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Age Differences in Technology Readiness and Its Effects on Information System Acceptance and Use: The Case of Online Electricity Services in Finland

MARKUS MAKKONEN, LAURI FRANK & KERTTULI KOIVISTO

Abstract Although technology readiness (TR) has been found to influence the acceptance and use of information systems (IS), little is known about how TR varies in terms of different demographic variables and how these demographic variables moderate the effects of TR on IS acceptance and use. In this study, we aim to address this gap in prior research by examining the potential age differences in the four technology readiness index (TRI) constructs as well as their effects on IS use intention and its two main antecedents hypothesised in the technology acceptance model (TAM): perceived usefulness and perceived ease of use. The examination is conducted in the context of online electricity services and based on 1,176 online survey responses collected from Finnish consumers and analysed through structural equation modelling (SEM). The findings of the study suggest age differences in the optimism, innovation, and discomfort constructs of TRI, but not in the effects of any of the TRI constructs on the TAM constructs. These findings and their implications are discussed in more detail especially from the perspective of the so-called "young elderly" segment consisting of individuals aged 60–75 years.

Keywords: • Information System Acceptance and Use • Age Differences • Technology Readiness Index • Technology Acceptance Model • Online Electricity Services •

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1 Introduction

In several prior studies (e.g., Lin, Shih & Sher, 2007; Walczuch, Lemmink & Streukens, 2007; Lin & Chang, 2011; Godoe & Johansen, 2012), technology readiness (TR) has been found to significantly influence the acceptance and use of information systems (IS). Typically, individuals who rank higher in terms of TR have been found to be more apt adopters of IS in contrast to those whose ranking is lower. However, in spite of this central role, TR has gained relatively little attention in IS research. For example, little is known about how TR varies in terms of different demographic variables and how these demographic variables moderate the effects of TR on IS acceptance and use as well as its main antecedents. In this study, we aim to address this gap in prior research by examining the aforementioned issues in the case of one highly important demographic variable: age. Age is a demographic variable that has been of high interest in several prior studies on IS acceptance and use. For example, in the well-known and widely used unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. (2003) as well as its extension UTAUT2 by Venkatesh, Thong, and Xu (2012), age is hypothesised to act as an important moderator for the effects of various antecedent constructs on IS acceptance and use. However, no studies that we are aware of have examined age as a moderator for the effects of TR on IS acceptance and use as well as its main antecedents.

We conduct our examination in the case context of online electricity services offered by electric suppliers, which allow their customers, for example, to manage their electricity contracts and track their electricity consumption over the Internet. Such services have become increasingly common in the recent years and offer an ideal case context for the current study because they are often used by individuals with a widely varying age range. The only main exceptions are typically the very youngest and the very oldest individuals, who either still live at their childhood home or live in some sort of communal accommodation, such as a student apartment or a retirement home. As a theoretical framework for conceptualising and operationalising IS acceptance and use, its main antecedents, as well as TR, we utilise the technology acceptance model (TAM) by Davis (1989) and the technology readiness index (TRI) by Parasuraman (2000), which have also been integrated together in several prior studies (e.g., Lin, Shih & Sher, 2007; Walczuch, Lemmink & Streukens, 2007; Lin & Chang, 2011; Godoe & Johansen, 2012).

This paper is structured as follows. After this brief introductory section, the theoretical foundation of the paper is discussed in Section 2. After this, the methodology and results of the study are reported in Sections 3 and 4. The results are discussed in more detail in Section 5, concentrating especially on the implications for the so-called "young elderly" segment consisting of individuals aged 60–75 years. Finally, Section 6 considers the limitations of the study and some potential paths of future research.

2 Theoretical Foundation

TAM by Davis (1989) is an adaptation of the theory of reasoned action (TRA) by Fishbein and Azjen (1975, 1980) to the IS context, which posits that the acceptance and use of a particular system can be best predicted by the use intention towards it. Use intention, in turn, is hypothesised to be predicted by two main antecedents associated with the perceived system characteristics: perceived usefulness (PU), which has traditionally been defined as "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease of use (PEOU), which has traditionally been defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, Bagozzi & Warshaw, 1989). The more useful and easier to use a particular system is perceived to be, the higher should be the intention to use it. In addition, perceived ease of use is hypothesised to act as a predictor of perceived usefulness, so that systems that are perceived as easier to use should also be perceived as more useful. These hypotheses are illustrated in Figure 1.

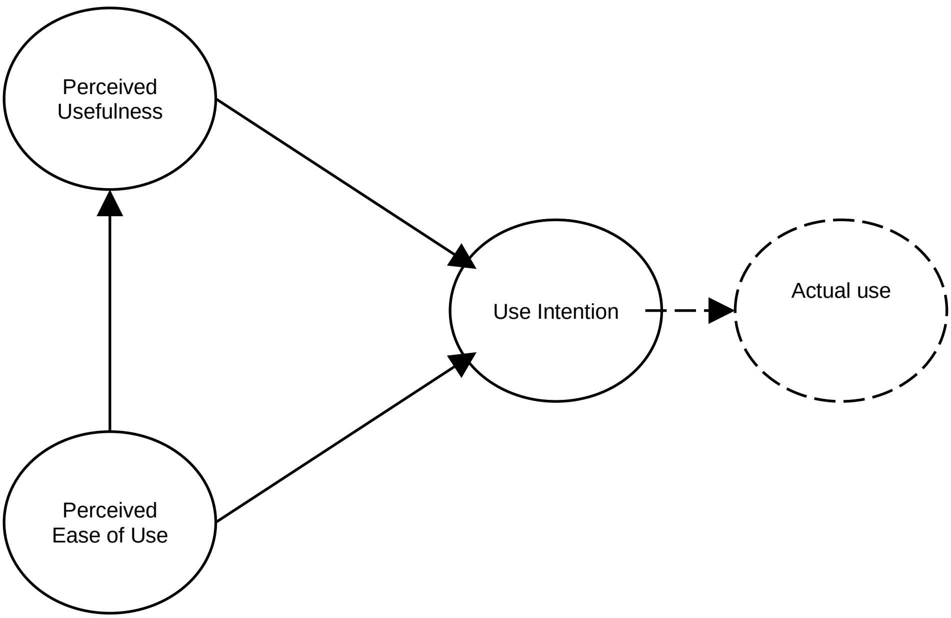

Figure 1: Technology acceptance model (TAM)

Although TAM was originally developed to explain and predict IS acceptance and use only in the organisational context, it has since been applied also outside it. To promote its applicability to other contexts, numerous extensions to the original TAM have been suggested, such as TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008) as well as the aforementioned UTAUT (Venkatesh et al., 2003) and UTAUT2 (Venkatesh, Thong & Xu, 2012). In this study, we utilise only the original TAM as our theoretical framework for conceptualising and operationalising IS acceptance and use as well as its main antecedents because we consider it highly applicable to our current case context of online electricity services, which can be characterised as utilitarian self-service technologies. Thus, their use intention is likely to be influenced mostly by the usefulness and ease of use aspects included in the original TAM rather than, for example, the more hedonic, social, and resource related aspects added to it in extensions like UTAUT and UTAUT2. However, like many prior IS studies, we omit the empirical examination of the linkage between use intention and actual use because this would have required a longitudinal rather than a cross-sectional study setting, which was not possible due to practical reasons.

As a theoretical framework for TR, we utilise TRI by Parasuraman (2000), which defines TR as "people's propensity to embrace and use new technologies to accomplish goals in home life and at work" and postulates it to comprise of four co-existing dimensions defined as follows (Parasuraman & Colby, 2015):

- Optimism: "a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives"
- Innovativeness: "a tendency to be a technology pioneer and thought leader"
- Discomfort: "a perceived lack of control over technology and a feeling of being overwhelmed by it"
- Insecurity: "distrust of technology, stemming from scepticism about its ability to work properly and concerns about its potential harmful consequences"

Of these four dimensions, optimism and innovativeness are hypothesised to increase TR, whereas discomfort and insecurity are hypothesised to decrease it.

TAM and TRI have also been integrated together in several prior studies. For example, in their technology readiness and acceptance model (TRAM), Lin, Shih, and Sher (2007) examined the effects of the aggregate TRI construct on TAM constructs, whereas the studies by Walczuch, Lemmink, and Streukens (2007) as well as Godoe and Johansen (2012) concentrated on effects of the four composite TRI constructs, hypothesising optimism and innovativeness to have a positive effect on PU and PEOU and discomfort and insecurity to have a negative effect on them. In this study, we follow this latter approach by examining the individual effects of the four composite TRI constructs on not only PU and PEOU, but also use intention because in the study by Lin and Chang (2011), TR has been found to affect use intention not only indirectly through PU and PEOU, but also directly. This research model is illustrated in Figure 2.

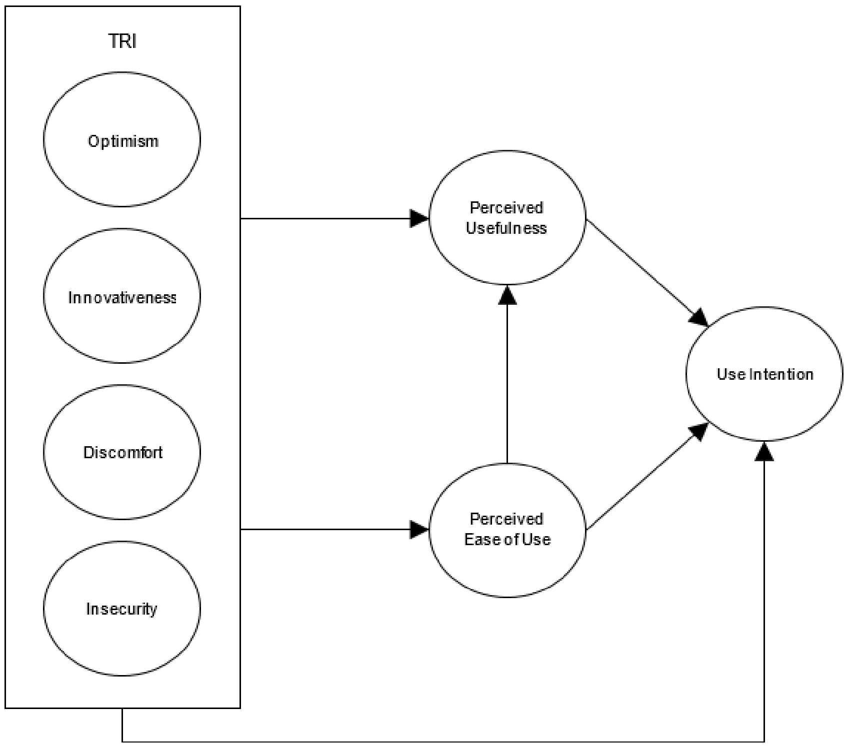

Figure 2: Research model of the study (TAM + TRI)

3 Methodology

To examine the potential age differences in TR and its effects on IS acceptance and use, we conducted a self-administered online survey targeted at Finnish consumers between December 2015 and January 2016. Due to the case context of the study, the survey was promoted via the online channels of two electric suppliers (e.g., websites, newsletters, and social media) as well as via the internal communication channels of our university and several discussion forums. To raise the response rate, also several gift cards with a total worth of 356 € were raffled among the respondents.

In the survey questionnaire, the 9 items measuring the three TAM constructs of perceived usefulness, perceived ease of use, and use intention were adapted from Davis (1989) as well as Davis, Bagozzi, and Warshaw (1989), whereas the 16 items measuring the four TRI constructs of optimism, innovativeness, discomfort, and insecurity were adapted from the TRI 2.0 scale by Parasuraman and Colby (2015). The exact wording of each item, translated from Finnish to English, is presented in Appendix A. All the items were measured on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The respondents were also able to skip individual items, which resulted in a missing value.

The collected data was analysed by using the IBM SPSS Statistics version 24 and the Mplus version 7.11 software. SPSS was mainly used for data preparation and preliminary analysis, whereas Mplus was used for the structural equation modelling (SEM). More information about Mplus can be found in its user's guide and technical appendices (Muthén & Muthén, 2017). As the model estimator, we used the MLR option of Mplus, which stands for maximum likelihood estimator robust to non-normal data. The missing values in the construct indicators were handled by using the FIML option of Mplus, which stands for full information maximum likelihood and uses all the available data in the model estimation. The potential age differences in the construct means and regression relationships were examined by dividing the sample into three age groups with an approximately equal age range and using multiple group analysis (MGA).

4 Results

The conducted online survey was completed by a total of 1,370 respondents. However, to promote the quality of data, 194 of them were excluded from the final sample in two phases. First, we excluded 124 respondents who had not reported being customers of any electric supplier and, thus, were not likely to be able to give reliable assessments on the online electricity services offered by the companies to their customers. Second, we also excluded an additional 70 respondents who had reported missing values in all the items measuring the three TAM constructs. This resulted in a final sample size of 1,176 respondents to be used in the model estimations. Descriptive statistics of this sample are reported in Table 1. All in all, the gender and age distributions of the sample corresponded quite well with those of the adult Finnish population at the end of 2015, which are reported in the final column of Table 1 (Statistics Finland, 2017). The main deviations were the underrepresentation of the age group of under 40 years and the overrepresentation of the age group of 40–59 years. The age of the respondents ranged from 18 to 83 years, with the mean age being 50.4 years (SD = 15.5 years).

Table 1: Sample statistics

	Sample (N = 1,176)		**Finland**
	N	**%**	**%**
Gender			
Male	631	53.7	49.2
Female	545	46.3	50.8
Age			
18–39 years	308	26.2	34.2
40–59 years	472	40.1	32.0
60– years	396	33.7	33.9
Monthly net income			
0–999 €	213	18.1	
1000–1999 €	351	29.8	
2000–2999 €	343	29.2	
3000– €	180	15.3	
No response	89	7.6	
Socioeconomic status			
Employed	532	45.2	
Unemployed	97	8.2	
Student	155	13.2	
Pensioner	332	28.2	
Other	60	5.1	

In the next four sub-sections, we first assess the reliability and validity of the 25 construct indicators and the seven constructs included in the research model: use intention (INT), perceived usefulness (PU), perceived ease of use (PEOU), optimism (OPT), innovativeness (INN), discomfort (DIS), and insecurity (INS). These assessments are based on a model that contains all the aforementioned constructs but does not yet contain any regression relationships between them. This is followed by the estimation of the actual research model and the examination of the potential age differences in the construct means and regression relationships.

4.1 Indicator Reliability and Validity

Indicator reliabilities and validities were evaluated by using the standardised loadings and residuals of the indicators, which are reported in Appendix B. In the 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 of each indicator is explained by the construct on which it loads. As can be seen, the two indicators that were furthest from meeting this criterion were DIS1 and INS4, which both had a standardised loading of less than 0.5. Thus, after assessing that there would be no adverse effects on the content validity of the two constructs that they were measuring, we decided to eliminate them and to re-estimate the model. In the re-estimated model, all the indicators now met the criterion or at least were very close to meeting it (DIS4 was furthest away with a standardised loading of 0.672), meaning that the re-estimated model could be considered to exhibit satisfactory indicator reliability and validity.

4.2 Construct Reliability and Validity

Construct reliabilities were evaluated by using the composite reliabilities (CR – Fornell & Larcker, 1981) of the constructs, with which it is commonly expected that each construct should have a CR greater than or equal to 0.7 in order for it to exhibit satisfactory reliability (Nunnally & Bernstein, 1994). The CR of each construct is reported in the first column of Table 2. As can be seen, all the constructs met this criterion. In turn, construct validities were evaluated by examining the convergent and discriminant validity of the constructs, which were evaluated by using the two criteria proposed by Fornell and Larcker (1981). They are both based on the average variance extracted (AVE) of the constructs, 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 reported in the second column of Table 2. As can be seen, all the constructs except for DIS and INS met this criterion. However, they

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

	CR	**AVE**	**INT**	**PU**	**PEOU**	**OPT**	**INN**	**DIS**	**INS**
INT	0.951	0.866	**0.931**						
PU	0.881	0.712	0.722	**0.844**					
PEOU	0.894	0.738	0.594	0.869	**0.859**				
OPT	0.835	0.558	0.384	0.532	0.471	**0.747**			
INN	0.828	0.546	0.328	0.309	0.375	0.588	**0.739**		
DIS	0.730	0.475	-0.126	-0.289	-0.399	-0.398	-0.415	**0.689**	
INS	0.739	0.486	-0.151	-0.182	-0.202	-0.459	-0.420	0.637	**0.697**

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. This means 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 reported in the remaining columns of Table 2. As can be seen, all the constructs met this criterion, with the exception of PU and PEOU, which correlated very strongly with each other. However, this correlation was expected due to the hypothesised effect of PEOU on PU in TAM and, thus, does not warrant the elimination of either of the constructs.

4.3 Estimation Results

Figure 3 presents the standardised estimation results of the research model, which was able to explain 56.4 % of the variance in INT, 79.3 % of the variance in PU, and 31.2 % of the variance in PEOU. The effects between the three TAM constructs followed the hypotheses of TAM, with the exception that PEOU was actually found to have a negative, although a very weak and statistically not significant, effect on INT. In contrast, the effect of PEOU on PU as well as the effect of PU on INT were both found as positive and statistically significant. This also caused the total effect of PEOU on INT, which takes into account both the direct and indirect effects (-0.139 + 0.838 x 0.870 = 0.590), to be positive and statistically significant.

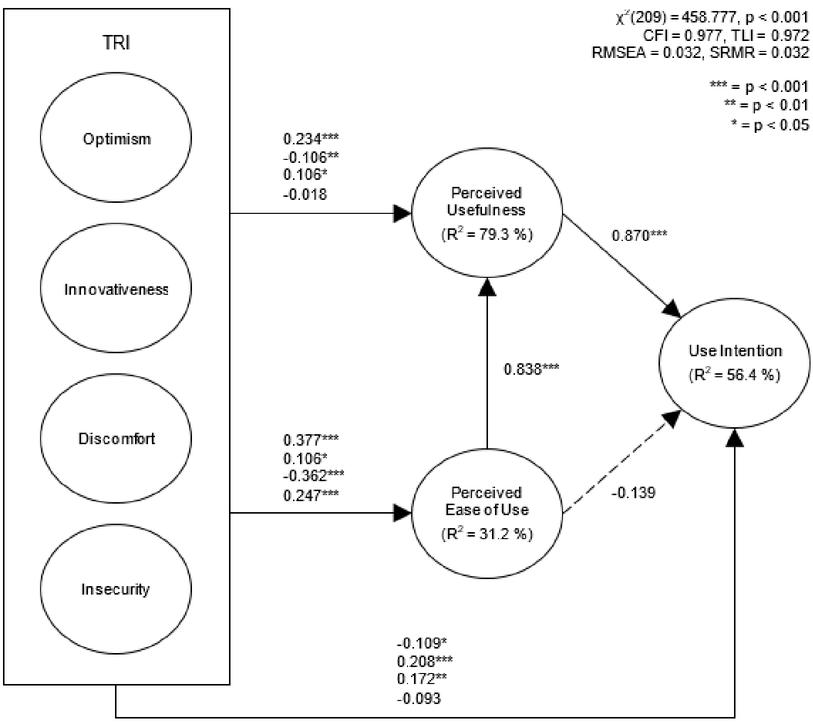

Figure 3: Estimation results of the research model (standardised)

Of the four TRI constructs, the first construct OPT was found to have positive effects on both PU and PEOU, but surprisingly a negative effect on INT, causing the total effect of

OPT on INT to be 0.316. All these effects were statistically significant. The second TRI construct INN was found to have positive effects on INT and PEOU, but surprisingly a negative effect on PU, causing the total effect of INN on INT to be 0.179. In this case as well, all these effects were statistically significant. The third TRI construct DIS was found to have a negative effect on PEOU, but surprisingly positive effects on both INT and PU. Although these two latter effects were weaker than the former one, they were all statistically significant. However, they caused the total effect of DIS on INT to be only 0.051, which was statistically not significant. Finally, the fourth TRI construct INS was found to have negative effects on both INT and PU, but surprisingly a positive effect on PEOU, which was the only one of these effects that was statistically significant. However, the total effect of INS on INT was only 0.036, which was statistically not significant.

The goodness-of-fit statistics of the model are reported in the top-right corner of Figure 3. As can be seen, the $\chi 2$ test of model fit rejected the null hypothesis of the model fitting the data. However, instead of actual misfit, this may have been caused by the tendency of the test to underestimate the fit especially in the case of large samples and more complex models (Bentler & Bonett, 1980). For this reason, also four alternative fit indices were used to evaluate the fit: 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 clearly fulfilled the commonly accepted cut-off criteria (CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08 – Hu & Bentler, 1999), meaning that the model could be considered to exhibit a good fit with the data.

4.4 Age Differences in Construct Means and Regression Relationships

In order to examine the potential age differences in the construct means and regression relationships, we first divided the sample into the age groups of under 40 years, 40–59 years, and 60 years or over and then tested whether a sufficient level of measurement invariance existed across the groups to allow meaningful comparisons between them. At the minimum, the comparison of the regression coefficients requires the existence of configural and metric invariance, whereas the comparison of the construct means requires the existence of configural, metric, and scalar invariance (Steenkamp & Baumgartner, 1998). The testing followed the method formalised by Steenkamp and Baumgartner (1998), in which increasingly strict constraints on parameter equality are added across the groups and the fit of the resulting constrained model is compared to the fit of the unconstrained model. As the main test criterion, we used the $\chi 2$ test of difference, corrected with the Satorra-Bentler (2001) scaling correction factor (SCF) due to the use of the MLR estimator. However, because the $\chi 2$ test of difference suffers from a similar sensitivity to sample size and model complexity as the $\chi 2$ test of model fit, also the changes in the four aforementioned fit indices were considered as suggested by Steenkamp and Baumgartner (1998). The results of the tests are reported in Table 3.

Table 3: Tests of measurement invariance and path invariance

Model	**CFI**	**TLI**	**RMSEA**	**SRMR**	**χ^2**	**df**	**SCF**	**$\Delta\chi^2$**	**Δdf**	**p**
Full configural invariance	0.979	0.975	0.032	0.040	871.605	627	1.1463	–	–	–
Full metric invariance	0.978	0.975	0.031	0.045	914.525	659	1.1444	42.862	32	0.095
Full scalar invariance	0.966	0.962	0.038	0.051	1089.681	691	1.1378	192.894	32	< 0.001
Partial scalar inv. (INN3 in –39 years)	0.970	0.967	0.036	0.048	1038.741	690	1.1379	135.439	31	< 0.001
Partial scalar inv. (INN1 in –39 years)	0.974	0.972	0.033	0.048	989.832	689	1.1383	79.800	30	< 0.001
Partial scalar inv. (INN4 in 40–59 years)	0.975	0.972	0.033	0.047	978.096	688	1.1384	66.745	29	< 0.001
Partial scalar inv. (INN2 in 40–59 years)	0.977	0.974	0.032	0.047	957.562	687	1.1388	43.584	28	0.031
Partial scalar inv. (DIS2 in –39 years)	0.978	0.975	0.031	0.046	947.172	686	1.1390	32.016	27	0.231
Full path invariance	0.977	0.975	0.031	0.056	985.110	716	1.1398	37.993	30	0.150

First, configural invariance was tested by estimating the model separately for each group while constraining only the simple structure of the model to be equal across the groups. As can be seen, the fit of this full configural invariance model remained approximately as good as the fit of the model without the group separation. Thus, the hypothesis on full configural invariance was accepted. Second, metric invariance was tested by constraining also the indicator loadings equal across the groups and comparing the fit of this full metric invariance model to the fit of the previous full configural invariance model. As can be seen, the $\chi 2$ test suggested no statistically significant deterioration in the model fit ($\Delta\chi 2(32) = 42.862$, $p = 0.095$), which was supported by the four fit indices as well (ΔCFI =-0.001, ΔTLI = 0.000, ΔRMSEA = -0.001, ΔSRMR = 0.005). Thus, also the hypothesis on full metric invariance was accepted.

Third, full scalar invariance was tested by constraining also the indicator intercepts equal across the groups and comparing the fit of this full scalar invariance model to the fit of the previous full metric invariance model. As can be seen, in this case, the $\chi 2$ test suggested a statistically significant deterioration in the model fit ($\Delta\chi 2(32) = 192.894$, $p < 0.001$), which was supported by the four fit indices as well (ΔCFI = -0.012, ΔTLI = -0.013, ΔRMSEA = 0.007, ΔSRMR = 0.006). Thus, the hypothesis on full scalar invariance was rejected. As a result of this, we tested for partial scalar invariance by relaxing the added constraints concerning the equality of indicator intercepts one by one based on the highest modification indices of the model and comparing the fit of these partial scalar invariance models to the fit of the full metric invariance model. After relaxing the constrains concerning the equality of the intercepts of INN1, INN3, and DIS2 in the age group of under 40 years as well as the intercepts of INN2 and INN4 in the age group of 40–59 years, the $\chi2$ test did not anymore suggest a statistically significant deterioration in the model fit ($\Delta\chi2(27) = 32.016$, $p = 0.231$), which was supported by the four fit indices as well (ΔCFI = 0.000, ΔTLI = 0.000, ΔRMSEA = 0.000, ΔSRMR = 0.001). Thus, the hypothesis on partial scalar invariance, with the indicator intercepts of INN1, INN3, and DIS2 in the age group of under 40 years as well as the indicator intercepts of INN2 and INN4 in the age group of 40–59 years varying across the groups, was accepted. Because the meaningful comparison of construct means requires at least one indicator besides the marker indicator of a construct (INN1 in the case of INN and DIS3 in the case of DIS) to have invariant indicator loadings and intercepts across the groups (Steenkamp & Baumgartner, 1998), this partial scalar invariance prevents the comparisons of the construct mean of INN between the age groups of under 40 years and 40–59 years as well as the age groups of under 40 years and 60 years or over, but still makes them possible between the age groups of 40–59 years and 60 years or over. Meaningful comparisons of the construct mean of DIS across all the age groups are also possible.

The results of the comparisons of the construct means are reported in Table 4. The first and the second columns list the differences in the construct means of the age groups of 40–59 years and 60 years or over in comparison to the age group of under 40 years as well as their statistical significance, whereas the third column lists the differences in the construct means of the age group of 60 years or over in comparison to the age group of 40–59 years as well as their statistical significance. All the reported differences are unstandardised in order to ease their interpretation. As can be seen, of the four TRI constructs, statistically significant differences were found in case of all the constructs except for INS. The age groups of 40–59 years and 60 years or over were found to score lower in terms of OPT in comparison to the age group of under 40 years, but having no statistically significant difference between each other. In contrast, the age group of 60 years or over was found to score lower in terms of INN in comparison to the age group of 40–59 years. Both of these age groups also seemed to have higher scores in comparison to the age group of under 40 years but, as mentioned above, these comparisons cannot be meaningfully conducted because of the lack of sufficient measurement invariance. Finally, the score of DIS seemed to rise with age both between the age groups of under 40 years and 40–59 years and the age groups of 40–59 years and 60 years or over. A similar difference was found also in the construct mean of INT, although the differences in the construct means of this construct as well as PU and PEOU were not the main interest of this study.

Table 4: Comparisons of construct means (unstandardised)

	40–59 years vs. –39 years	60– years vs. –39 years	60– years vs. 40–59 years
INT	0.239**	0.441***	0.202**
PU	-0.083	0.023	0.106
PEOU	-0.068	-0.058	0.010
OPT	-0.167**	-0.117*	0.049
INN	0.490***	0.278**	-0.212**
DIS	0.581***	0.807***	0.226***
INS	-0.050	-0.081	-0.030

Finally, we tested for the invariance of the regression relationships by constraining also the regression coefficients equal across the groups and comparing the fit of this full path invariance model to the fit of the previous partial scalar invariance model. As can be seen from Table 3, the $\chi 2$ test suggested no statistically significant deterioration in the model fit ($\Delta\chi 2(30) = 37.993$, $p = 0.150$), which was supported by the four fit indices as well (ΔCFI = -0.001, ΔTLI = 0.000, ΔRMSEA = 0.000, ΔSRMR = 0.010), although there was a significant increase in the value of SRMR. Thus, the hypothesis on full path invariance was accepted, meaning that there were no statistically significant differences in the effects of the TRI constructs on the TAM constructs or on the effects of PU and PEOU on INT as well as PEOU on PU across the groups.

5 Discussion and Conclusions

In summary, the findings of this study on the potential age differences in TR and its effects on IS acceptance and use suggest several differences in the TRI constructs of optimism, innovation, and discomfort, but no differences in the effects of any of the TRI constructs on the TAM constructs of PU, PEOU, and INT. All in all, the effects of the TRI constructs on the TAM constructs were found to be in line with those found in prior studies (e.g., Walczuch, Lemmink & Streukens, 2007; Godoe & Johansen, 2012), which have also suggested optimism and innovation having the strongest effects on PU and PEOU, whereas the effects of discomfort and insecurity have typically been weaker and often statistically not significant. From a theoretical perspective, the findings of the study promote the understanding on the effects of TR on IS acceptance and use by considering also the vital role of various demographic variables like age. This promoted understanding can be utilised, for example, to better explain and predict the potential differences in the antecedents of IS acceptance and use as well as in IS acceptance and use itself between various user segments. Respectively, from a practical perspective, the findings of the study can be utilised by IS developers and marketers to promote the acceptance and use of the newly introduced systems and services especially in user segments that have traditionally been found more challenging in terms of IS adoption.

One example of such a segment is the so-called "young elderly" segment, which consists of individuals aged 60–75 years and has often been overlooked, for example, in the development and marketing of digital services in spite of its vast market potential (Carlsson & Walden, 2015; Carlsson & Carlsson, 2016). This segment can be considered as practically equivalent to the age group of 60 years or over in this study because, although this age group contained also individuals that were older than 75 years, about 95 % of the individuals in it were aged 75 years or younger. Thus, if we use the age group of 60 years or over as its proxy, the findings of the study suggest that the young elderly segment is characterised by a slightly lower level of technology optimism in comparison to the individuals aged under 40 years and also a considerably higher level of technology discomfort, especially in comparison to the individuals aged under 40 years but also in comparison to individuals aged 40–59 years. In addition, the young elderly segment seems to be characterised by a lower level technology innovativeness in comparison to individuals aged 40–59 years. Thus, in spite of being on par with the younger individuals in terms of technology insecurity, this all suggests that individuals in the young elderly segment have a somewhat lower level of TR in comparison to younger individuals, which should be taken into account if one wants to maximise the acceptance and use of the newly introduced systems and services in this user segment. Of the aforementioned differences, the most important ones are obviously the differences concerning technology optimism and innovation because these two TRI constructs were the ones that were found having a statistically significant total effect on the intention to use IS when considering both the direct and indirect effects on it.

Consequently, when developing and marketing new systems and services to the young elderly segment, special attention should be paid to making them as easily approachable as possible for also people who are typically not at the forefront of adopting new technological innovations as well as to highlighting the benefits that the usage of these new systems and services can bring to their everyday lives. The strategies that aim at doing this may include, for example, marketing and advertising campaigns as well as various technological solutions, such as the usage of tutorials, which lower the threshold to trial the systems and services and make their overall learning curve less steep. The implementation of such strategies is likely to result in two synergetic advantages. First, in the short term, they are likely advance the adoption of the systems and services amongst the users in the young elderly segment with a lower level of TR. Second, in the long term, through this adoption, they are also likely to advance the level of TR in the whole young elderly segment, especially if the use experiences of the adopted systems and services are positive and they are able to fulfil the user expectations towards them.

6 Limitations and Future Research

This study can be seen to have three main limitations. First, the study was conducted by analysing the survey data collected from only Finnish consumers, which obviously limits the generalisability of its findings to other countries and cultures. Second, the study was conducted in the case context of online electricity services, which poses limitations on the generalisability of its findings concerning the effects of the TRI constructs on the TAM constructs, but not on the generalisability of its findings concerning the mean differences in the TRI constructs themselves, since their measurement was conducted independently of the case context in question. Finally, the third main limitation of the study stems from the selection of TAM as the theoretical framework for conceptualising and operationalising IS acceptance and use as well as its main antecedents, which obviously omits the antecedents that have been added to the original TAM in its subsequent extensions, such as UTAUT (Venkatesh et al., 2003) and UTAUT2 (Venkatesh, Thong & Xu, 2012). However, as already stated in Section 2, we consider this selection well-justified because of the utilitarian case context of the current study.

Future studies should aim to address the aforementioned limitations by replicating the study also in other countries and cultures as well as in the case context of other types of IS. The selection of the case context should also be reflected in the selection of the theoretical framework for conceptualising and operationalising IS acceptance and use as well as its main antecedents. In addition to age, we also encourage future studies to concentrate on examining the potential differences in terms of other interesting and important demographic variables, such as gender and income.

Appendix A: Indicator Wordings

INT1	I intend to use the e-services in the following year.
INT2	I plan to use the e-services in the following year.
INT3	It is likely that I will use the e-services in the following year.
PU1	Using the e-services to manage my electricity affairs would be convenient.
PU2	Using the e-services would make it easier for me to manage my electricity affairs.
PU3	I would find the e-services useful in managing my electricity affairs.
PEOU1	I would find the e-services easy to use.
PEOU2	My interaction with the e-services would be clear and understandable.
PEOU3	Learning to use the e-services would be easy for me.
OPT1	New technologies contribute to a better quality of life.
OPT2	Technology gives me more freedom of mobility.
OPT3	Technology gives people more control over their daily lives.
OPT4	Technology makes me more productive in my personal life.
INN1	Other people come to me for advice on new technologies.
INN2	In general, I am among the first in my circle of friends to acquire new technology when it appears.
INN3	I can usually figure out new high-tech products and services without help from others.
INN4	I keep up with the latest technological developments in my areas of interest.
DIS1	When I get technical support from a provider of a high-tech product or service, I sometimes feel as if I am being taken advantage of by someone who knows more than I do.
DIS2	Technical support lines are not helpful because they do not explain things in terms I understand.
DIS3	Sometimes, I think that technology systems are not designed for use by ordinary people.

DIS4 There is no such thing as a manual for a high-tech product or service that is written in plain language.
INS1 People are too dependent on technology to do things for them.
INS2 Too much technology distracts people to a point that is harmful.
INS3 Technology lowers the quality of relationships by reducing personal interaction.
INS4 I do not feel confident doing business with a place that can only be reached online.

Note: The indicators of OPT, INN, DIS, and INS comprise the TRI 2.0 scale, which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 2014. It may be duplicated only with a written permission from the authors.

Appendix B: Indicator Loadings and Residuals

	Loading	Residual
INT1	0.952***	0.093***
INT2	0.903***	0.184***
INT3	0.935***	0.125***
PU1	0.868***	0.247***
PU2	0.838***	0.299***
PU3	0.825***	0.319***
PEOU1	0.887***	0.213***
PEOU2	0.871***	0.242***
PEOU3	0.818***	0.332***

	Loading	Residual
OPT1	0.749***	0.439***
OPT2	0.735***	0.459***
OPT3	0.759***	0.424***
OPT4	0.745***	0.445***
INN1	0.771***	0.406***
INN2	0.762***	0.420***
INN3	0.726***	0.473***
INN4	0.696***	0.516***

	Loading	Residual
DIS1	0.585***	0.658***
DIS2	0.692***	0.521***
DIS3	0.691***	0.523***
DIS4	0.648***	0.581***
INS1	0.690***	0.523***
INS2	0.689***	0.526***
INS3	0.672***	0.548***
INS4	0.514***	0.736***

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

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