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DE-RISK Project

D2.3: Strategies and recommendation plan for consumer engagement

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Abbreviations and Acronyms	
AVE	Average variance extracted
CCm	Community commitment
CId	Community identification
CN	Costs of non-protective behaviour
CP	Competence
CR	Composite reliability
cSV	Community shared vision
D	Deliverable
DP	Discount program
DSO	Distribution system operator
EC	European Commission
EU	European Union
GA	Grant Agreement
HM	Hedonic motivations
IoT	Internet of things
IP	Impact
LFM	Local Flexibility Market
M	Month
MGA	Multigroup analysis
MN	Meaning
p	P-value
PLS	Partial least squares
PW	Perceived well-being
PU	Perceived usefulness
RE	Response efficacy
RES	Renewable energy systems
RN	Rewards of non-protective behaviour
R2	R-squared
UNL	Universidade Nova de Lisboa
SC	Spending control
SD	Self-determination
SEF	Self-efficacy
SEM	Structural equation modeling
SV	Severity
ST	Sustainable technologies
T	Task
TR	Community trust
V	Vulnerability
WP	Work Package

EXECUTIVE SUMMARY

The present work was developed by the Universidade Nova de Lisboa (UNL) – Nova Information Management School team, within the scope of WP2. This report summarises all tasks and results of Task 2.3 – Define a Strategy and Recommendations Plan for Consumer Engagement. This deliverable builds upon the work developed under Task 2.1 (Consumer behaviour Analysis in relation to LFMs) and Task 2.2 (Data Collection and behaviour Analysis).

The deliverable has two main goals:

(1) Define engagement recommendations that integrate the drivers and barriers of consumer engagement in LFM type of initiatives, making use of the results of D2.2 and advancing them by performing a cluster and multigroup analysis based on the 4Es model of behaviour change;

(2) Help in the development of dashboards to improve the user experience and acceptability of a set of devices, like IoT smart home devices (such as smart meters, smart thermostats, and smart plugs), electric vehicles, and renewable energy systems (RES), relevant for the implementation of LFMs.

To achieve the proposed objectives, the team performed a cluster analysis and a multigroup analysis (for objective 1) and developed and analysed a research model using structural equation modelling techniques (for objective 2). The data used for both analyses is the one collected under Task 2.2 for all countries' pilots and Portugal, the country of the task's main researchers.

Regarding the first objective, results suggest that citizens can be segmented not only based on the country they live in but also based on the different behaviour change measures. The 4Es model of behaviour change states that citizens can be motivated by both soft (exemplify and engage) and active methods (enable and encourage). However, results revealed that active methods are more effective/relevant for citizens to participate in LFMs than soft ones. We also verified that, besides country differences, segments of people more motivated by behaviour change measures are mainly young, whereas segments of less motivated citizens are older. Less motivated groups exhibit lower intention to participate in LFMs, as well as a lower usage level of technologies like IoT home devices, RES, or electrical vehicles, which are relevant for the implementation of an LFM initiative. According to these characteristics, several engagement recommendations were developed.

Regarding the main objective 2, results show a set of motivators that impact users' acceptability/use behaviour of the three main analysed technologies (i.e. IoT smart home devices, renewable energy systems, and electrical cars) – in this deliverable, we will refer to them as sustainable technologies. Results suggest that factors like gamification, empowerment, effort expectancy, and social influence present a strong impact on citizens' use of these technologies. By identifying these factors, it will be possible to develop dashboards that can better meet citizens' needs and expectations.

Finally, the results of this task will be used for other tasks under Work Package 2, namely Task 2.4 (Lessons Learned and Best Practices based on the Customer behaviour Change Journey), and Work Package 4 (Case Study Preparation, Implementation and Validation), by helping with the development of dashboards in the countries' pilots, and overall increasing social acceptability/engagement.

A. INTRODUCTION

Scope of the deliverable

Local flexibility markets (LFMs) refer to platforms for electricity trading aimed at managing flexibility at the distribution system operator (DSO) level, typically within confined geographical areas like neighbourhoods, communities, towns, and small cities (Jin et al., 2020). Energy communities play a pivotal role within LFMs as suppliers of flexibility. This involvement often entails citizens adopting a suite of sustainable technologies, including renewable energy sources, smart meters, electric vehicles, and smart thermostats, among others. Within these communities, consumers assume a significant role in grid operations by adjusting their electricity usage in response to dynamic pricing or other financial incentives. Consequently, the success of LFMs hinges largely on citizens' willingness to participate in such initiatives. Thus, it is imperative to identify and assess citizens' primary needs, concerns, and motivations to involve them in these solutions and ensure their satisfaction effectively. D2.1[1] provided a holistic research model with the identification of all possible factors influencing citizens' decisions based on both a literature review and a qualitative study. D2.2[2] tested the research model, quantifying the main drivers and barriers for citizens to participate in LFMs. Therefore, building upon the prior work of D2.1 and D2.2, the specific objectives of the current task are the following:

Objective 1: Segment citizens according to the different types of motivators (making use of the 4Es behaviour change model measures);

Objective 2: Test the research model and compare the results between different segments of citizens, allowing to conclude engagement recommendations that go beyond geographical factors;

Objective 3: Develop and test a research model to identify and quantify the main drivers and barriers to citizens' use of sustainable technologies (enabling of LFMs), namely IoT smart home devices, renewable energy systems, and electric cars;

Objective 4: Develop recommendations for developing the dashboards and increasing user acceptability of the proposed technologies.

[1] D2.1. Research model and survey instrument
[2] D2.2. Data collection and analysis

Methodology

The following methods were applied to meet the objectives defined:

Methodology for achieving objective 1: Cluster analysis (making use of hierarchical and non-hierarchical clustering methods) – this will allow the creation of homogeneous segments regarding a set of characteristics;

Methodology for achieving objective 2: Multigroup analysis, making use of structural equation modeling technique – Estimation of the research model resorting to partial least squares method of structural equation modeling (evaluation of measurement and structural model);

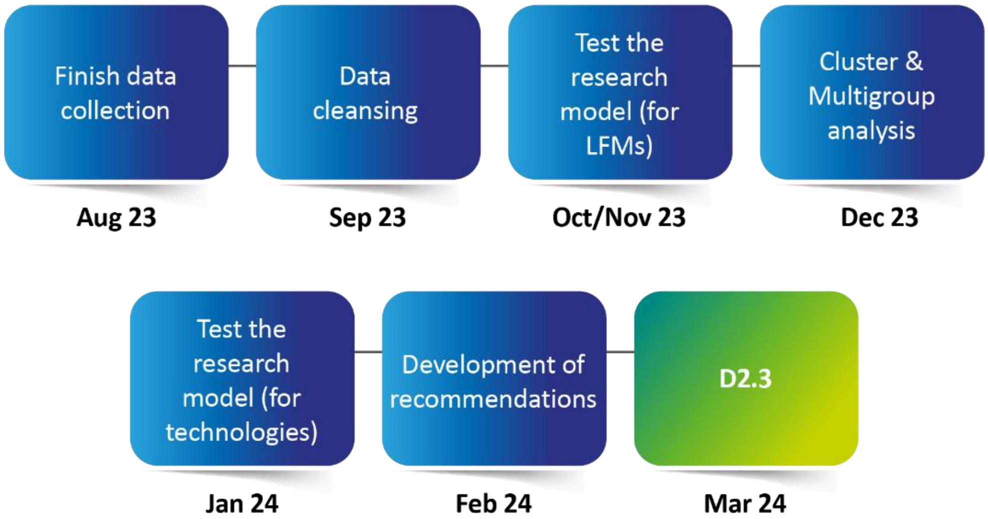
Methodology for achieving objective 3: Test the research model for technologies' use resorting to the partial least squares method of structural equation modeling (evaluation of measurement and structural model);

Methodology for achieving objective 4: Presentation of results.

Structure

Several steps were conducted to achieve the proposed objectives. First, data was collected through a subcontracted research market company. After data collection, data was cleaned and analysed using descriptive statistics and tested for any bias. Later, the research model was tested using the partial least squares technique of structural equation modelling (please refer to D2.2. for details). After that, a cluster analysis was performed, creating groups of citizens with similar motivations (for objective 1), followed by a multigroup analysis (for objective 2). Additionally, a research model was developed and tested to identify and quantify the main motivators for citizens' use of sustainable technologies (for objective 3). Finally, results were presented, and a set of recommendations was developed (for objective 4). Figure 1 summarises the timeline of the mentioned steps. Each step is described explicitly in later sections.

Figure 1. Steps of data collection and analysis



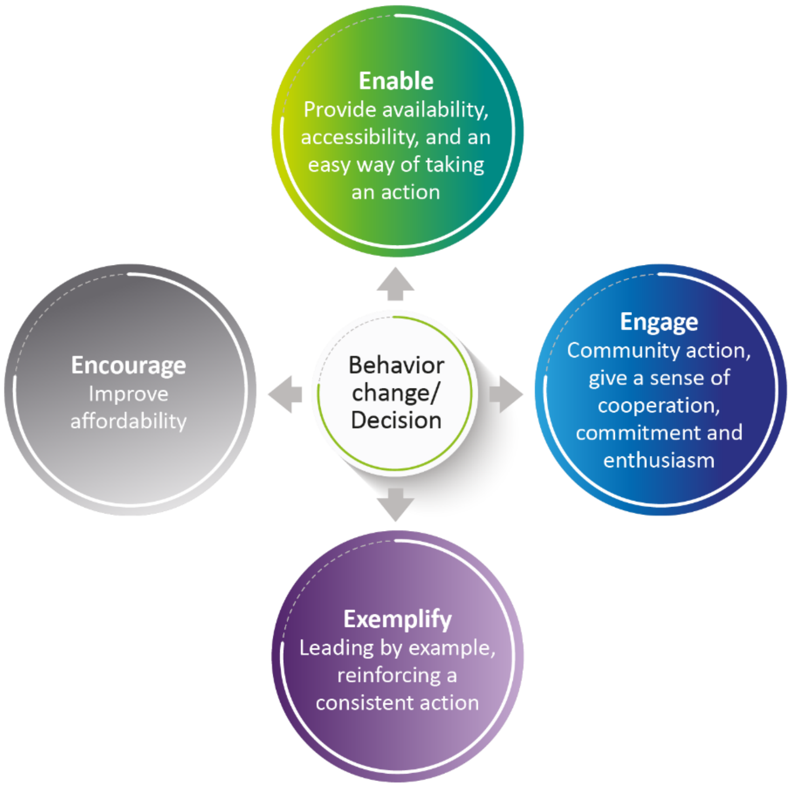
The document is structured as follows. Section B presents cluster and multigroup analysis. Section C describes the engagement recommendations defined for each target group defined in Section B. Section D presents the research model for sustainable technologies acceptance, and Section E presents the main recommendations to improve user acceptability and experience of these technologies, with a focus on the development of dashboards. Finally, the main conclusions are described in Section F.

B. CLUSTER & MULTIGROUP ANALYSIS

As stated above, one of the main goals of this task is to define an engagement strategy based not only on the results of D2.2., segmented by country but also based on a cluster and multigroup analysis using the mix of measures drawn from across the 4Es model. Given this, it will be possible to develop customized recommendations.

Following the above rationale and to provide effective engagement strategies, we decided to segment the individuals reached (2,000 citizens) and understand how different engagement dimensions can contribute to enhancing citizens' willingness to participate in community energy initiatives (such as LFMs). For that, we have resorted to the 4Es model measures. The 4Es model recognizes that different segments of the population have different attitudes regarding sustainability issues and respond differently to behaviour change methods (Cotton et al., 2015). These methods (the *E* measures) can be divided into active (Enable and Encourage) and soft methods (Exemplify and Engage) methods. Figure 2 presents the 4Es model.

Figure 2. 4Es model of behaviour change



Each ***E*** measure represents the following:

- **Enable** – it represents the importance of providing availability, accessibility, and a somewhat effortless way of participating in LFMs. In the context of the project, it can also be represented as the expected effort required to participate.
- **Engage** – it represents the importance of giving a sense of commitment, cooperation, and enthusiasm while participating in LFMs. It is related to empowerment feelings, in having a meaning, impact, and self-determination.
- **Exemplify** – it represents the encouragement of others (usually high-level entities) for individuals to take sustainable behaviours. In the context of the project, this can also be measured by the influence/encouragement of the social circle in which the individual is inserted.
- **Encourage** – it represents the importance of improving the affordability of the solutions. In the context of LFMs can be measured as the availability of discount programs that can alleviate some sort of financial burden on the individuals.

Given this, citizens may be encouraged to act by all, some, or none of these dimensions. Therefore, the purpose of the following analysis is to segment the citizens according to their level of response to the 4Es model. For this, a cluster analysis will be performed.

Cluster analysis

Cluster analysis is a statistical technique used to classify data points into groups, or clusters, based on similarities between them. It aims to ensure group homogeneity among individuals while maintaining heterogeneity between groups. There are various methods for cluster analysis, including hierarchical clustering and non-hierarchical (k-means) clustering. The two techniques will be used sequentially to get the most optimal clustering solution.

The first step of cluster analysis is to define the variables/dimensions for which we want to segment individuals. As stated above, the cluster base will be the 4Es measures. Then, hierarchical methods were developed to determine the optimal number of clusters, offering the advantage of not requiring a predefined cluster count. The cluster solution with this method varies depending on the chosen algorithm. Therefore, five algorithms were tested: single, complete, centroid, average, and Ward's method. To assess the best method, a comparison of the R-squared measure was made. The R-squared compares between cluster variation to the total variation in data, varying between 0 and 1. A larger value of R-squared will indicate a better fit of the clusters to the data, since it means that most of the variation in data comes from between-cluster instead of within-cluster variability. In Figure 3, the R-squared is plotted for each method according to the number of clusters computed. Based on R-squared analysis, Ward's method emerged as the most effective since it provided higher R-squared measures for all numbers of clusters and was thus selected. Subsequently, the dendrogram generated by Ward's method was examined to choose the optimal number of segments to be created.

Figure 3. Comparison between hierarchical methods

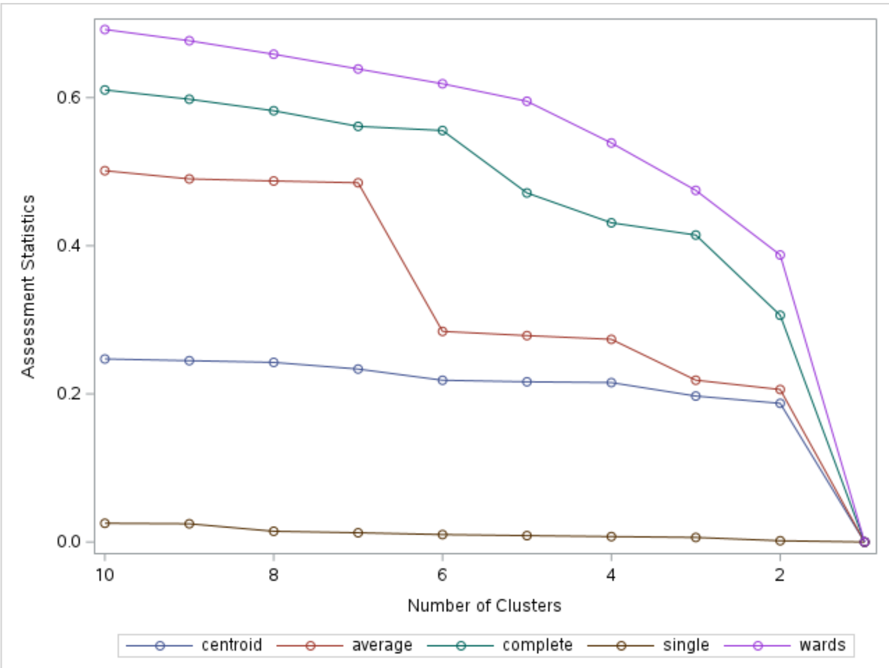
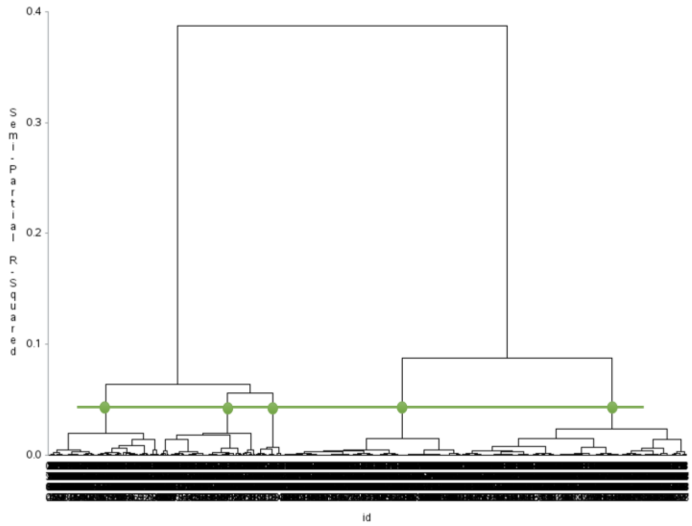


Figure 4 presents the dendrogram. The horizontal axis represents the individuals, and the vertical axis represents the Semi-partial R-squared. This measures the loss of homogeneity when joining two clusters. Therefore, one should stop joining clusters when that distance starts to become very significant. Based on those measures, the five-clusters' solution seemed appropriate. Some neighbour solutions were tested, but five clusters were chosen as the best solution, presenting a good performance and suitable interpretation of the segments.

Figure 4. Dendrogram of Ward's method



Having chosen the number of clusters, one can now perform the non-hierarchical method, using the centroids of the clusters created by Ward's method as initial seeds for the non-hierarchical method. This will optimize the method. The non-hierarchical method, namely K-means, is a well-known technique that usually presents a better performance for clustering. K-means solution with five clusters presents an R-squared of 64%, and all variables seemed to perform well in segmenting the citizens. The profiling and results are presented in the next section.

Profiling citizens

The final step of cluster analysis is to characterise the clusters. Table 1 presents the clusters' means according to each measure. Since data is standardized, values below 0 mean "below the average", and above 0 means "above the average". The clusters were labeled based on the clusters' means. Cluster 1 presents all values above the average in all behavioural change measures. Therefore, this segment contains all individuals that are driven by all 4Es measures of the behaviour change model. Cluster 2 is composed of individuals who are mainly motivated by the active measures of the behaviour change model (Encourage and Enable). Cluster 3 is characterized by citizens that only present values above the average on the Enable dimension (being the only dimension with values above the average), whereas Cluster 4 includes all citizens who are more driven by the Encourage dimension (being the only dimension with values above the average, although still very close to the average). Finally, cluster 5 includes all citizens with the lowest levels in all four behaviour change measures.

Table 1. Cluster labels and means

Cluster	Active measures		Soft measures	
	Encourage	Enable	Engage	Exemplify
1. Driven by all 4Es	0.69	0.84	0.97	0.96
2. Driven by active methods	0.31	0.10	0.04	-0.02
3. Driven by Enable	-1.38	0.07	-0.32	-0.09
4. Driven by Encourage	0,05	-1.19	-0.86	-0.99
5. Not driven by 4Es	-2.13	-1.56	-1.99	-1.73

Additionally, clusters should be characterised according to key variables, such as the level of intention to participate in LFMs, the use of sustainable technologies (e.g., IoT smart home devices, RES, electrical cars), and other socio-demographic variables (see Table 2).

Table 2. Clusters' characterisation

Cluster	Nº of individuals	Average of age	% of Female	Home owner	Urban area	Intention to participate in LFMs	Use of sustainable technologies
1. Driven by all 4Es	601	39.6	51%	23%	83%	6.1	6.0
2. Driven by active methods	672	39.2	51%	40%	78%	4.7	4.9
3. Driven by Enable	264	36.7	42%	46%	72%	4.1	4.5
4. Driven by Encourage	349	44.8	56%	42%	67%	3.4	3.7
5. Not driven by 4Es	114	49.2	61%	49%	61%	2.0	2.5
Total	2,000	40.6	51%	37%	76%	4.7	4.8

Note: Intention to participate in LFMs and Use of sustainable technologies are measured on a scale from 1 to 7

Based on the tables above, we can conclude the following:

- **Cluster 1 (Individuals driven by all 4Es)** has the highest intention to participate in LFMs and the highest usage levels of sustainable technologies. Most of them are not homeowners and live in urban areas. This is the second cluster with the highest frequency.
- **Cluster 2 (Individuals driven by active methods)** is the cluster that includes citizens with the highest intention to participate in LFMs and with the highest use of

sustainable technologies, following Cluster 1. This is the group with the highest frequency.

- **Cluster 3 (Individuals driven by Enable)** is the third one with the highest intention to participate in LFMs and the high use of sustainable technologies. This is the segment with the youngest citizens.
- **Cluster 4 (Individuals driven by Encourage)** consists of citizens who are somewhat less willing to participate in LFMs and use sustainable technologies. This segment is composed of individuals older than the average. This suggests that strategies solely based on encouraging measures, like discount programs or financial incentives, are not enough to increase citizens' willingness to participate in this type of initiative.
- Finally, **Cluster 5 (Individuals not driven by any of the 4Es)** is the one with the lowest intention to participate in LFMs and the lowest use of sustainable technologies. This segment is composed of the oldest citizens and the lowest number of individuals.

Additionally, one can conclude that the population has an overall positive tendency towards LFMs and sustainable technologies since the less motivated groups have the lowest frequency, while the highly motivated groups have the highest number of individuals. Moreover, one can comprehend that soft methods (engage and exemplify) are the ones with less discriminant, showing a somewhat low relevance for all segments except for Cluster 1. This suggests that efforts should be put especially into more active measures (enable and encourage).

Furthermore, Table 3 presents the countries' distribution in each cluster, showing that most of the citizens in all countries belong to clusters 1 and 2, indicating that is important to develop the 4Es methods, especially active ones. One can also conclude that Turkiye is the country with the most citizens in the first cluster, whereas France and Ireland are the ones that show the greatest frequency in the last clusters (4 and 5), suggesting that these engagement strategies are slightly more difficult to have an impact on citizens behaviour. Nevertheless, we reinforce that most citizens in all countries belong to the first clusters, proving a good tendency of citizens towards participation in LFMs where active methods of engagement are the most relevant.

Table 3. Countries' profile

Country	1. Driven by all 4Es	2. Driven by active methods	3. Driven by Enable	4. Driven by Encourage	5. Not driven by 4Es	Total
Spain	31%	36%	13%	15%	6%	**400**
France	25%	29%	13%	25%	10%	**400**
Portugal	28%	39%	11%	19%	3%	**400**
Ireland	16%	36%	16%	24%	9%	**400**
Turkiye	51%	29%	14%	5%	1%	**400**
Total	**601**	**672**	**264**	**349**	**114**	**2,000**

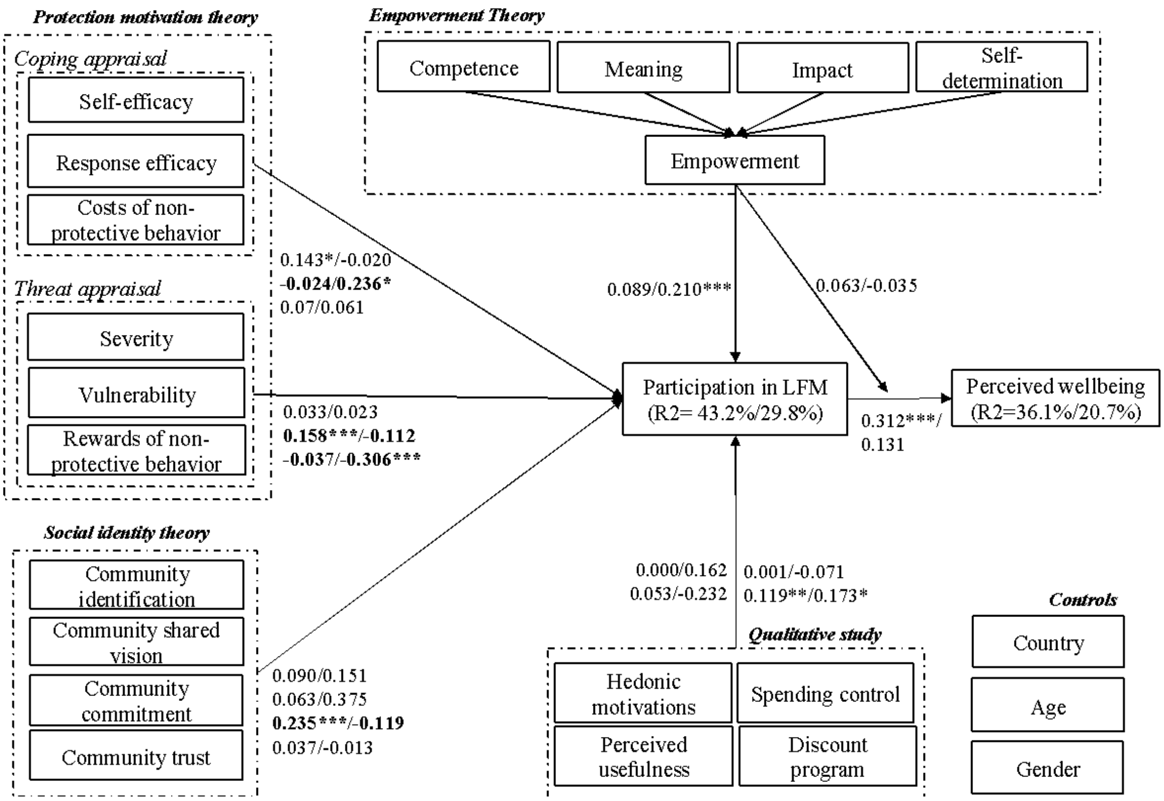
Multigroup analysis

To confirm whether any difference exists between clusters regarding the consumer behaviour model developed in Deliverable 2.1, a multigroup analysis (MGA) was performed, comparing the two most opposite clusters (Cluster 1 and Cluster 5).

A multigroup analysis is a statistical technique used to compare the structural relationships between variables across different groups. In this analysis, the main objective is to assess whether the relationships among variables are invariant across different groups of interest. These subgroups could be based on demographic characteristics (e.g., gender, age, ethnicity), experimental conditions (e.g., control group vs. treatment group), or any other grouping variable of interest. In this case, it was based on the cluster/segment each individual belongs to. By comparing the same model between the two groups, it is possible to understand whether the underlying theoretical model holds true across various groups or if relationships (in this case, motivators of LFMs participation) can change through different groups.

Figure 5 presents the results of the MGA between Cluster 1 and Cluster 5. The first value corresponds to the path coefficient of Cluster 1, whereas the second corresponds to Cluster 5. Bold coefficients show statistically significant differences between the two groups.

Figure 5. MGA results (bold coefficients show statistically significant differences between the two groups)



Analysing the above research model, more than identifying what is statistically significant or not, is relevant to understand the main differences between the two groups. The results are summarized as follows:

- Analyzing the R-squared (the proportion of the variability of the target variable explained by the independent variables), one can conclude that citizens driven by all 4Es (Cluster 1) present a much greater value than those in Cluster 5.
- Regarding the statistically significant differences, results suggest that Cluster 1 citizens are motivated by exposure to vulnerability and community commitment, while Cluster 5 are motivated by rewards of non-protective behaviour. Therefore, results confirm that Cluster 1 citizens, driven by all 4Es measures, show a high level of awareness of the vulnerability situation regarding climate change (significant impact of vulnerability), as well as high importance of community commitment for them to participate in LFMs, suggesting a sense of responsibility towards the local community and a willingness to participate for the greater good. On the other side, individuals

from Cluster 5, not driven by any 4Es measure, by presenting a strong impact of rewards of non-protective behaviour, prove to be individuals that have established routines, have a preference for maintaining the status quo, and an overall desire for comfort or familiarity, potentially leading to resistance towards adopting new, potentially disruptive practices (strong negative impact of rewards of non-protecting behaviour).

C. ENGAGEMENT STRATEGIES BASED ON 4Es MODEL

Based on the cluster and multigroup analysis, it was possible to comprehend 4 main groups of citizens based on the most effective ways of engagement (4Es model of behaviour change). Results showed that active methods should mainly be the ones developed and reinforced by the citizens. Therefore, a set of engagement recommendations is presented for each active method. The following figure summarises the main engagement strategies of each active method of the 4Es model (Enable and Engage).

Figure 6. Active strategies for behaviour change

As presented in the previous section, active methods of engagement are much more relevant for citizens. Therefore, a set of strategies and recommendations were developed for each type of method.

Enable strategies - engagement strategies aimed at providing availability, accessibility, and ease of participation while considering the expected effort required:

- User-Friendly Platforms: Develop or utilise platforms that are intuitive and easy to use for participants. One place where the citizens can straightforwardly access LFM information, minimizing technical barriers. For example, the creation of mobile applications delivers convenience and flexibility and enables participation on the go. This can also have real-time notifications to alert participants about relevant opportunities, updates, or changes, ensuring that users stay informed.
- Automated Participation Options: The implementation of automated participation options that simplify the process for users, as well as different options for citizens to be involved in the community, according to their desired level of involvement.
- Educational Resources: Offer educational resources, tutorials, and guides to help participants understand the concept of local flexibility markets and how they can participate effectively. This reduces the perceived complexity. This can also be

included in a mobile application, as referred to above, providing clear and transparent information about how the local flexibility market operates, including participation requirements, rules, and potential benefits.

- Feedback Mechanisms: Establish feedback mechanisms to gather input from participants about their experiences and suggestions for improvement. Actively listen to their feedback and make adjustments to enhance the user experience.

Encourage strategies - engagement strategies aimed at providing affordability of the solutions:

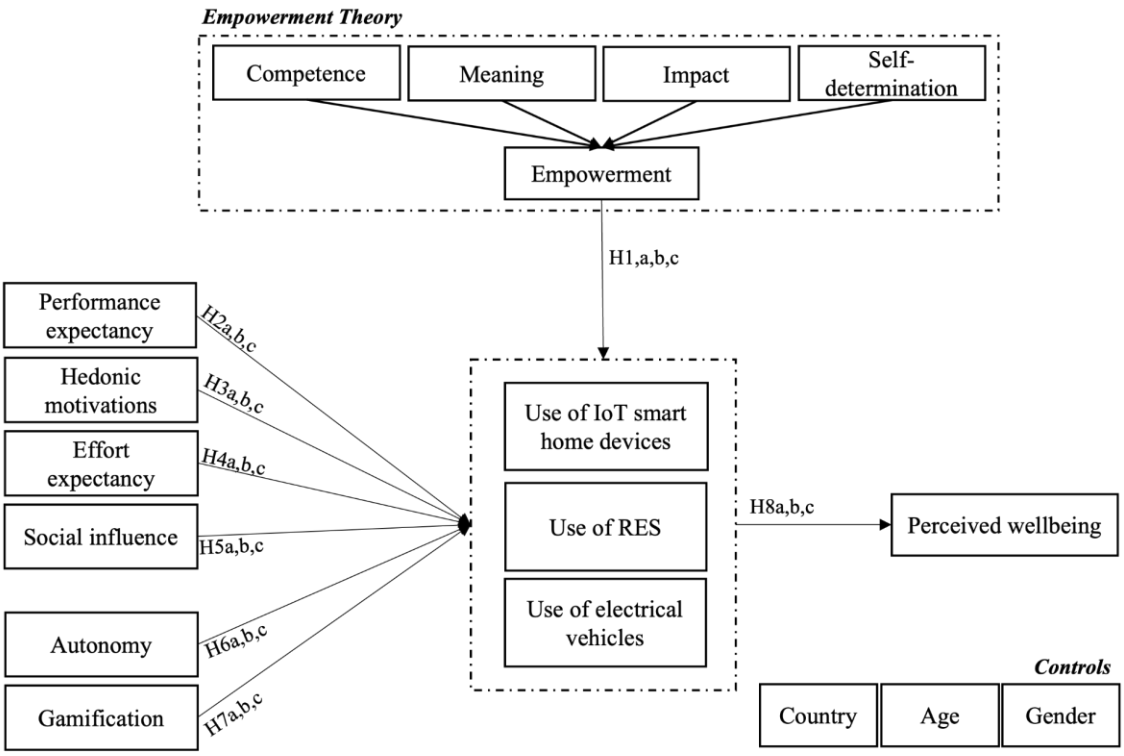
- Partnerships: Partner with local organizations and businesses, collaborate with local governments, utility companies, non-profit organizations, and other stakeholders to develop and implement discount programs.
- Incentives and Rewards: Offer incentives or rewards to encourage participation in the local flexibility market. This could include financial incentives, discounts, or recognition for contributions made. Several channels such as social media, newsletters, community events, and local media outlets can be used to disseminate information about these programs. Additionally, offering flexible payment options for participation, such as deferred payment arrangements can help alleviate financial constraints and make participation more accessible.
- Community Training: Organize workshops or training sessions to educate individuals about the availability and benefits of discount programs within the local flexibility market.
- Community Advocacy: Empower community leaders to advocate the importance of affordability and discount programs within the local flexibility market. This can also make citizens feel their rights are being represented and defended, especially regarding financial issues.
- Evaluation and Reporting: Regularly evaluate the impact and effectiveness of discount programs within the local flexibility market.

It is important to notice that, with the exception of the last cluster, all others were strongly influenced by these types of engagement measures. Although we recognize that some groups are more influenced by Enable measures and others by Encourage ones, in an initial phase, the deployment of both is relevant. In a later phase, possibly only Enable methods should be continuous, as results showed that they result in higher levels of participation in comparison to the Encourage methods.

D. RESEARCH MODEL FOR SUSTAINABLE TECHNOLOGIES

To help in the development of dashboards to improve the user experience and acceptability of a set of devices, such as IoT smart home devices, electric cars, and renewable energy sources, a research model was developed to evaluate the main motivators for the citizens' use of these technologies. For the deliverable, we refer to these as sustainable technologies, as mentioned in past literature (Neves et al., 2022; Wunderlich et al., 2019). The model's variables were identified in the literature and included a set of social and technical factors to be tested as motivators or barriers to user acceptability. Figure 7 presents the research model. This model will not only allow better comprehension of relevant factors to increase user acceptability and experience but will also reveal if these motivators can change according to the type of technology.

Figure 7. Research model for sustainable technologies use



Hypothesis development

Empowerment – This is described *as "the connection between a sense of personal competence, a desire for, and a willingness to take action in the public domain"* (Zimmerman & Rappaport, 1988, p. 746). Empowerment is conceptualised into four dimensions: competence, meaning, impact, and self-determination. Competence represents the degree to which an individual has adequate skills to perform a task. Meaning is defined as the individual judgment of the value of a certain task. Impact refers to the degree to which a certain task is perceived as having an envisioned effect. Finally, self-determination is defined as the perception of having responsibility for a particular outcome of a performed activity (Ryan & Deci, 1985). Prior research has suggested empowerment as a relevant motivator not only for the acceptance of technologies but also for the adoption of sustainable related behaviours (Hartmann et al., 2018; Shaukat et al., 2018). Therefore, we hypothesize:

H1a: Empowerment positively influences the use of IoT smart devices.
H1b: Empowerment positively influences the use of RES.
H1c: Empowerment positively influences the use of electrical vehicles.

Perceived usefulness – This factor measures the degree to which a technology is perceived as useful, helping to improve the performance and/or productivity of the user tasks (Venkatesh et al., 2012). Past research on technology adoption, including sustainable technologies, has suggested that when individuals perceive the utilitarian benefits of the technology, they tend to use it more (Neves et al., 2023). Hence, we hypothesize:

H2a: Perceived usefulness positively influences the use of IoT smart devices.
H2b: Perceived usefulness positively influences the use of RES.
H2c: Perceived usefulness positively influences the use of electrical vehicles.

Hedonic motivations – This variable refers to the level of enjoyment or fun provided by the technology perceived by its user. It measures an enjoyable user experience (Venkatesh et al., 2012). Past research has shown that when individuals perceive their use of technology as something enjoyable, they tend to use them more (Neves et al., 2023). Therefore, we hypothesize the following:

H3a: Hedonic motivations positively influence the use of IoT smart devices.
H3b: Hedonic motivations positively influence the use of RES.
H3c: Hedonic motivations positively influence the use of electrical vehicles.

Effort expectancy – This factor refers to the user's perception of how easy it is to use the technology (Venkatesh et al., 2012). It is, therefore, related to the effort needed for using the features of the technology (Neves et al., 2023). This variable has proven to be relevant, especially in technologies where the user doesn't feel a great knowledge or competence in using it. In the case of these technologies, since there is a strong "smart"/innovative component attached, users might perceive the technology as difficult to use (Neves et al., 2023). Therefore, if the users perceive the technology as easy to use, they will probably use it more (Habib et al., 2020). Thus, the following is hypothesized:

H4a: Effort expectancy positively influences the use of IoT smart devices.
H4b: Effort expectancy positively influences the use of RES.
H4c: Effort expectancy positively influences the use of electrical vehicles.

Social influence – This factor refers to the impact of the social circle on the individual's decisions about whether to use a technology (Venkatesh et al., 2012). It measures how important the opinions of family, friends, and colleagues regarding the use of technology are. Especially in sustainable technologies, its use is many times related to a certain status, and lifestyle, and social norms tend to play a relevant role (Hmielowski et al., 2019). Therefore, we hypothesize the following:

H5a: Social influence positively influences the use of IoT smart devices.
H5b: Social influence positively influences the use of RES.
H5c: Social influence positively influences the use of electrical vehicles.

Autonomy – This variable refers to how autonomous the user feels while using the technology. This is especially relevant in technologies that require little to no frequent interaction with the user. Overall, prior research has shown that this autonomy, self-determination, and even the feeling of being in control, even when the technology is very automated, tend to positively influence the use (Fell et al., 2015). Thus, we hypothesize:

H6a: Autonomy positively influences the use of IoT smart devices.
H6b: Autonomy positively influences the use of RES.
H6c: Autonomy positively influences the use of electrical vehicles.

Gamification – The addition of elements typically seen in games to non-gaming environments is known as gamification (Deterding et al., 2011; Huotari, 2017). Several fields, including sustainable technologies, have investigated how gamification might increase the adoption of a certain technology or behaviour (Lounis et al., 2013; Neves et al., 2024). Gamification is a tactic that may be applied, especially in the development of dashboards and the user interface, to increase involvement and engagement with the suggested solutions. A system of points, accomplishments, prizes, and rivalry amongst neighbours or neighbourhoods are a few examples of these tactics. Usually, the addition of game features also simplifies the use of the technology and creates a better user experience. Consequently, it is postulated that:

H7a: Gamification positively influences the use of IoT smart devices.
H7b: Gamification positively influences the use of RES.
H7c: Gamification positively influences the use of electrical vehicles.

well-being – Often, engaging in sustainable practices or employing eco-friendly technologies requires a deliberate pursuit of specific objectives. Consumers are primarily motivated by the prospect of saving energy and money, generating renewable energy, and reducing costs when they opt for sustainable technologies (Rasmussen, 2017). As a result, when consumers achieve or make progress towards these objectives, they experience a sense of tranquillity and achievement, which contributes to their overall well-being. Research has consistently shown that embracing pro-environmental behaviours positively impacts well-being (Capstick et al., 2022; Guillen-Royo, 2019). Therefore, we posit that the use of these technologies, given their significant environmental benefits, can indeed enhance well-being. Thus, we hypothesize:

H8a: The use of IoT smart devices positively impacts perceived well-being.
H8b: The use of RES positively impacts perceived well-being.
H8c: The use of electrical vehicles positively impacts perceived well-being.

Control variables – The study of consumer behaviour is usually controlled by some variables, especially socio-demographic parameters (Erell et al., 2018; Mills & Schleich, 2009; Neves & Oliveira, 2023). Age, gender, and country were used as control variables in the model. These attributes will preserve the impacts on explanatory variables.

Data and methods

Regarding data collection, an online questionnaire was utilised based on the research model variables from Task 2.1. Questions were adapted from each construct to fit the research context, and an informed consent form was provided at the start of the questionnaire. The data collection process was taken by a subcontracted Portuguese market research company (QMetrics), and data was collected from France, Ireland, Spain, Turkey, and Portugal (400 responses per country) during July and August 2023. Quotas are set for age and gender classes to ensure representativeness. The target population was defined as individuals responsible for adopting technologies in households. Please refer to D2.1 and D2.2 for more details. More details on sample characteristics on D2.1 and D2.2.

Results

The conceptual model is estimated using the partial least squares method, a variance-based technique in structural equation modelling (Hair et al., 2016). The first step in using this approach is to examine the measurement model, paying close attention to how the items/questions relate to the constructs they are meant to assess. The structural model is then examined, with an emphasis on the connections among the constructs and concepts. The model's findings, which were tested using data from every country collected, are shown in the sections that follow.

Measurement model

To evaluate the measurement model, various measures need to be analysed. First, constructs need to have a composite reliability (CR) above 0.7 and an Average Variance Extracted exceeding 0.5 to ensure the reliability of scales and convergent validity (Fornell & Larcker, 1981; J. F. Hair et al., 2011). These measures meet the specified criteria.

The next step is to evaluate discriminant validity, which is confirmed when a set of items designed to measure a construct does not simultaneously measure another construct. To achieve this, the Fornell-Larcker criterion, cross-loadings, and the Heterotrait-Monotrait Ratio (HTMT) were employed. According to the Fornell-Larcker criterion, the diagonal elements, representing the square root of AVE, should exceed the correlation between the constructs (Fornell & Larcker, 1981), which is verified in Table 4. The HTMT criterion is examined in Table 5, where diagonal values should be below 0.9 to establish discriminant validity, which is also verified. Finally, Table 6 displays loadings and cross-loadings, revealing that all loadings surpass the cross-loadings, satisfying the criterion (Chin, 1998), and therefore establishing discriminant validity.

Table 4. Fornell-Larcker criterion. The diagonal values are the square-root of AVE

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.803													
CP	0.587	0.933												
EE	0.448	0.577	0.921											
GA	0.571	0.607	0.424	0.773										
HM	0.541	0.618	0.720	0.560	0.942									
IP	0.616	0.741	0.489	0.603	0.596	0.946								
MN	0.623	0.772	0.525	0.613	0.647	0.811	0.953							
PU	0.499	0.576	0.689	0.487	0.742	0.532	0.602	0.924						
PW	0.566	0.638	0.557	0.538	0.646	0.631	0.674	0.612	0.933					
SD	0.563	0.669	0.546	0.531	0.575	0.695	0.717	0.571	0.615	0.906				
SI	0.512	0.584	0.605	0.489	0.667	0.591	0.623	0.631	0.605	0.552	0.937			
Use1	0.364	0.446	0.398	0.388	0.452	0.436	0.433	0.379	0.556	0.385	0.425	1.000		
Use2	0.381	0.453	0.372	0.404	0.411	0.456	0.449	0.325	0.518	0.384	0.408	0.535	1.000	
Use3	0.386	0.433	0.351	0.417	0.395	0.468	0.433	0.283	0.454	0.385	0.401	0.483	0.653	1.000

Note: A-Autonomy; CP-Competence; EE-Effort expectancy; GA-Gamification; HM-Hedonic motivations; IP-Impact; MN-Meaning; PU-Perceived usefulness; PW-Perceived well-being; SD-Self-determination; SI-Social influence; Use1- Use of IoT smart devices; Use2-Use of RES; Use3-Use of electric vehicles

Table 5. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.714													
EE	0.540	0.618												
GA	0.789	0.738	0.521											
HM	0.649	0.664	0.768	0.686										
IP	0.751	0.794	0.519	0.718	0.634									
MN	0.746	0.823	0.555	0.741	0.686	0.857								
PU	0.591	0.616	0.731	0.617	0.790	0.563	0.635							
PW	0.673	0.680	0.589	0.655	0.685	0.667	0.709	0.646						
SD	0.697	0.735	0.596	0.668	0.631	0.756	0.777	0.623	0.667					
SI	0.624	0.629	0.646	0.593	0.715	0.632	0.663	0.673	0.643	0.605				
Use1	0.434	0.463	0.410	0.445	0.467	0.449	0.444	0.389	0.571	0.407	0.440			
Use2	0.457	0.472	0.383	0.449	0.424	0.470	0.460	0.334	0.532	0.406	0.422	0.535		
Use3	0.466	0.450	0.362	0.455	0.408	0.483	0.445	0.290	0.465	0.407	0.416	0.483	0.653	

Note: A-Autonomy; CP-Competence; EE-Effort expectancy; GA-Gamification; HM-Hedonic motivations; IP-Impact; MN-Meaning; PU-Perceived usefulness; PW-Perceived well-being; SD-Self-determination; SI-Social influence; Use1- Use of IoT smart devices; Use2-Use of RES; Use3-Use of electric vehicles

Table 6. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.901	0.561	0.439	0.514	0.525	0.561	0.601	0.511	0.551	0.551	0.494	0.317	0.333	0.325
A2	0.893	0.561	0.420	0.522	0.538	0.576	0.602	0.495	0.563	0.529	0.473	0.325	0.329	0.333
A3	0.571	0.243	0.183	0.309	0.185	0.309	0.241	0.136	0.190	0.227	0.228	0.220	0.247	0.268
CP1	0.544	0.912	0.513	0.576	0.559	0.691	0.685	0.501	0.586	0.596	0.536	0.426	0.454	0.448
CP2	0.548	0.947	0.562	0.563	0.591	0.689	0.730	0.555	0.603	0.629	0.552	0.420	0.414	0.385
CP3	0.552	0.941	0.541	0.560	0.579	0.696	0.745	0.557	0.597	0.646	0.549	0.402	0.403	0.380
EE1	0.377	0.500	0.914	0.354	0.629	0.420	0.450	0.605	0.473	0.479	0.516	0.355	0.320	0.306
EE2	0.430	0.550	0.928	0.407	0.683	0.476	0.508	0.652	0.539	0.522	0.586	0.379	0.366	0.346
EE3	0.423	0.532	0.922	0.401	0.672	0.446	0.491	0.630	0.521	0.499	0.571	0.367	0.348	0.335
EE4	0.418	0.543	0.918	0.395	0.666	0.455	0.482	0.647	0.517	0.507	0.550	0.364	0.333	0.305
GA1	0.454	0.449	0.368	0.674	0.467	0.419	0.467	0.465	0.441	0.451	0.364	0.285	0.228	0.228
GA2	0.446	0.474	0.305	0.877	0.406	0.495	0.467	0.299	0.388	0.387	0.384	0.321	0.365	0.410
GA3	0.437	0.468	0.301	0.887	0.413	0.489	0.464	0.304	0.399	0.382	0.377	0.327	0.380	0.400
GA4	0.473	0.532	0.398	0.619	0.514	0.485	0.558	0.557	0.504	0.492	0.426	0.272	0.245	0.196
HM1	0.496	0.576	0.675	0.526	0.950	0.551	0.598	0.683	0.596	0.532	0.623	0.429	0.397	0.380
HM2	0.511	0.594	0.699	0.510	0.932	0.566	0.622	0.751	0.623	0.567	0.637	0.410	0.364	0.341
HM3	0.523	0.578	0.665	0.546	0.945	0.567	0.610	0.668	0.611	0.530	0.628	0.438	0.400	0.395
IP1	0.570	0.699	0.459	0.551	0.559	0.939	0.790	0.517	0.599	0.658	0.560	0.393	0.404	0.412

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
IP2	0.581	0.717	0.475	0.579	0.573	0.954	0.773	0.515	0.606	0.666	0.566	0.423	0.434	0.447
IP3	0.598	0.686	0.452	0.582	0.558	0.944	0.735	0.475	0.586	0.648	0.551	0.421	0.456	0.469
MN1	0.598	0.739	0.497	0.596	0.610	0.786	0.951	0.566	0.646	0.687	0.595	0.422	0.438	0.434
MN2	0.587	0.734	0.504	0.573	0.620	0.762	0.954	0.581	0.637	0.679	0.596	0.409	0.410	0.396
MN3	0.596	0.734	0.500	0.584	0.618	0.769	0.953	0.574	0.642	0.682	0.591	0.406	0.434	0.408
PU1	0.457	0.555	0.650	0.453	0.703	0.505	0.568	0.924	0.570	0.529	0.591	0.360	0.309	0.276
PU2	0.470	0.520	0.640	0.454	0.699	0.491	0.558	0.928	0.577	0.535	0.597	0.358	0.313	0.268
PU3	0.471	0.539	0.642	0.455	0.682	0.509	0.569	0.937	0.568	0.533	0.594	0.356	0.304	0.272
PU4	0.444	0.516	0.613	0.438	0.655	0.458	0.526	0.907	0.546	0.513	0.547	0.325	0.272	0.225
PW1	0.525	0.584	0.531	0.494	0.597	0.579	0.613	0.579	0.920	0.583	0.551	0.528	0.493	0.434
PW2	0.519	0.595	0.510	0.507	0.596	0.584	0.627	0.555	0.939	0.569	0.558	0.517	0.473	0.421
PW3	0.538	0.601	0.510	0.499	0.601	0.606	0.639	0.564	0.936	0.570	0.569	0.517	0.493	0.434
PW4	0.530	0.601	0.529	0.508	0.619	0.587	0.635	0.587	0.938	0.576	0.580	0.515	0.476	0.404
SD1	0.507	0.630	0.509	0.494	0.539	0.659	0.680	0.524	0.567	0.919	0.504	0.355	0.360	0.358
SD2	0.533	0.626	0.497	0.506	0.523	0.673	0.680	0.522	0.586	0.918	0.530	0.363	0.362	0.369
SD3	0.489	0.557	0.475	0.439	0.501	0.549	0.581	0.505	0.515	0.879	0.462	0.326	0.318	0.315
SI1	0.473	0.534	0.567	0.458	0.618	0.551	0.572	0.586	0.554	0.517	0.936	0.384	0.380	0.367
SI2	0.470	0.541	0.550	0.451	0.612	0.545	0.577	0.573	0.557	0.496	0.941	0.399	0.385	0.384
SI3	0.497	0.569	0.584	0.467	0.646	0.567	0.603	0.616	0.590	0.539	0.935	0.411	0.382	0.376
Use2	0.364	0.446	0.398	0.388	0.452	0.436	0.433	0.379	0.556	0.385	0.425	1.000	0.535	0.483
Use3	0.381	0.453	0.372	0.404	0.411	0.456	0.449	0.325	0.518	0.384	0.408	0.535	1.000	0.653
Use4	0.386	0.433	0.351	0.417	0.395	0.468	0.433	0.283	0.454	0.385	0.401	0.483	0.653	1.000

Note: A-Autonomy; CP-Competence; EE-Effort expectancy; GA-Gamification; HM-Hedonic motivations; IP-Impact; MN-Meaning; PU-Perceived usefulness; PW-Perceived well-being; SD-Self-determination; SI-Social influence; Use1- Use of IoT smart devices; Use2-Use of RES; Use3-Use of electric vehicles

As we are dealing with a reflective-formative construct (empowerment), we need to evaluate multicollinearity, statistical significance, and the relevance of weights (Becker et al., 2012). Multicollinearity was examined through the variance inflation factor (VIF), yielding a value below 5, indicating the absence of collinearity issues (Hair et al., 2011). Examining the weights, as presented in Table 7, results revealed that all are statistically significant.

*Table 7. Measurement model evaluation for second-order formative construct (*p<0.10; **p<0.05; ***p<0.01)*

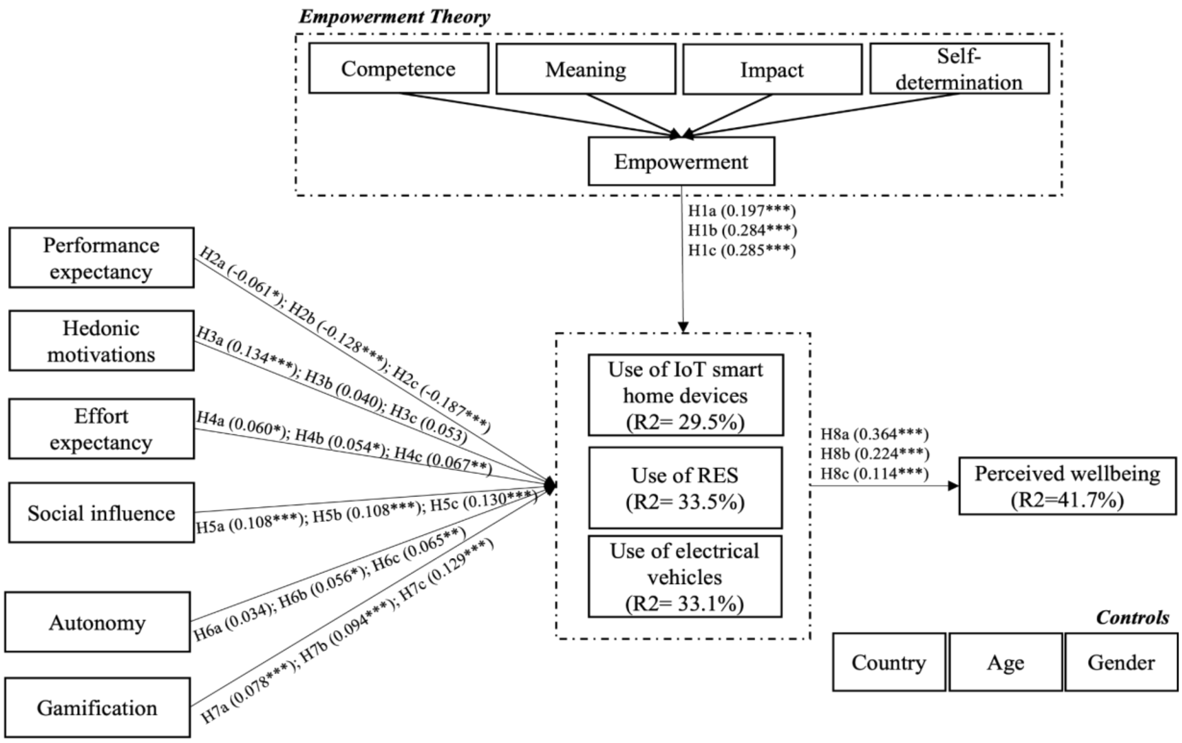
	VIF	Weights
Competence	2.842	0.281***
Impact	3.384	0.296***
Meaning	3.868	0.297***
Self-determination	2.315	0.242***

Concluding, we successfully established a robust measurement model. Confirming the measurement items, the reflective constructs, construct reliability, convergent validity, indicator reliability, and discriminative validity all exhibit satisfactory outcomes. In the case of the formative construct, no collinearity issues were identified, and the significance of weights was confirmed. The research model was tested using the complete dataset and individually for each country sample, requiring the repetition of this process for each model. The detailed results for each model can be found in Annexes A–E. With these validations in place, we can proceed to estimate the structural model, as detailed in the next subsection.

Structural model

After confirming the measurement model, the structural model was evaluated resorting to bootstrapping procedure with 5,000 resamples to test the statistical significance of the explanatory variables. Figure 8 presents the results of the model tested with data from all countries. As observed, the model explains 29.5%, 33.5%, and 33.1% of the variation in the use of IoT smart devices, RES, and electrical vehicles, and 41.7% of the variation in perceived well-being.

Figure 8. Research model results for all sample



From the figure, we can identify the most relevant factors that affect the use of each technology. Empowerment is an important motivator for all technologies studied, supporting H1a,b,c. Performance expectancy is also relevant in all variables; however, it shows a negative impact. Hedonic motivations is a motivator, but only on smart home devices, supporting H3a. Effort expectancy is a positive motivator for all technologies, as well as social influence, supporting hypotheses H4 and H5. Autonomy is especially relevant for the use of RES and electrical vehicles. Gamification is an important driver for all technologies, supporting H7a,b, and c. Finally, all technologies positively contribute to the perceived well-being of the user, supporting H8a,b,c.

Table 8 summarises the direct effects of individual models per country. We will first discuss the results globally and then specifically to each country.

Table 8. Results per country

	Spain	France	Portugal	Ireland	Turkiye
Use of IoT smart devices	**27.3%**	**38.4%**	**25.6%**	**27.8%**	**20.9%**
Autonomy	-0.011	0.013	0.037	0.107	0.034
Effort expectancy	0.088	0.050	0.058	0.036	0.138*
Gamification	0.055	0.196***	0.074	0.059	0.059
Hedonic motivations	0.148*	0.019	0.207***	0.187**	0.058
Perceived usefulness	-0.124	-0.162**	-0.088	0.089	-0.037
Social influence	0.158**	0.164**	0.164**	0.036	0.065
Empowerment	0.238***	0.267***	0.150*	0.126	0.256***
Use of RES	**26.4%**	**44%**	**29.4%**	**26.6%**	**28.9%**
Autonomy	0.028	0.082	0.136**	-0.030	0.092
Effort expectancy	0.012	0.102*	0.199***	-0.060	0.034
Gamification	0.029	0.236***	0.104*	0.054	0.101*
Hedonic motivations	0.069	0.001	0.029	0.066	0.044
Perceived usefulness	-0.117	-0.184**	-0.282***	0.073	-0.142**
Social influence	0.081	0.111*	0.143**	0.116	0.065
Empowerment	0.351***	0.171**	0.209***	0.257***	0.405***
Use of electric vehicles	**30%**	**41.7%**	**24.8%**	**30.2%**	**26%**
Autonomy	-0.027	0.021	0.173***	0.067	0.139*
Effort expectancy	0.006	0.114**	0.070	0.065	0.070
Gamification	0.092	0.261***	0.112*	0.080	0.113*
Hedonic motivations	0.190**	-0.054	0.143**	0.030	-0.049

Perceived usefulness	-0.231**	-0.208***	-0.253***	-0.121**	-0.101*
Social influence	0.129*	0.115*	0.120*	0.146**	0.092
Empowerment	0.302***	0.273***	0.115*	0.265***	0.325***
Perceived well-being	**40.3%**	**38.1%**	**29.9%**	**43.7%**	**35.8%**
Use of IoT smart devices	0.422***	0.288***	0.432***	0.402***	0.278***
Use of RES	0.189***	0.195***	0.175***	0.264***	0.320***
Use of electric vehicles	0.141***	0.183***	0.008	0.157***	0.094*

E. RECOMMENDATIONS FOR SUSTAINABLE TECHNOLOGIES

Recommendations to increase the use of sustainable technologies

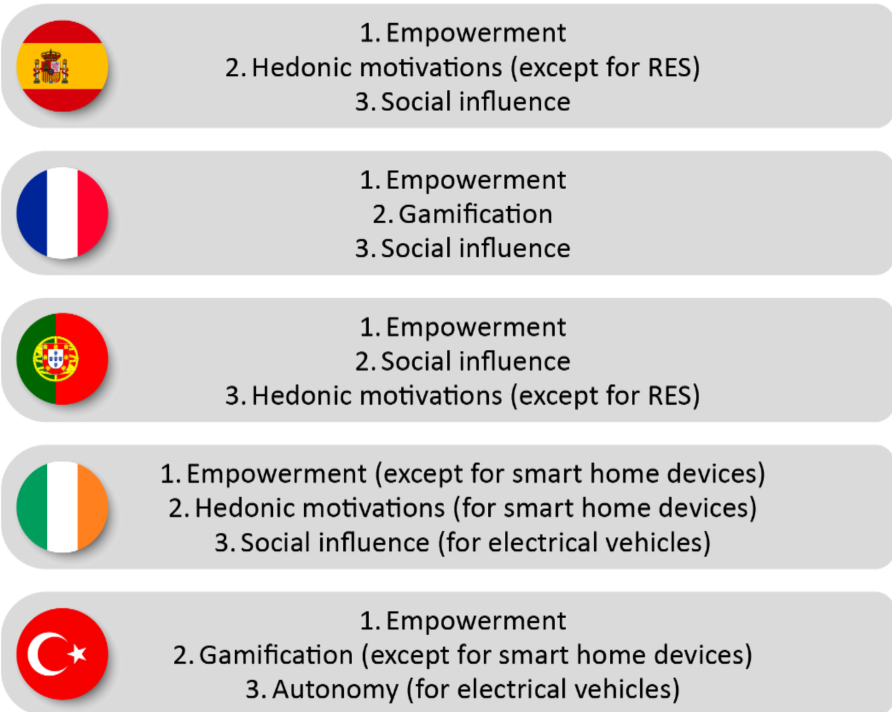
The results presented above allow us to identify the most relevant factors for citizens to use relevant technologies: IoT smart home devices, RES, and electric vehicles. Based on the results, the following recommendations were developed to increase the use:

- **Empowerment**: This factor presents a strong positive impact on all technologies. Therefore, to increase the usage of sustainable technologies, it is important to emphasize the impact and control users have while using them. Highlight how these technologies put users in charge of their energy consumption, home automation, or transportation choices, for example.
- **Hedonic Motivations**: This factor shows relevance only for smart home devices. It is, therefore, important to showcase the enjoyment that smart home devices bring to everyday life, focusing not only on productivity and efficiency measures but also on some comfort and entertainment indicators that smart home technologies can provide.
- **Effort Expectancy**: This dimension proved to be relevant for all technologies. It is thus recommended that the setup process and user interfaces for these technologies to be simplified. Provide clear instructions and intuitive controls to reduce the perceived effort of using them. The existence of some guides, forums, and visual documentation can help in increasing the perceived ease of use.
- **Social Influence**: This is one of the variables with the greatest impact on the use of sustainable technologies. Strategies may pass by encouraging social sharing and community engagement around these technologies. Create online forums, social media groups, or local meetups where users can exchange tips, experiences, and success stories. This is especially reinforced if these are inserted in an LFM.
- **Autonomy**: Results showed that autonomy is a relevant factor, but only for RES and electrical vehicles. Therefore, it is relevant to highlight the independence and self-sufficiency that renewable energy systems and electric vehicles offer. Illustrate how they enable users to generate their own energy or travel with minimal reliance on traditional fuel sources. Most of these technologies are very automated, however, it is still extremely relevant to demonstrate to its users that they are not losing control over it.
- **Gamification**: This factor is relevant for all tested technologies. This result suggests the relevance of introducing rewards, challenges, or competitive elements to

incentivize and motivate users to engage more with these technologies. For example, offer badges or discounts for achieving energy-saving milestones or adopting eco-friendly driving habits.

Results suggest that the main drivers for citizens' use of sustainable technologies are somewhat similar between countries, proposing the robustness of the presented model. Figure 9 presents the top three most relevant dimensions per country.

Figure 9. Main results per country



Recommendations for the development of dashboards

Besides increasing the use of sustainable technologies, it is also relevant for the DE-RISK project to develop recommendations for the development of dashboards that can support all these devices. Therefore, based on the results, we recommend the following:

- **User-Friendly Interface:** An intuitive and user-friendly interface with clear navigation, consistent layout, and minimalistic design. If possible, the ability to allow the users to personalize the layout and content based on their preferences and priorities, customizing the dashboard to individual needs. For example, allowing them to choose colors, graphics, measures, etc. This will respond to the need for ease of use referred to above.
- **Real-time Data Visualization:** Incorporating dynamic charts, graphs to visualize real-time data on energy consumption, generation, charging status, or vehicle performance. Make it easy for users to track and monitor relevant metrics. This will mainly respond to the need for a sense of autonomy.
- **Goal Setting and Progress Tracking:** This capability will mainly respond to the gamification and enjoyment needs of the citizens. Enable users to set energy-saving goals, sustainability targets, or driving efficiency objectives within the dashboard. Provide visual progress indicators, notifications, and alerts to help users stay on track, achieve their goals, and feel more empowered. If possible, and related to LFMs, integrate social features that allow users to connect with peers, share experiences, collaborate on energy-saving initiatives or sustainable practices, compare performances, and/or create friendly competitions. This will also be aligned with the importance of social influence found previously.
- **Smart Recommendations:** Finally, the application of machine learning algorithms to analyse user data and provide personalized recommendations for optimizing energy usage, home automation settings, or driving behaviours can contribute to users feeling more empowered and competent.

These recommendations will be considered by the partner R2M for the development (during the second half of the DE-RISK project) of visualisation tools and dashboards to improve the users' experience and acceptability of smart devices in the case study countries.

F. CONCLUSION

Local flexibility markets offer several advantages for the environment and citizens, playing a crucial role in advancing the energy transition process and alleviating the electricity grid. However, successful participation in LFMs requires an examination of consumer behaviour related to these initiatives. Therefore, this deliverable focused on two main issues: (1) Define recommendations for LFM engagement by identifying and characterizing different types of citizens according to the main types of engagement methods (4Es behavior change model); (2) Help to develop dashboards to improve the user experience and acceptability of a set of devices relevant to implement LFMs, such as IoT smart home devices (smart meters, thermostats, and plugs), electric vehicles, and renewable energy systems (RES).

To achieve the first objective, a cluster analysis was performed in order to identify the types of engagement strategies that were the most effective for each type of citizen. Based on the analysis, five main clusters/groups of citizens were identified, and results suggested the importance of mainly focusing on active measures of engagement since those drove most clusters found. Therefore, engagement strategies should mainly focus on enabling - i.e., providing availability and accessibility, simplifying processes when possible, and encouraging - i.e., improving affordability, with incentives, partnerships, and/or rewards. Additionally, results suggested that Turkiye is the country with more citizens driven by all 4 engagement measures and with greater levels of intention to participate in LFMs, followed by Portugal and Spain. France and Ireland, although showing an average willingness to participate in LFMs, are the countries with more citizens in the cluster of individuals who are not driven by any 4E measure neither are willing to participate in LFMs.

To achieve the second objective, a research model was developed to analyse the main dimensions impacting the use of each of the three main technologies (IoT smart home devices, renewable energy systems, and electric vehicles). A set of technical, social, and psychological dimensions were analyzed, and the results suggested strong importance of empowerment, hedonic motivations, gamification, and social influence. This led to the development of several recommendations, especially the addition of gamification features on technologies, leading to more enjoyable use experiences (hedonic motivations), being especially relevant for smart home devices. From this, recommendations for developing dashboards that support those technologies were also developed, focusing on supporting:

- Ease of use, with user-friendly and adaptable interfaces;
- Autonomy, especially with the ability to have real-time data visualization to improve decision-making;
- Empowerment, enjoyment, and social influence, with the ability to set goals and track progress, as well as develop friendly neighbourhood competitions.

These results will support the pilots' engagement process by providing guidelines for the best engagement methods and for developing dashboards in WP4 (during the second half of the DE-RISK project).

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Appendix A – Measurement model – France

Table 9. Fornell-Larcker

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.778													
CP	0.611	0.938												
EE	0.418	0.546	0.919											
GA	0.617	0.639	0.391	0.764										
HM	0.536	0.630	0.738	0.546	0.934									
IP	0.637	0.786	0.537	0.658	0.646	0.931								
MN	0.635	0.796	0.492	0.662	0.628	0.885	0.947							
PU	0.510	0.585	0.680	0.485	0.774	0.635	0.610	0.915						
PW	0.555	0.667	0.550	0.576	0.659	0.702	0.694	0.604	0.918					
SD	0.585	0.662	0.480	0.549	0.595	0.762	0.756	0.609	0.604	0.911				
SI	0.579	0.612	0.622	0.565	0.714	0.696	0.686	0.671	0.664	0.578	0.937			
Use1	0.393	0.506	0.371	0.484	0.417	0.497	0.493	0.348	0.548	0.425	0.476	1.000		
Use2	0.416	0.491	0.395	0.501	0.420	0.471	0.472	0.344	0.547	0.417	0.462	0.683	1.000	
Use3	0.396	0.479	0.372	0.510	0.389	0.490	0.486	0.318	0.526	0.455	0.450	0.625	0.725	1.000

Table 10. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.783													
EE	0.527	0.581												
GA	0.907	0.794	0.508											
HM	0.692	0.679	0.792	0.711										
IP	0.819	0.847	0.574	0.831	0.699									
MN	0.812	0.850	0.520	0.827	0.673	0.948								
PU	0.657	0.627	0.723	0.669	0.835	0.683	0.649							
PW	0.713	0.713	0.582	0.725	0.708	0.754	0.738	0.644						
SD	0.760	0.721	0.520	0.726	0.651	0.833	0.819	0.662	0.656					
SI	0.737	0.656	0.663	0.703	0.769	0.750	0.731	0.717	0.711	0.629				
Use1	0.474	0.525	0.382	0.535	0.433	0.517	0.508	0.359	0.565	0.447	0.493			
Use2	0.497	0.509	0.405	0.547	0.436	0.491	0.487	0.354	0.563	0.438	0.478	0.683		
Use3	0.475	0.497	0.382	0.563	0.404	0.511	0.501	0.327	0.542	0.478	0.467	0.625	0.725	

Note: Confidence intervals were calculated for the values higher than 0.9. Interval limits did not achieve the value of 1, confirming discriminant validity.

Table 11. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.853	0.576	0.401	0.540	0.524	0.601	0.626	0.520	0.567	0.575	0.566	0.350	0.306	0.296
A2	0.797	0.561	0.361	0.485	0.514	0.580	0.601	0.511	0.529	0.510	0.489	0.265	0.257	0.267
A3	0.675	0.303	0.218	0.409	0.231	0.319	0.275	0.184	0.220	0.291	0.303	0.289	0.384	0.343
CP1	0.582	0.932	0.508	0.612	0.580	0.724	0.721	0.533	0.617	0.611	0.571	0.502	0.488	0.482
CP2	0.573	0.944	0.532	0.617	0.623	0.753	0.750	0.571	0.629	0.622	0.580	0.472	0.459	0.439
CP3	0.566	0.939	0.498	0.570	0.571	0.736	0.771	0.544	0.632	0.630	0.571	0.453	0.437	0.429
EE1	0.326	0.439	0.903	0.305	0.648	0.419	0.375	0.584	0.425	0.403	0.514	0.309	0.314	0.300
EE2	0.399	0.524	0.932	0.361	0.698	0.531	0.481	0.666	0.527	0.464	0.611	0.363	0.376	0.349
EE3	0.415	0.526	0.928	0.410	0.696	0.518	0.484	0.639	0.538	0.461	0.595	0.346	0.404	0.383
EE4	0.386	0.510	0.911	0.351	0.665	0.496	0.457	0.603	0.519	0.431	0.558	0.341	0.350	0.328
GA1	0.483	0.495	0.339	0.644	0.503	0.523	0.530	0.516	0.488	0.501	0.462	0.292	0.270	0.310
GA2	0.506	0.509	0.276	0.899	0.375	0.508	0.509	0.264	0.432	0.378	0.427	0.442	0.469	0.486
GA3	0.472	0.505	0.268	0.901	0.396	0.507	0.514	0.302	0.441	0.394	0.457	0.461	0.489	0.465
GA4	0.506	0.526	0.432	0.549	0.545	0.583	0.578	0.636	0.504	0.558	0.458	0.227	0.224	0.232
HM1	0.491	0.595	0.679	0.526	0.951	0.589	0.571	0.698	0.604	0.531	0.660	0.385	0.402	0.370
HM2	0.504	0.597	0.727	0.475	0.911	0.621	0.611	0.812	0.607	0.600	0.692	0.379	0.371	0.331
HM3	0.507	0.576	0.664	0.528	0.939	0.601	0.578	0.666	0.636	0.539	0.651	0.404	0.402	0.387
IP1	0.580	0.724	0.482	0.584	0.611	0.918	0.845	0.606	0.634	0.722	0.665	0.438	0.381	0.422
IP2	0.592	0.753	0.517	0.614	0.598	0.945	0.842	0.602	0.658	0.716	0.638	0.466	0.434	0.459
IP3	0.608	0.719	0.502	0.640	0.596	0.931	0.783	0.566	0.669	0.689	0.642	0.485	0.503	0.489
MN1	0.609	0.749	0.441	0.642	0.576	0.830	0.949	0.578	0.659	0.715	0.636	0.492	0.462	0.471
MN2	0.589	0.772	0.470	0.605	0.613	0.855	0.948	0.586	0.663	0.715	0.664	0.463	0.426	0.449

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
MN3	0.606	0.741	0.487	0.633	0.594	0.827	0.943	0.570	0.650	0.719	0.647	0.445	0.453	0.460
PU1	0.420	0.526	0.628	0.413	0.731	0.566	0.548	0.907	0.544	0.541	0.594	0.300	0.309	0.299
PU2	0.478	0.525	0.627	0.457	0.712	0.579	0.549	0.917	0.550	0.554	0.650	0.314	0.321	0.295
PU3	0.512	0.546	0.633	0.467	0.705	0.611	0.602	0.936	0.594	0.592	0.647	0.350	0.345	0.322
PU4	0.450	0.545	0.598	0.434	0.682	0.566	0.528	0.897	0.516	0.537	0.556	0.307	0.278	0.240
PW1	0.500	0.617	0.538	0.503	0.595	0.648	0.646	0.589	0.914	0.572	0.612	0.506	0.529	0.489
PW2	0.524	0.618	0.466	0.547	0.614	0.643	0.639	0.529	0.928	0.556	0.600	0.498	0.473	0.483
PW3	0.504	0.599	0.498	0.523	0.574	0.640	0.626	0.524	0.912	0.526	0.601	0.509	0.529	0.509
PW4	0.512	0.617	0.516	0.543	0.642	0.646	0.640	0.578	0.920	0.568	0.628	0.498	0.473	0.449
SD1	0.506	0.618	0.460	0.487	0.574	0.681	0.693	0.571	0.536	0.924	0.527	0.386	0.370	0.407
SD2	0.577	0.642	0.461	0.548	0.575	0.760	0.749	0.577	0.613	0.912	0.575	0.409	0.423	0.454
SD3	0.513	0.543	0.388	0.460	0.470	0.633	0.617	0.512	0.495	0.897	0.472	0.363	0.341	0.379
SI1	0.529	0.546	0.562	0.489	0.631	0.634	0.629	0.614	0.604	0.522	0.935	0.422	0.420	0.405
SI2	0.530	0.565	0.599	0.544	0.676	0.644	0.626	0.631	0.622	0.526	0.940	0.440	0.420	0.428
SI3	0.567	0.605	0.587	0.552	0.696	0.677	0.670	0.640	0.640	0.575	0.936	0.475	0.457	0.432
Use1	0.393	0.506	0.371	0.484	0.417	0.497	0.493	0.348	0.548	0.425	0.476	1.000	0.683	0.625
Use2	0.416	0.491	0.395	0.501	0.420	0.471	0.472	0.344	0.547	0.417	0.462	0.683	1.000	0.725
Use3	0.396	0.479	0.372	0.510	0.389	0.490	0.486	0.318	0.526	0.455	0.450	0.625	0.725	1.000

Appendix B – Measurement model – Ireland

Table 12. Fornell-Larcker

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.816													
CP	0.518	0.936												
EE	0.324	0.503	0.917											
GA	0.505	0.498	0.251	0.734										
HM	0.458	0.548	0.622	0.452	0.932									
IP	0.591	0.684	0.369	0.581	0.575	0.954								
MN	0.554	0.710	0.418	0.501	0.579	0.810	0.966							
PU	0.382	0.473	0.686	0.326	0.632	0.478	0.477	0.938						
PW	0.526	0.577	0.478	0.390	0.596	0.523	0.614	0.562	0.944					
SD	0.507	0.588	0.511	0.415	0.502	0.544	0.609	0.499	0.562	0.914				
SI	0.368	0.512	0.593	0.366	0.645	0.515	0.545	0.556	0.526	0.457	0.935			
Use1	0.311	0.400	0.337	0.323	0.443	0.398	0.351	0.297	0.517	0.331	0.413	1.000		
Use2	0.364	0.403	0.318	0.335	0.323	0.366	0.361	0.161	0.391	0.286	0.338	0.474	1.000	
Use3	0.356	0.316	0.235	0.330	0.324	0.374	0.302	0.127	0.298	0.240	0.292	0.420	0.612	1.000

Table 13. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.621													
EE	0.386	0.540												
GA	0.714	0.644	0.353											
HM	0.546	0.594	0.670	0.609										
IP	0.702	0.728	0.389	0.713	0.614									
MN	0.648	0.751	0.438	0.632	0.614	0.846								
PU	0.445	0.500	0.724	0.486	0.678	0.499	0.496							
PW	0.614	0.612	0.502	0.555	0.635	0.548	0.639	0.587						
SD	0.615	0.642	0.557	0.585	0.553	0.587	0.652	0.536	0.604					
SI	0.440	0.553	0.633	0.466	0.697	0.548	0.575	0.589	0.559	0.499				
Use1	0.364	0.416	0.346	0.368	0.457	0.408	0.357	0.301	0.528	0.349	0.428			
Use2	0.430	0.419	0.325	0.348	0.333	0.376	0.367	0.163	0.399	0.301	0.350	0.474		
Use3	0.420	0.329	0.238	0.324	0.330	0.384	0.307	0.127	0.304	0.252	0.302	0.420	0.612	

Table 14. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.897	0.503	0.325	0.441	0.454	0.547	0.549	0.421	0.549	0.511	0.336	0.278	0.304	0.255
A2	0.912	0.513	0.293	0.501	0.474	0.587	0.567	0.377	0.537	0.500	0.370	0.289	0.312	0.338
A3	0.599	0.213	0.156	0.264	0.152	0.272	0.191	0.102	0.151	0.189	0.169	0.181	0.269	0.272
CP1	0.489	0.902	0.497	0.465	0.533	0.619	0.631	0.449	0.532	0.525	0.519	0.419	0.426	0.341
CP2	0.494	0.954	0.466	0.471	0.509	0.651	0.683	0.444	0.544	0.558	0.473	0.358	0.362	0.277
CP3	0.471	0.951	0.452	0.462	0.499	0.649	0.679	0.435	0.545	0.567	0.448	0.350	0.346	0.272
EE1	0.271	0.435	0.917	0.182	0.539	0.302	0.364	0.605	0.416	0.451	0.516	0.302	0.274	0.217
EE2	0.350	0.488	0.928	0.260	0.590	0.372	0.401	0.650	0.474	0.480	0.570	0.342	0.341	0.255
EE3	0.273	0.447	0.921	0.224	0.581	0.337	0.389	0.615	0.433	0.450	0.565	0.299	0.293	0.226
EE4	0.283	0.476	0.902	0.251	0.569	0.338	0.374	0.649	0.425	0.496	0.519	0.287	0.248	0.149
GA1	0.374	0.287	0.257	0.488	0.312	0.291	0.278	0.347	0.358	0.379	0.214	0.128	0.123	0.110
GA2	0.452	0.433	0.192	0.930	0.366	0.550	0.458	0.235	0.278	0.337	0.317	0.295	0.331	0.342
GA3	0.418	0.421	0.195	0.941	0.383	0.484	0.409	0.229	0.318	0.320	0.321	0.303	0.328	0.329
GA4	0.292	0.402	0.203	0.408	0.395	0.402	0.398	0.376	0.397	0.345	0.261	0.188	0.083	0.025
HM1	0.400	0.507	0.588	0.399	0.951	0.513	0.509	0.595	0.552	0.460	0.621	0.426	0.290	0.295
HM2	0.429	0.527	0.608	0.404	0.907	0.551	0.557	0.663	0.586	0.496	0.584	0.368	0.265	0.228
HM3	0.451	0.505	0.552	0.457	0.938	0.547	0.555	0.530	0.537	0.456	0.598	0.437	0.341	0.365
IP1	0.529	0.656	0.371	0.524	0.531	0.949	0.817	0.464	0.522	0.526	0.503	0.383	0.338	0.336
IP1	0.529	0.656	0.371	0.524	0.531	0.949	0.817	0.464	0.522	0.526	0.503	0.383	0.338	0.336
IP2	0.563	0.661	0.352	0.552	0.553	0.964	0.773	0.464	0.485	0.514	0.483	0.365	0.358	0.348
IP2	0.563	0.661	0.352	0.552	0.553	0.964	0.773	0.464	0.485	0.514	0.483	0.365	0.358	0.348

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
IP3	0.599	0.637	0.332	0.588	0.561	0.948	0.725	0.438	0.487	0.516	0.487	0.389	0.351	0.387
IP3	0.599	0.637	0.332	0.588	0.561	0.948	0.725	0.438	0.487	0.516	0.487	0.389	0.351	0.387
MN1	0.536	0.674	0.413	0.487	0.543	0.789	0.962	0.445	0.581	0.595	0.530	0.341	0.359	0.319
MN2	0.523	0.685	0.412	0.467	0.564	0.768	0.970	0.477	0.604	0.590	0.527	0.341	0.336	0.269
MN3	0.545	0.698	0.385	0.499	0.569	0.789	0.964	0.459	0.593	0.578	0.521	0.334	0.349	0.285
PU1	0.367	0.473	0.660	0.337	0.619	0.465	0.452	0.933	0.544	0.486	0.555	0.311	0.158	0.141
PU2	0.369	0.445	0.642	0.311	0.606	0.462	0.466	0.949	0.529	0.482	0.516	0.276	0.168	0.129
PU3	0.366	0.446	0.652	0.288	0.579	0.449	0.446	0.939	0.512	0.466	0.516	0.273	0.148	0.117
PU4	0.325	0.401	0.616	0.277	0.559	0.408	0.420	0.930	0.522	0.431	0.491	0.245	0.123	0.079
PW1	0.494	0.525	0.465	0.357	0.545	0.479	0.532	0.519	0.917	0.534	0.472	0.491	0.365	0.279
PW2	0.503	0.544	0.433	0.360	0.567	0.479	0.577	0.501	0.955	0.536	0.490	0.506	0.363	0.289
PW3	0.503	0.571	0.472	0.384	0.590	0.519	0.616	0.556	0.952	0.530	0.522	0.484	0.380	0.291
PW4	0.484	0.539	0.434	0.372	0.546	0.496	0.593	0.548	0.952	0.520	0.503	0.470	0.369	0.267
SD1	0.451	0.555	0.475	0.374	0.444	0.529	0.586	0.440	0.493	0.902	0.414	0.288	0.268	0.241
SD2	0.472	0.544	0.459	0.391	0.454	0.504	0.568	0.454	0.522	0.931	0.434	0.310	0.269	0.227
SD3	0.466	0.510	0.465	0.372	0.480	0.456	0.512	0.476	0.525	0.908	0.403	0.308	0.247	0.189
SI1	0.375	0.464	0.597	0.334	0.598	0.488	0.522	0.546	0.493	0.449	0.937	0.403	0.330	0.293
SI2	0.332	0.474	0.510	0.343	0.578	0.482	0.513	0.481	0.461	0.398	0.935	0.386	0.328	0.270
SI3	0.323	0.500	0.554	0.351	0.635	0.473	0.492	0.533	0.524	0.434	0.932	0.367	0.288	0.252
Use1	0.311	0.400	0.337	0.323	0.443	0.398	0.351	0.297	0.517	0.331	0.413	1.000	0.474	0.420
Use2	0.364	0.403	0.318	0.335	0.323	0.366	0.361	0.161	0.391	0.286	0.338	0.474	1.000	0.612
Use3	0.356	0.316	0.235	0.330	0.324	0.374	0.302	0.127	0.298	0.240	0.292	0.420	0.612	1.000

Appendix C – Measurement model – Portugal

Table 15. Fornell-Larcker

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.816													
CP	0.518	0.936												
EE	0.324	0.503	0.917											
GA	0.505	0.498	0.251	0.734										
HM	0.458	0.548	0.622	0.452	0.932									
IP	0.591	0.684	0.369	0.581	0.575	0.954								
MN	0.554	0.710	0.418	0.501	0.579	0.810	0.966							
PU	0.382	0.473	0.686	0.326	0.632	0.478	0.477	0.938						
PW	0.526	0.577	0.478	0.390	0.596	0.523	0.614	0.562	0.944					
SD	0.507	0.588	0.511	0.415	0.502	0.544	0.609	0.499	0.562	0.914				
SI	0.368	0.512	0.593	0.366	0.645	0.515	0.545	0.556	0.526	0.457	0.935			
Use1	0.311	0.400	0.337	0.323	0.443	0.398	0.351	0.297	0.517	0.331	0.413	1.000		
Use2	0.364	0.403	0.318	0.335	0.323	0.366	0.361	0.161	0.391	0.286	0.338	0.474	1.000	
Use3	0.356	0.316	0.235	0.330	0.324	0.374	0.302	0.127	0.298	0.240	0.292	0.420	0.612	1.000

Table 16. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.621													
EE	0.386	0.540												
GA	0.714	0.644	0.353											
HM	0.546	0.594	0.670	0.609										
IP	0.702	0.728	0.389	0.713	0.614									
MN	0.648	0.751	0.438	0.632	0.614	0.846								
PU	0.445	0.500	0.724	0.486	0.678	0.499	0.496							
PW	0.614	0.612	0.502	0.555	0.635	0.548	0.639	0.587						
SD	0.615	0.642	0.557	0.585	0.553	0.587	0.652	0.536	0.604					
SI	0.440	0.553	0.633	0.466	0.697	0.548	0.575	0.589	0.559	0.499				
Use1	0.364	0.416	0.346	0.368	0.457	0.408	0.357	0.301	0.528	0.349	0.428			
Use2	0.430	0.419	0.325	0.348	0.333	0.376	0.367	0.163	0.399	0.301	0.350	0.474		
Use3	0.420	0.329	0.238	0.324	0.330	0.384	0.307	0.127	0.304	0.252	0.302	0.420	0.612	

Table 17. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.897	0.503	0.325	0.441	0.454	0.547	0.549	0.421	0.549	0.511	0.336	0.278	0.304	0.255
A2	0.912	0.513	0.293	0.501	0.474	0.587	0.567	0.377	0.537	0.500	0.370	0.289	0.312	0.338
A3	0.599	0.213	0.156	0.264	0.152	0.272	0.191	0.102	0.151	0.189	0.169	0.181	0.269	0.272
CP1	0.489	0.902	0.497	0.465	0.533	0.619	0.631	0.449	0.532	0.525	0.519	0.419	0.426	0.341
CP2	0.494	0.954	0.466	0.471	0.509	0.651	0.683	0.444	0.544	0.558	0.473	0.358	0.362	0.277
CP3	0.471	0.951	0.452	0.462	0.499	0.649	0.679	0.435	0.545	0.567	0.448	0.350	0.346	0.272
EE1	0.271	0.435	0.917	0.182	0.539	0.302	0.364	0.605	0.416	0.451	0.516	0.302	0.274	0.217
EE2	0.350	0.488	0.928	0.260	0.590	0.372	0.401	0.650	0.474	0.480	0.570	0.342	0.341	0.255
EE3	0.273	0.447	0.921	0.224	0.581	0.337	0.389	0.615	0.433	0.450	0.565	0.299	0.293	0.226
EE4	0.283	0.476	0.902	0.251	0.569	0.338	0.374	0.649	0.425	0.496	0.519	0.287	0.248	0.149
GA1	0.374	0.287	0.257	0.488	0.312	0.291	0.278	0.347	0.358	0.379	0.214	0.128	0.123	0.110
GA2	0.452	0.433	0.192	0.930	0.366	0.550	0.458	0.235	0.278	0.337	0.317	0.295	0.331	0.342
GA3	0.418	0.421	0.195	0.941	0.383	0.484	0.409	0.229	0.318	0.320	0.321	0.303	0.328	0.329
GA4	0.292	0.402	0.203	0.408	0.395	0.402	0.398	0.376	0.397	0.345	0.261	0.188	0.083	0.025
HM1	0.400	0.507	0.588	0.399	0.951	0.513	0.509	0.595	0.552	0.460	0.621	0.426	0.290	0.295
HM2	0.429	0.527	0.608	0.404	0.907	0.551	0.557	0.663	0.586	0.496	0.584	0.368	0.265	0.228
HM3	0.451	0.505	0.552	0.457	0.938	0.547	0.555	0.530	0.537	0.456	0.598	0.437	0.341	0.365
IP1	0.529	0.656	0.371	0.524	0.531	0.949	0.817	0.464	0.522	0.526	0.503	0.383	0.338	0.336
IP2	0.563	0.661	0.352	0.552	0.553	0.964	0.773	0.464	0.485	0.514	0.483	0.365	0.358	0.348
IP3	0.599	0.637	0.332	0.588	0.561	0.948	0.725	0.438	0.487	0.516	0.487	0.389	0.351	0.387
MN1	0.536	0.674	0.413	0.487	0.543	0.789	0.962	0.445	0.581	0.595	0.530	0.341	0.359	0.319
MN2	0.523	0.685	0.412	0.467	0.564	0.768	0.970	0.477	0.604	0.590	0.527	0.341	0.336	0.269

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
MN3	0.545	0.698	0.385	0.499	0.569	0.789	0.964	0.459	0.593	0.578	0.521	0.334	0.349	0.285
PU1	0.367	0.473	0.660	0.337	0.619	0.465	0.452	0.933	0.544	0.486	0.555	0.311	0.158	0.141
PU2	0.369	0.445	0.642	0.311	0.606	0.462	0.466	0.949	0.529	0.482	0.516	0.276	0.168	0.129
PU3	0.366	0.446	0.652	0.288	0.579	0.449	0.446	0.939	0.512	0.466	0.516	0.273	0.148	0.117
PU4	0.325	0.401	0.616	0.277	0.559	0.408	0.420	0.930	0.522	0.431	0.491	0.245	0.123	0.079
PW1	0.494	0.525	0.465	0.357	0.545	0.479	0.532	0.519	0.917	0.534	0.472	0.491	0.365	0.279
PW2	0.503	0.544	0.433	0.360	0.567	0.479	0.577	0.501	0.955	0.536	0.490	0.506	0.363	0.289
PW3	0.503	0.571	0.472	0.384	0.590	0.519	0.616	0.556	0.952	0.530	0.522	0.484	0.380	0.291
PW4	0.484	0.539	0.434	0.372	0.546	0.496	0.593	0.548	0.952	0.520	0.503	0.470	0.369	0.267
SD1	0.451	0.555	0.475	0.374	0.444	0.529	0.586	0.440	0.493	0.902	0.414	0.288	0.268	0.241
SD2	0.472	0.544	0.459	0.391	0.454	0.504	0.568	0.454	0.522	0.931	0.434	0.310	0.269	0.227
SD3	0.466	0.510	0.465	0.372	0.480	0.456	0.512	0.476	0.525	0.908	0.403	0.308	0.247	0.189
SI1	0.375	0.464	0.597	0.334	0.598	0.488	0.522	0.546	0.493	0.449	0.937	0.403	0.330	0.293
SI2	0.332	0.474	0.510	0.343	0.578	0.482	0.513	0.481	0.461	0.398	0.935	0.386	0.328	0.270
SI3	0.323	0.500	0.554	0.351	0.635	0.473	0.492	0.533	0.524	0.434	0.932	0.367	0.288	0.252
Use1	0.311	0.400	0.337	0.323	0.443	0.398	0.351	0.297	0.517	0.331	0.413	1.000	0.474	0.420
Use2	0.364	0.403	0.318	0.335	0.323	0.366	0.361	0.161	0.391	0.286	0.338	0.474	1.000	0.612
Use3	0.356	0.316	0.235	0.330	0.324	0.374	0.302	0.127	0.298	0.240	0.292	0.420	0.612	1.000

Appendix D – Measurement model – Spain

Table 18. Fornell-Larcker

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.802													
CP	0.514	0.919												
EE	0.384	0.603	0.916											
GA	0.473	0.549	0.362	0.777										
HM	0.480	0.637	0.695	0.463	0.932									
IP	0.559	0.715	0.518	0.498	0.609	0.934								
MN	0.613	0.754	0.514	0.559	0.656	0.826	0.936							
PU	0.450	0.651	0.701	0.449	0.782	0.604	0.675	0.912						
PW	0.500	0.626	0.545	0.510	0.666	0.675	0.693	0.636	0.934					
SD	0.484	0.646	0.530	0.472	0.560	0.712	0.703	0.599	0.620	0.907				
SI	0.475	0.565	0.590	0.434	0.704	0.584	0.600	0.658	0.621	0.536	0.934			
Use1	0.288	0.399	0.390	0.310	0.429	0.438	0.388	0.353	0.580	0.338	0.410	1.000		
Use2	0.287	0.367	0.314	0.281	0.348	0.444	0.395	0.285	0.501	0.286	0.322	0.552	1.000	
Use3	0.255	0.378	0.316	0.312	0.378	0.394	0.378	0.261	0.451	0.290	0.345	0.485	0.690	1.000

Table 19. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.594													
EE	0.433	0.653												
GA	0.648	0.686	0.446											
HM	0.537	0.695	0.744	0.583										
IP	0.665	0.780	0.553	0.606	0.658									
MN	0.707	0.820	0.549	0.692	0.708	0.889								
PU	0.498	0.706	0.747	0.579	0.839	0.644	0.721							
PW	0.554	0.674	0.574	0.606	0.710	0.719	0.736	0.672						
SD	0.563	0.716	0.577	0.595	0.615	0.779	0.768	0.652	0.670					
SI	0.539	0.616	0.632	0.530	0.762	0.631	0.646	0.704	0.661	0.589				
Use1	0.323	0.419	0.401	0.344	0.447	0.455	0.402	0.356	0.595	0.356	0.425			
Use2	0.330	0.387	0.323	0.304	0.361	0.462	0.410	0.291	0.513	0.300	0.334	0.552		
Use3	0.293	0.397	0.325	0.333	0.393	0.410	0.392	0.264	0.462	0.305	0.358	0.485	0.690	

Table 20. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.928	0.508	0.392	0.416	0.470	0.529	0.595	0.455	0.471	0.475	0.475	0.253	0.260	0.232
A2	0.929	0.492	0.362	0.461	0.477	0.526	0.586	0.440	0.511	0.465	0.455	0.295	0.277	0.245
A3	0.450	0.118	0.075	0.210	0.076	0.211	0.167	0.058	0.089	0.118	0.098	0.092	0.117	0.104
CP1	0.487	0.892	0.530	0.549	0.566	0.643	0.667	0.529	0.594	0.557	0.478	0.394	0.409	0.402
CP2	0.464	0.934	0.592	0.473	0.596	0.663	0.707	0.618	0.566	0.602	0.534	0.387	0.316	0.348
CP3	0.467	0.931	0.539	0.493	0.593	0.667	0.704	0.645	0.567	0.622	0.544	0.320	0.291	0.294
EE1	0.342	0.542	0.918	0.316	0.599	0.479	0.472	0.622	0.456	0.482	0.506	0.334	0.284	0.269
EE2	0.348	0.562	0.922	0.371	0.679	0.525	0.518	0.637	0.556	0.511	0.584	0.383	0.318	0.330
EE3	0.347	0.533	0.899	0.297	0.595	0.411	0.415	0.626	0.469	0.448	0.519	0.317	0.259	0.274
EE4	0.371	0.570	0.927	0.336	0.663	0.475	0.473	0.682	0.506	0.497	0.546	0.390	0.285	0.281
GA1	0.401	0.409	0.321	0.678	0.418	0.356	0.450	0.433	0.370	0.394	0.308	0.202	0.150	0.169
GA2	0.344	0.411	0.254	0.877	0.334	0.363	0.387	0.285	0.407	0.353	0.367	0.265	0.226	0.287
GA3	0.358	0.419	0.275	0.898	0.326	0.419	0.439	0.295	0.418	0.345	0.322	0.294	0.300	0.321
GA4	0.445	0.552	0.340	0.615	0.461	0.462	0.554	0.520	0.428	0.458	0.401	0.184	0.157	0.138
HM1	0.423	0.544	0.597	0.422	0.912	0.534	0.587	0.654	0.576	0.477	0.599	0.384	0.342	0.363
HM2	0.450	0.624	0.663	0.426	0.933	0.580	0.627	0.794	0.655	0.547	0.705	0.412	0.310	0.330
HM3	0.469	0.613	0.683	0.448	0.951	0.588	0.620	0.740	0.632	0.541	0.665	0.404	0.319	0.364
IP1	0.509	0.675	0.507	0.466	0.578	0.936	0.796	0.602	0.645	0.670	0.547	0.393	0.403	0.331
IP2	0.520	0.673	0.476	0.464	0.587	0.935	0.754	0.571	0.640	0.660	0.554	0.414	0.408	0.377
IP3	0.537	0.655	0.467	0.466	0.539	0.929	0.762	0.519	0.605	0.662	0.533	0.419	0.433	0.397
MN1	0.565	0.726	0.499	0.538	0.612	0.803	0.939	0.633	0.655	0.696	0.567	0.373	0.390	0.376
MN2	0.582	0.682	0.481	0.501	0.618	0.745	0.931	0.638	0.627	0.628	0.554	0.359	0.348	0.335

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
MN3	0.574	0.707	0.464	0.529	0.611	0.769	0.938	0.624	0.662	0.647	0.564	0.357	0.371	0.349
PU1	0.413	0.616	0.657	0.410	0.733	0.577	0.645	0.929	0.580	0.541	0.610	0.363	0.293	0.273
PU2	0.428	0.569	0.632	0.422	0.744	0.573	0.620	0.912	0.618	0.577	0.612	0.340	0.273	0.247
PU3	0.400	0.618	0.673	0.414	0.715	0.568	0.628	0.935	0.588	0.558	0.620	0.333	0.250	0.242
PU4	0.406	0.573	0.588	0.393	0.650	0.469	0.557	0.872	0.527	0.506	0.551	0.221	0.210	0.169
PW1	0.460	0.599	0.539	0.485	0.625	0.616	0.643	0.613	0.927	0.614	0.576	0.560	0.476	0.427
PW2	0.449	0.567	0.503	0.474	0.592	0.619	0.634	0.566	0.935	0.562	0.570	0.535	0.444	0.405
PW3	0.462	0.574	0.490	0.464	0.636	0.648	0.649	0.600	0.936	0.580	0.561	0.543	0.484	0.447
PW4	0.498	0.597	0.504	0.482	0.637	0.639	0.662	0.598	0.939	0.559	0.613	0.530	0.467	0.406
SD1	0.420	0.608	0.479	0.439	0.515	0.669	0.670	0.546	0.561	0.912	0.475	0.349	0.300	0.294
SD2	0.498	0.610	0.515	0.465	0.533	0.690	0.678	0.588	0.612	0.911	0.518	0.307	0.276	0.274
SD3	0.394	0.535	0.444	0.372	0.469	0.568	0.554	0.489	0.507	0.897	0.461	0.257	0.194	0.216
SI1	0.415	0.534	0.545	0.423	0.655	0.548	0.540	0.583	0.547	0.499	0.926	0.350	0.298	0.300
SI2	0.439	0.510	0.524	0.375	0.641	0.524	0.546	0.590	0.583	0.475	0.940	0.414	0.306	0.336
SI3	0.476	0.540	0.586	0.419	0.677	0.565	0.595	0.670	0.607	0.528	0.935	0.382	0.299	0.329
Use1	0.288	0.399	0.390	0.310	0.429	0.438	0.388	0.353	0.580	0.338	0.410	1.000	0.552	0.485
Use2	0.287	0.367	0.314	0.281	0.348	0.444	0.395	0.285	0.501	0.286	0.322	0.552	1.000	0.690
Use3	0.255	0.378	0.316	0.312	0.378	0.394	0.378	0.261	0.451	0.290	0.345	0.485	0.690	1.000

Appendix E – Measurement model – Turkey

Table 21. Fornell-Larcker

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A	0.788													
CP	0.591	0.929												
EE	0.525	0.510	0.894											
GA	0.509	0.562	0.414	0.757										
HM	0.512	0.513	0.659	0.486	0.935									
IP	0.554	0.748	0.414	0.514	0.440	0.958								
MN	0.577	0.742	0.458	0.519	0.500	0.710	0.935							
PU	0.473	0.439	0.614	0.394	0.627	0.368	0.471	0.871						
PW	0.591	0.596	0.461	0.475	0.483	0.580	0.597	0.440	0.918					
SD	0.576	0.693	0.510	0.503	0.501	0.702	0.710	0.509	0.626	0.871				
SI	0.504	0.416	0.448	0.330	0.429	0.472	0.475	0.500	0.434	0.469	0.919			
Use1	0.316	0.379	0.336	0.288	0.319	0.373	0.326	0.258	0.503	0.344	0.274	1.000		
Use2	0.377	0.436	0.282	0.353	0.300	0.479	0.384	0.196	0.533	0.452	0.286	0.549	1.000	
Use3	0.397	0.403	0.292	0.349	0.264	0.489	0.344	0.213	0.444	0.418	0.308	0.515	0.634	1.000

Table 22. HTMT values

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A														
CP	0.742													
EE	0.663	0.555												
GA	0.718	0.687	0.510											
HM	0.637	0.555	0.718	0.594										
IP	0.692	0.798	0.442	0.606	0.466									
MN	0.719	0.802	0.497	0.631	0.538	0.753								
PU	0.595	0.483	0.678	0.490	0.692	0.398	0.518							
PW	0.734	0.642	0.497	0.575	0.515	0.613	0.640	0.480						
SD	0.753	0.784	0.583	0.639	0.570	0.773	0.799	0.590	0.700					
SI	0.642	0.454	0.491	0.402	0.466	0.507	0.516	0.555	0.470	0.533				
Use1	0.391	0.396	0.351	0.337	0.329	0.381	0.338	0.272	0.518	0.372	0.287			
Use2	0.457	0.455	0.294	0.408	0.310	0.491	0.398	0.206	0.550	0.489	0.299	0.549		
Use3	0.492	0.420	0.305	0.397	0.273	0.501	0.356	0.225	0.458	0.452	0.323	0.515	0.634	

Table 23. Loadings and cross-loadings

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
A1	0.877	0.543	0.513	0.434	0.505	0.460	0.539	0.461	0.538	0.578	0.463	0.233	0.336	0.316
A2	0.878	0.569	0.459	0.458	0.479	0.494	0.558	0.483	0.594	0.535	0.434	0.264	0.345	0.313
A3	0.570	0.245	0.239	0.290	0.188	0.336	0.225	0.129	0.220	0.204	0.272	0.249	0.189	0.308
CP1	0.525	0.893	0.418	0.533	0.437	0.745	0.638	0.361	0.533	0.635	0.394	0.340	0.429	0.453
CP2	0.572	0.951	0.507	0.513	0.498	0.677	0.714	0.432	0.573	0.646	0.390	0.366	0.391	0.321
CP3	0.551	0.943	0.495	0.520	0.493	0.663	0.716	0.429	0.555	0.650	0.376	0.352	0.394	0.349
EE1	0.455	0.433	0.888	0.360	0.566	0.358	0.384	0.518	0.391	0.423	0.369	0.331	0.245	0.257
EE2	0.503	0.474	0.903	0.405	0.606	0.366	0.432	0.616	0.421	0.494	0.422	0.296	0.258	0.272
EE3	0.439	0.432	0.881	0.333	0.594	0.347	0.416	0.493	0.421	0.432	0.407	0.288	0.231	0.254
EE4	0.480	0.484	0.904	0.379	0.592	0.409	0.409	0.568	0.415	0.474	0.408	0.286	0.273	0.261
GA1	0.348	0.468	0.392	0.681	0.425	0.331	0.412	0.337	0.384	0.400	0.223	0.217	0.237	0.169
GA2	0.357	0.369	0.246	0.831	0.307	0.395	0.299	0.205	0.308	0.318	0.224	0.182	0.237	0.352
GA3	0.395	0.399	0.272	0.849	0.336	0.431	0.332	0.210	0.328	0.339	0.255	0.179	0.291	0.332
GA4	0.435	0.478	0.362	0.646	0.420	0.386	0.539	0.457	0.427	0.475	0.293	0.297	0.297	0.181
HM1	0.459	0.444	0.635	0.452	0.943	0.404	0.445	0.572	0.423	0.453	0.386	0.289	0.259	0.241
HM2	0.481	0.517	0.658	0.466	0.922	0.396	0.487	0.661	0.449	0.503	0.407	0.261	0.269	0.237
HM3	0.495	0.480	0.566	0.449	0.940	0.432	0.472	0.536	0.478	0.454	0.411	0.340	0.309	0.261
IP1	0.541	0.718	0.397	0.495	0.432	0.958	0.690	0.375	0.557	0.666	0.465	0.353	0.447	0.463
IP2	0.520	0.735	0.414	0.510	0.431	0.964	0.692	0.346	0.579	0.685	0.462	0.361	0.455	0.448
IP3	0.530	0.695	0.378	0.470	0.402	0.951	0.657	0.335	0.531	0.665	0.430	0.356	0.476	0.495
MN1	0.562	0.727	0.425	0.531	0.503	0.716	0.921	0.410	0.584	0.664	0.465	0.314	0.381	0.381
MN2	0.520	0.676	0.424	0.466	0.442	0.628	0.942	0.446	0.549	0.664	0.434	0.306	0.359	0.304

	A	CP	EE	GA	HM	IP	MN	PU	PW	SD	SI	Use1	Use2	Use3
MN3	0.535	0.679	0.437	0.458	0.457	0.645	0.943	0.467	0.540	0.665	0.432	0.293	0.336	0.277
PU1	0.438	0.435	0.509	0.381	0.531	0.342	0.424	0.893	0.399	0.434	0.425	0.246	0.175	0.188
PU2	0.408	0.355	0.566	0.347	0.568	0.297	0.400	0.882	0.396	0.458	0.458	0.235	0.190	0.184
PU3	0.419	0.367	0.496	0.308	0.532	0.359	0.427	0.858	0.355	0.410	0.430	0.202	0.152	0.194
PU4	0.381	0.371	0.570	0.334	0.554	0.284	0.393	0.850	0.382	0.471	0.431	0.215	0.162	0.176
PW1	0.502	0.527	0.430	0.420	0.462	0.541	0.530	0.391	0.909	0.580	0.395	0.480	0.523	0.414
PW2	0.539	0.554	0.403	0.450	0.376	0.514	0.538	0.402	0.924	0.551	0.368	0.454	0.482	0.414
PW3	0.569	0.574	0.390	0.433	0.437	0.563	0.579	0.430	0.923	0.580	0.426	0.461	0.471	0.400
PW4	0.564	0.536	0.468	0.444	0.496	0.513	0.547	0.394	0.917	0.588	0.406	0.449	0.478	0.403
SD1	0.512	0.650	0.465	0.468	0.464	0.667	0.678	0.467	0.590	0.916	0.438	0.318	0.426	0.377
SD2	0.534	0.640	0.439	0.473	0.433	0.684	0.653	0.435	0.586	0.909	0.441	0.340	0.424	0.410
SD3	0.457	0.509	0.433	0.366	0.414	0.458	0.510	0.431	0.447	0.783	0.338	0.232	0.319	0.295
SI1	0.433	0.364	0.385	0.320	0.375	0.435	0.410	0.448	0.391	0.432	0.922	0.228	0.250	0.268
SI2	0.466	0.385	0.421	0.303	0.395	0.414	0.456	0.457	0.395	0.408	0.920	0.259	0.272	0.291
SI3	0.488	0.396	0.428	0.288	0.412	0.454	0.441	0.474	0.411	0.455	0.916	0.267	0.265	0.291
Use1	0.316	0.379	0.336	0.288	0.319	0.373	0.326	0.258	0.503	0.344	0.274	1.000	0.549	0.515
Use2	0.377	0.436	0.282	0.353	0.300	0.479	0.384	0.196	0.533	0.452	0.286	0.549	1.000	0.634
Use3	0.397	0.403	0.292	0.349	0.264	0.489	0.344	0.213	0.444	0.418	0.308	0.515	0.634	1.000

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