930***	0.135***
HWB2	0.932***	0.132***	0.935***	0.126***
HWB3	0.934***	0.127***	0.956***	0.086***
PER1	0.947***	0.103***	0.936***	0.125***
PER2	0.937***	0.123***	0.946***	0.105***
PER3	0.874***	0.236***	0.895***	0.200***
APP1	0.905***	0.181***	0.934***	0.127***
APP2	0.944***	0.109***	0.951***	0.096***
APP3	0.914***	0.165***	0.916***	0.160***

	PMs		RTs	
Indicator	**Loading**	**Residual**	**Loading**	**Residual**
ENJ1	0.965***	0.068***	0.925***	0.145***
ENJ2	0.940***	0.116***	0.872***	0.240***
ENJ3	0.958***	0.082***	0.946***	0.105***
STA1	0.953***	0.092***	0.947***	0.103***
STA2	0.947***	0.102***	0.943***	0.111***
STA3	0.913***	0.166***	0.951***	0.096***
ETH1	0.952***	0.094***	0.947***	0.102***
ETH2	0.948***	0.102***	0.949***	0.100***
ETH3	0.929***	0.138***	0.942***	0.112***
EOU1	0.850***	0.277***	0.868***	0.247***
EOU2	0.933***	0.130***	0.840***	0.294**
EOU3	0.888***	0.212**	0.852***	0.274***
COM1	0.811***	0.342***	0.779***	0.393***
COM2	0.859***	0.262***	0.811***	0.342***
COM3	0.533***	0.715***	0.649***	0.578***
DIS1	0.867***	0.248***	0.911***	0.171***
DIS2	0.865***	0.251**	0.956***	0.086**
DIS3	0.946***	0.104**	0.899***	0.192**

*** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$