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Mobile Phone Use by the Elderly: Relationship between Usability, Social Activity, and the Environment

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Abstract: Mobile phones have caused diverging opinions regarding the change in communication patterns and the isolation among young people. However, in the case of the elderly, there are positive effects related to their use, their social activity, and their environmental awareness. This study connects these three variables beginning with the mobile telephone use by the elderly. A sample of 399 self-reliant elderly people was interviewed in Chile, where 159 had mobile phones. They answered the Usefulness, Satisfaction and Ease of Use Questionnaire (USE) and a series of questions about the environment and social life developed from previous studies. The results were analyzed using a multiple correspondence and correlation analysis. A high correlation between the three variables was found. Hence, a higher usability of mobile phones was associated with higher social activity and a higher environmental concern. These results showed that a design approach for the elderly could increase satisfaction regarding the use of a product and, as a result, improve communication with their social setting. From an environmental point of view, an indirect relationship was seen between the selection, use, and expectations of the end of life of the products.

Keywords: mobile phone; elderly; usability; social activity; environment

1. Introduction

Between 2000 and 2050, the proportion of the planet's inhabitants over 60 years old will double; rising from 11% to 22%. In absolute numbers, this age group will rise from 605 million to two billion over half a century. The number of people over 80 will almost quadruple to 395 million. This means that a higher number of children will get to know their grandparents and even their great-grandparents, especially their great-grandmothers, as women, on average, live six to eight years longer than men [1].

This growth will have a different distribution throughout the world. It is projected that the percentage of growth of the elderly over 65 versus considering the world population between 2000 and 2025 will be: 17% for Sub-Saharan Africa; 47% for the Middle East; 79% for Asia (excluding the Middle East); and 82% for Latin America and the Caribbean [2]. In Chile, the population over 60 in 2015 will be 182% higher than in 2000 and 368% higher in 2050 [3].

However, currently, a large part of the elderly population lives with age related health complications (Alzheimer's, dementia, diabetes, cardiovascular diseases, degenerative diseases, bone diseases, and other chronic pathologies). This has added to the difficulties arising from the normal and progressive deterioration of physical and cognitive abilities, which together make independent living difficult for the elderly [4].

The United Nations [5] indicates that the elderly population who lives independently, alone, or together with their spouse is increasing. This carries with it the desire to live in their own homes and not in retirement houses or hospitals. However, the lack of support and the deterioration of their social networks, along with the work demands of the younger population make it less likely that they can keep up face-to-face contact.

This leads to questioning the way that the elderly could adapt to virtual communication, just as other generations do [6], and if and how this age group is considered in the design of such devices. For example, with regard to environmental awareness, older adults are generally not considered because they are perceived as not motivated by sustainability or as being too late in life to have a significant impact, even though they can play a crucial role in promoting sustainability within communities [6]. This implies that there is a need to promote empowerment among the elderly, or their capacity to make informed decisions, exercise influence, continuously contribute to society, or benefit from it [7].

With regard to the objects the elderly use, designers shape the development of products and services that directly influence society and the environment [8]. In this sense, we find studies where the perception of different (food) products slightly varies among the elderly versus the rest of the population due to their own experience and social concern [9]. Vlontzos et al. [10] pointed out a high influence in the purchasing decisions of traditional food. Lumpkin and Dunn [11] examined the perceived risk of elderly and other consumers in three areas: the perceived risk associated with buying products, the perceived risk attached to a complete range of forms of retail marketing, and the risk reduction strategies used.

Liu et al. [12] applied Kansei engineering to design kitchen utensils for the elderly; on the one hand, generating kitchenware to boost the motivation of the elderly cook, giving them independence and dignity, and the use of resources in the central region of the metal industry, developing kitchenware for the elderly cook. The results were limited by the lack of processing technology and knowledge, and the production concept result was difficult, because help was still needed in different professional technical areas. However, the perception of the elderly regarding the environmental impact of mass consumption products has not been evaluated. Mobile phone products fall into these.

The use of mobile phones is associated with several problems related to: the number of phones per person; the high replacement rate due to technological improvements; and the large amount of waste, which is difficult to manage correctly at the end of life due to the rare materials these contain (minerals like gold, copper, silver, antimony, and palladium, among others) [13]. Consumers such as elderly people can indirectly make requirements so that the environmental impact of using the phone is reduced.

Currently, it is unknown whether mobile phone use positively or negatively affects the social activity of the elderly. Likewise is the indirect importance given to the environment from the use of mobile phones. Therefore, this study is focused on answering the following question: Is there any relationship between the use of mobile phones, social activity, and environmental concern, among the elderly? To know that, two essential goals are pursued:

- Identify the variables that have an influence on mobile phone use and the social activity of an elderly person.
- Identify whether there is a relationship between mobile phone use and concern for the environment.

After presenting the studies that link the elderly, technology, and environment (Section 1), the method and the research tools used are presented (Section 2), where those who have taken part

(Section 2.1), the instruments used (Section 2.2), and the protocol followed (Section 2.3) are explained. The results are presented in Section 3, and Section 4 closes the paper with the discussions, conclusions, and limitations.

1.1. The Elderly and Mobile Phone Use

Technologies and services are essential for the elderly, to improve their quality of life [5]. In this context, Pedro et al. used the term gerontechnology for those technologies that help improve the quality of life, comfort, and security of the elderly and that, all in all, help them keep their independence [14]. This term has been used internationally to refer to auxiliary technologies in the health and social domains for improving the quality of life, comfort, and security of elderly people [15]. Among these are those that help their daily activities and those applications that are used through computers and mobile phones, that let them improve their relationships and quality of life. In the same way, the rapid progress of IT and, in particular, the high use of mobile phones by different age groups (in number and penetration) mean that the elderly are willing to use them more often and more naturally. In spite of this, the use of applications (apps) that would allow improving the quality of life of the elderly is still limited due to, to a great extent, the characteristics of the elderly, the individual motivation, the social setting, and the technical suitability [16].

The main difficulties for the elderly in the use of smartphones are: financial limitations, limited sight, lack of interest, and lack of knowledge about how to use technological devices and their advanced functionalities [17]. Other authors mentioned that this is really not about overriding issues, but rather that the elderly have lost abilities [18].

In spite of the age related impairment that the lack of connection with mobile phones has been attributed to, there is another group of authors who have attributed the issue to the design approach. Some authors indicate that technologies treat the elderly as passive receivers [19]. Pargaonkar et al. [20] identified factors and barriers that affect the elderly when adopting and using IT, indicating that the product and service development processes do not consider them, focusing more on young adults, who represent a higher market share. For this reason, a change in approach in technology development for the elderly is promoted, translating their problems into needs and, then, design requirements [21]. In particular, the revision of Harada et al. [22] has been focused on analyzing the issues behind the interaction of users and their mobile devices, through the evaluation of low-level interaction features, or through qualitative methods. Concluding, a representative study of "elderly users" has not been made due to the diversity of approaches there may be.

1.2. Use of Mobile Phones and the Environment

Mobile phones have become the leading mechanism for communication in the world, with over half of new sales in 2013 [23]. This has led to an acceleration in the development of new phones and their replacement rate due to obsolescence. The high rotation is worsened as the devices are not responsibly withdrawn as electronic waste [24]. Rare and precious metals included as components [25] finish their life without the possibility of being recovered, encouraging the current business model based on the collection of unused mobile phones [26]. In this way, the purchase decisions and concern with the environment of the elderly interviewed may reflect both the use patterns acquired throughout their lives and the learning achieved through the design and interaction with the products.

The profiles of users concerned about the environment have been studied based on some objects and the control of certain variables that explain, in part, their behavior. The study of Zambrano-Monserrate and Ruano [27] demonstrated that, starting from sociodemographic and descriptive variables, the level of studies and incomes were influential in the choice of reusable bags over plastic ones. If these people also take part in social activities, the use of plastic bags fell. Likewise, those who lived in cities tended to use more plastic bags than those living in rural areas. In the same way, the concern for the environment indirectly affected green consumption and was related to demographic factors, age and whether they lived in the city or in rural areas [28]. Women more often than men have claimed to: collect waste

paper and dispose of it into special containers, buy products in large packaging to minimize waste disposal, sort glass, paper, and plastics, prefer beverages in glass bottles, and take into consideration the sustainability of packaging when purchasing [29].

In this sense, Shahsavar and Kubeš [30] reviewed those parameters that could affect environmental behavior, and they found, among other results, that: Gender is considered as a significant demographic predictor for eco-friendly purchasing behavior in different studies. For example, females are the majority of green consumers and are more environmentally friendly than males. Likewise, the education and income level have a positive influence on eco-friendly behavior and eco-friendly purchasing intention along with gender and age. Marital and parental statuses are also essential variables concerning environmentally friendly consumption. Married couples and parents have greater preference towards pro-environmental knowledge, attitudes, and behaviors. Another study showed a moderate impact of marital status on eco-friendly purchasing behavior [31]. The reason for such an attitude and behavior is having potentially more stable lifestyles when it comes to habits like home ownership and joint efforts.

Regarding the impact of mobile telephone use, Suckling and Lee [21] demonstrated that there is a lack of control from the manufacturer with regard to what happens with mobiles when their service life ends. This leads them to not consider the best practices of the product end of life. They mentioned that this difficulty is based on the diversity of user profiles and their habits. However, most of the impact occurs in the extraction and manufacturing phases combined and electronic waste at the end of life [32].

Most consumers believe in "planned obsolescence" as a market fact and would like to have more durable products [33]. This is a problem for smartphones, where broken screens and poor battery performance are reported frequently. In spite of this, most phones still work when they are replaced after an average use of two years. However, short product cycles and new functionalities and features trigger replacement purchases (defined as functional and psychological obsolescence) more than broken devices. In addition, the repair needed for the products is costly due to the miniaturized product design, the built-in batteries, and the limited availability of spare parts (defined as economic obsolescence) [33].

In this regard, a study by Tröger et al. [34] identified that the causes behind no longer using a technological product are multiple and vary significantly between product categories. They are often closely linked with the reasons behind buying the replacement. In this sense, three main causes are identified: use ends due to poor technical-mechanical operation; use ends due to software issues and limited technical compatibility; use ends due to the introduction of new products: having the latest devices and "exaggerating the times".

Their lack of interest and awareness about this kind of product, as well as the loss of abilities and a differentiated physical relationship with mobile phones could make one think that the elderly could require fewer services. Changes like a simplification of the design, reduction of the amount of materials and weight, reduction of the energy consumption, and extension of the service life, among other options, could be useful in meeting the needs of their stage of the life cycle, but also a more efficient use of the product.

2. Materials and Methods

The methodology used in this research was based on three axes: usability, sustainability and social activity, which will be described in the following sections. This study is quantitative, non-experimental, using a survey as the information collection technique, with relational analytical and descriptive purposes [35].

2.1. Survey Development

The survey of usability, social activity, and the environment (USAE) was developed based on the Usefulness, Satisfaction and Ease of Use (USE) Questionnaire [36], which measures the subjective usability of a product or service. It is a 30-item survey that examines four dimensions of usability:

usefulness, ease of use, ease of learning, and satisfaction. This metric can be applied to various scenarios of usability assessment and indicates the positive and negative aspects of the interaction with products.

To include the social activities and environment domains in the study, new questions were developed by the researchers. Eight questions about social activity, referring to the "relations with other people outside their home" were included in the questionnaire. Seven new questions were included to account for environmental concerns, understood in this study as those variables that demonstrate concern for factors like the origin, use, and end of life of the single product studied based on previous questionnaires on the environment [37].

The population of interest for this study was defined as "self-reliant elderly", a definition that groups people over the age of 60 that can maintain functionality or functional independence [38], which means that they are in conditions to develop everyday activities without the special help of others [38]. Elderly people who lived in any institution and/or had mental health disorders that affected their judgment of reality (e.g. schizophrenia, etc.) were excluded from this study for ethical reasons related to the nature of this research.

For this study, self-reliant elderly people living in rural and urban areas of the Biobío region of Chile were selected, taking into account the definition of the elderly from WHO [39]. From this definition, the research was limited to those who maintained adequate levels of performance for daily activities or self-reliant elderly people [40]. Self-reliability or independence was measured on a scale that measured the degree to which the body and mind of the elderly allowed them to face aging and remain capable of independently performing day-to-day actions and feeling personal satisfaction. To evaluate this, the Older Adult Functional Exam (EFAM for its acronym in Spanish) survey was used [41], where a minimum of 43 points was needed.

Through a non-probabilistic study using quotas with a proportion allocated to each district of the region, 399 elderly people were chosen. The average age was 72.28, while 54.6% were female and 59.1% married.

Survey Validation and Testing

The USAE survey was validated by a group of 10 experts specialized in geriatrics, public health, industrial design, and psychometrics.

A pilot run of the questionnaires was done with 10 elderly people to evaluate the understanding of the instrument and the wording of the questions.

2.2. Survey Protocol

Once the final survey and the data collection procedure were prepared, they were submitted for the approval of the Ethics Committee of the University of Bío-Bío. Later, a group of interviewers was trained to perform the process face-to-face.

Before starting the survey, to obtain the explicit consent of those surveyed, they were informed about: the goals of the study, the type of participation requested, and the guarantee of voluntariness, confidentiality, anonymity of the information, and approximate time the questionnaire would take. The surveys were done over 3 months between January and March 2018.

2.3. Data Analysis

The Pearson correlation coefficient was used to evaluate the degree of relationship between the variables of interest: usability of the mobile phone, social activities, and sustainability [42]. Through the determination of the linearity assumption between two given variables as per Lalinde et al. [43], the linearity between the variables under study was established. The Pearson correlation coefficient is an index that measures the degree of covariation between different linearly related variables. This coefficient varies between -1 and +1. However, the magnitude of said relation is expressed by the value of its coefficient. If it is close to +1, it indicates a strong direct relationship between the variables

involved, while close to -1 indicates a strong inverse relationship. Meanwhile, if the coefficient is very close to zero, this means that there is no relationship between the variables. It is calculated as follows:

$$\rho = \frac{\sigma_{XY}}{\sigma_X \sigma_Y} \tag{1}$$

where: σ_{XY} is the covariance between variables X and Y;

σ_X: standard deviation of variable X

σ_Y: standard deviation of variable Y

After this, the multiple correspondences were studied to get to know visually what the joint behavior of the variables of interest was like, once they were coded [44]. For this, the variables were categorized into usability, sustainability, and social activities, with the criterion of the mean (M) ±1SD (Standard Deviation), resulting in three categories for each one of them.

- Values below M-1SD: considered the lowest (that is to say, lower usability, lower degree of awareness, and lower participation in social activities).
- Values between M-1SD and M+1SD: considered as an average level.
- Values above M+1SD: considered the highest (that is to say, higher usability, higher degree of awareness, and higher participation in social activities).

To finalize, the Spearman correlation coefficient was used to get to know the correlation between the sociodemographic and categorized variables, usability, environment, and social activities [42].

The Spearman correlation coefficient is a non-parametric coefficient alternative to the Pearson. It is used when the assumed normality is not met. The analysis was done using the STATA 11.0 SE statistical package. A value of $p < 0.05$ was considered statistically significant [45].

3. Results

From the 399 self-reliant elderly people interviewed, 45.1%% were male and 54.6% female, with ages between 60 and 99. Fifty-nine-point-one percent said they were married, while 21.3% had been widowed. With regard to the level of studies, 28.6% said that they had not finished university, while 22.8% said they had not finished secondary school, and 19.5% had not finished primary school.

Among the elderly people, 159 (39.8%) had a mobile phone. Eighty-point-five percent (n = 128) of them had chosen and bought one, while for 26 (16.4%), this was done by their child and three (1.9%) by their spouse. From these, 84 had smartphones and 72 a simple mobile, which represented 53.5% of the elderly with mobile phones.

Regarding the degree of usability of the mobile phones, it was found that the distribution of the mobile phone usability among the elderly people was average for 71.7% (n = 114) of those surveyed, while the remaining result was spread out with a limited difference between a high, 14.5% (n = 23), and low, 13.8% (n = 22), usability, as shown in Figure 1.
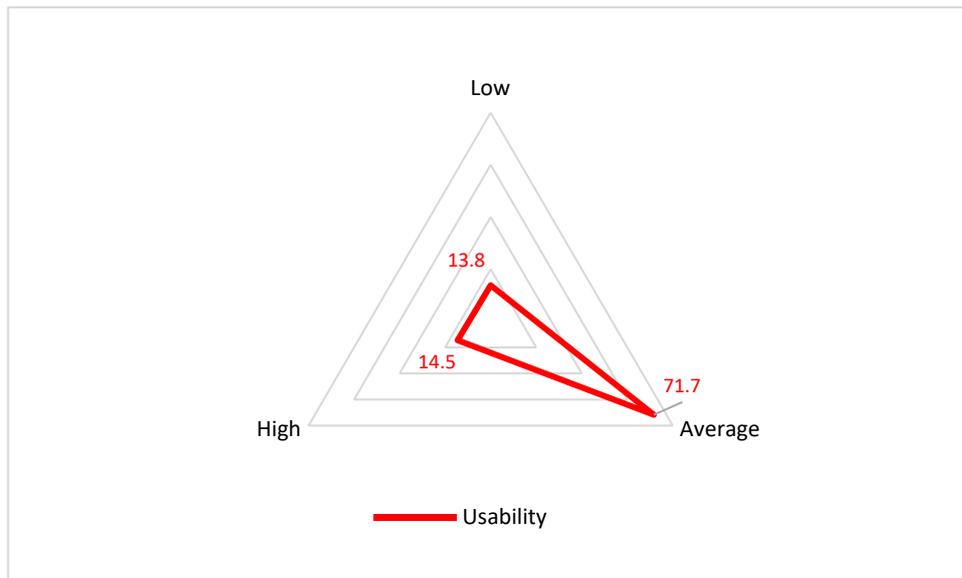
Figure 1. Use of mobile phones among the elderly.

In Figure 2, a positive correlation is detected between a high use of the mobile phone with the social activities in which the elderly people were involved ($\rho = -0.294$; *p*-value < 0.001).
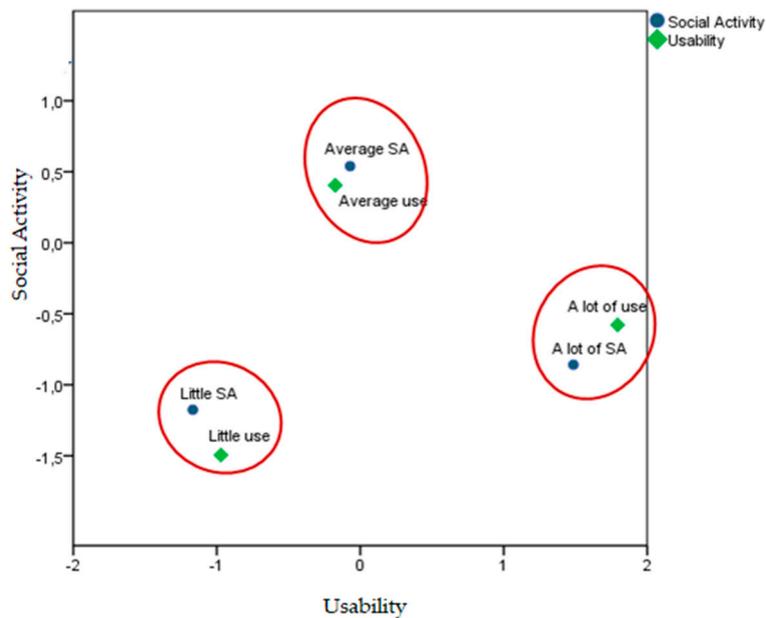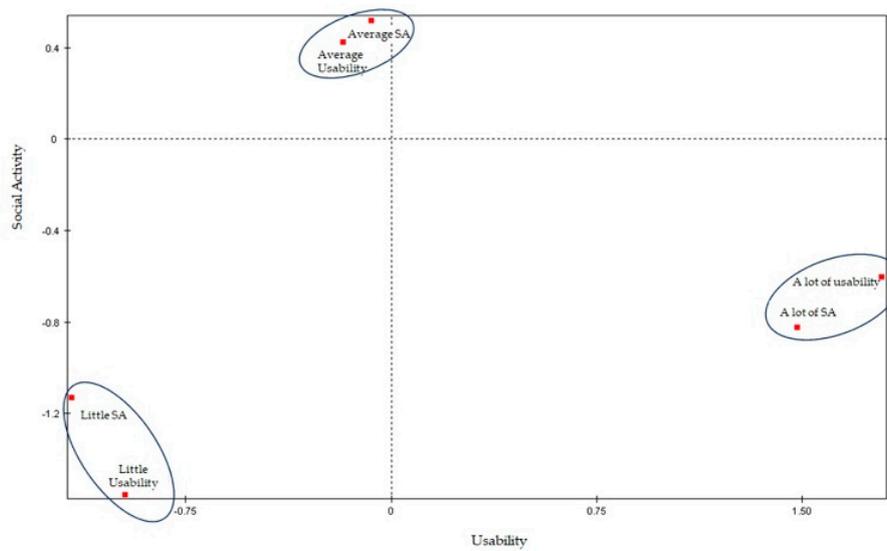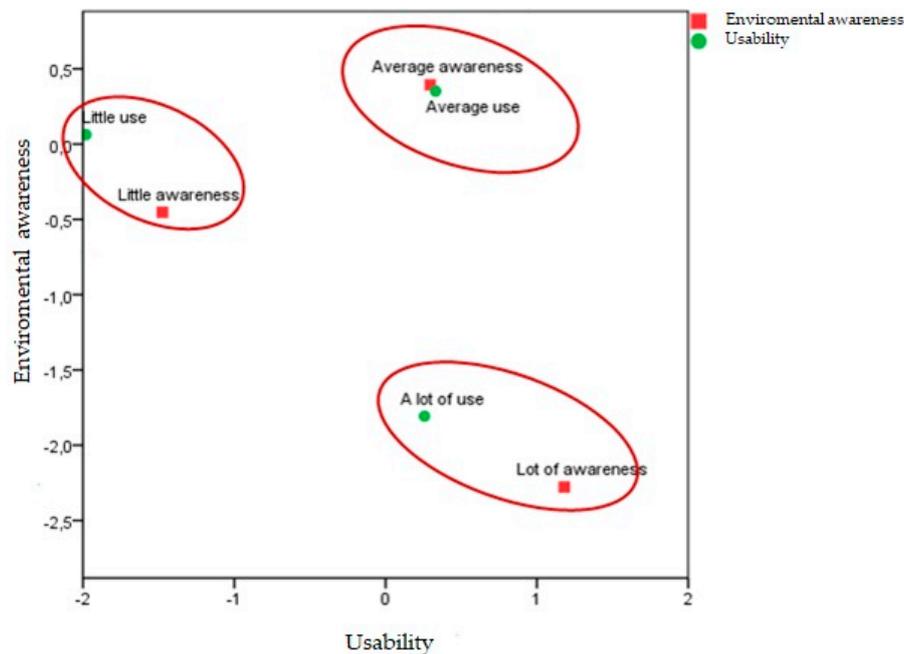

Figure 2. Correlation between the usability of the mobile and the Social Activity (SA) of the elderly.

The degree of relationship with the concern for the environment expressed by the elderly people in the survey showed that this was average for 71.1% (n = 113), followed by little with 20.8% (n = 33) and a lot with 8.2% (n = 13), as shown in Figure 3.

Figure 3. Correlation between the usability of the mobile and the concern for the environment.

The correlation of the results can be seen through the application over the studied sample of the multiple correspondence analysis (Figure 4). This visualization indicates that the level of mobile phone usability was correlated positively with the perception that the elderly people had about the environment in the variables consulted (ρ = 0.203; *p*-value < 0,05).

Figure 4. Correlation between the usability of the mobile and environmental awareness.

On Analyzing the Three Variables in Question Simultaneously

When the three variables were considered together, the individuals who had a low level of social activity had a high correlation with those who had a low usability of the mobile phone. In the same way, there was the same type of correlation with variables related to a low environmental awareness. On the other hand, the data showed that there was a high correlation between the data referring to a lot of social life, higher environmental awareness, and greater use of the mobile (Figure 5).
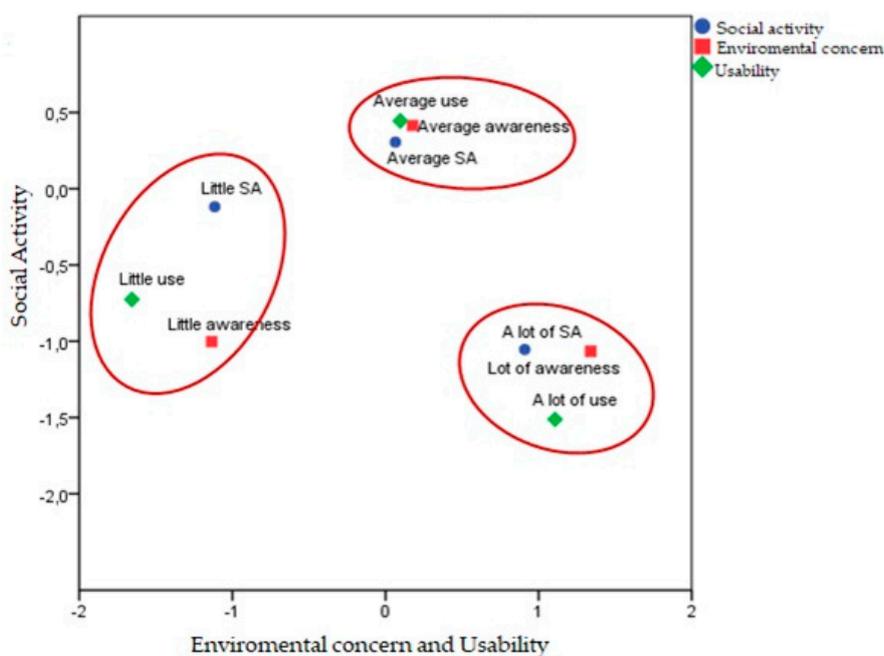
Figure 5. Correlation between usability, concern for the environment, and social activity of the elderly.

In addition, the correlation of the three variables studied, usability, environment, and social activity, with the sociodemographic variables is shown in Table 1. In this sense, a value of $p < 0.05$ was considered statistically significant [45].

Table 1. Correlation between the usability of the mobile and environmental awareness.

Variable		Usability	Social Activity	Environment
Age	Corr. Coef.	−0.248 ***	−0.128	−0.206 ***
	p-value	0.002	0.107	0.009
Gender	Corr. Coef.	0.010	0.228 ***	0.042
	p-value	0.899	0.004	0.601
Maximum education level reached	Corr. Coef.	0.150 *	0.055	0.266 ***
	p-value	0.061	0.495	0.001
Paid work	Corr. Coef.	0.082	−0.233***	−0.009
	p-value	0.311	0.003	0.910
Personal monthly income	Corr. Coef.	0.057	−0.019	0.182 **
	p-value	0.487	0.812	0.025
Monthly income per capita in the home	Corr. Coef.	0.161 *	−0.023	0.210 **
	p-value	0.056	0.783	0.012
Evaluation of own health	Corr. Coef.	0.163**	0.093	0.175 **
	p-value	0.041	0.246	0.028

Corr. Coef = Correlation Coefficient. * Significant at 10%; * *significant at 5%; *** significant at 1%.

In this sense, it showed that:

Usability: The use of the mobile phone was directly and statistically correlated with the level of education ($p = 0.061$); the income level of the home ($p = 0.056$), and the health level (0.041) and inversely with the age ($p = 0.02$), that is to say there was a higher use of mobile phones among adults with a higher level of education, higher income per capita in the home, better health, and among the "younger" ones.

Environment: With regard to environmental awareness, the behavior was very similar to the usability of the mobile, with the difference that both the personal monthly income and the per capita

income per home were significant. In this sense, the concern for the environment (limited to the variables set out in this study) was directly and statistically correlated with the level of education ($p = 0.001$), the personal level of income (0.025), the level of income in the home ($p = 0.012$), and the level of health (0.028) and inversely with the age ($p = 0.009$). That is to say, there was greater environmental awareness among the adults with a higher education, higher personal income, higher income per capita in the home, better health, and the "youngest".

Social activity: It is seen in Table 1 that social activity was directly correlated with the gender ($p = 0.004$) and inversely with the fact of having a paid job or not (0.003). If the person had a paid job or not, in this sense, the women had more social activity, as did the people who did not have a job.

4. Discussion and Conclusions

As the results showed, there was a high correlation between the perception of usability and the level of social activities the interviewees declared. It was possible to think that the mobile phone, when facing the problems related to mobility for the elderly, contributed to keeping them in contact with family and friends, in line with the technological adaptation that Shaw and Gant [6] indicated. However, it showed us that the virtuous circle that we could find between greater usability of the phones and higher social activity [14,16] was set against an opposing vicious circle: the elderly people with less social activity would also be those who would feel less prepared to use technological devices that would help them keep in interpersonal contact. This would imply a harmful feedback between both limitations, which was also shown as being associated with a limited environmental awareness.

In the same way, it was identified that elderly people showed a certain degree of sensitivity for the environment (in terms of mass consumption products). This could be analyzed as a great opportunity for the creation of sustainable business models based on material flows, adding value to the proposal of an elderly centered design, leaving behind the label of "passive receiver" mentioned by Righi et al. [19]. Likewise, a direct relationship was found between usability and environmental awareness, which showed that the adults perceived as more skillful with the mobile phones were also those who were more concerned about the environmental aspects in the product's life cycle, which may be a wake-up call for the mobile telephone business models. This relationship, which was already visible among the current elderly, where it was possible to detect a concern and interest for the environment, would probably be greater for future generations of elderly who today are passionately living their youth concerned about the effects of climate change.

It was also identified that usability was greater among the younger elderly (60 to 69), those with a higher educational level, higher incomes, and who perceived having a better health, results that were in line with Shahsavar, Kubeš, and Baran [30]. This showed that when facing devices like the mobile phone, the subjects who had greater possibilities of using and taking advantage of them were those from culturally richer settings. This relationship was related to the exposure to technology for richer and more educated subjects, as well as the complexity of stimuli that this group faced that could prepare them to use mobiles or because these factors empowered them to transcend the passive role that tends to be assigned to the elderly [19]. On the other hand, it was seen that the younger elderly people showed a greater usability (60 to 69), which may be because they were closer to middle age. This may be an advantage considering that the devices did not tend to be designed thinking about the needs of the elderly, but rather for other age groups, like those immediately prior [20].

Social activity was higher among women and among people without paid work. This first could be expected, as women resent retirement less and have networks with family, friends, and the community that are richer than men and they are more likely to remain in contact with these. However, it is unexpected that this is higher in unemployed people as the work itself is a source of interaction [46].

Finally, the environmental concern limited to the variable of this study was higher in the younger elderly (60 to 69), with a higher socioeconomic level, higher individual and family income, and better health, coinciding with the studies reviewed [27,28,30].

It is necessary to consider that the environment was identified through questions related to part of the mass consumption product's life cycle and did not consider the customs of the user. This may be because, just like the use of technologies can be mediated by the wealth and cultural complexity the individual is exposed to versus more depressed and vulnerable populations, the concern for the life cycle of a product is mediated by these cultural aspects. Likewise, this could be a generational concern, which has been emerging recently and is more evident in younger users. For this reason, it would be interesting in later studies to have evidence of whether, as expected, other younger populations (adolescents, young adults, or middle-aged adults) have a greater concern for the environment.

This study coincided with Suckling and Lee [21] regarding the need to ensure the handling of the end of the mobile phone's service life along with other products that generate a great amount of electronic waste. This must be accompanied by a greater awareness about the environmental problems that they generate throughout the life cycle. In the case of the elderly people studied here, it was clear that there was not an option that facilitated the recovery of the precious and rare metals of each handset and that the telephone companies should bear this in mind, considering the growing concern about the environment within society.

The possibility of applying the USE questionnaire generated a series of short-term results, which allowed delving deeper into the usability of the mobile phone for users located in different spaces (e.g., from their houses), at a relatively lower cost than the application of other usability measurement tools. The differences between answering a questionnaire and running a usability test could result in certain differences. The same would occur with a follow-up of the sample, to check the degree of social activity stated [36]. It should also be noted that the geographical area studied had a human development index of 0.808 [47], which could be classified as very high, a population density of 64.95 inhabitants per square kilometer, 88.6% urban population, and 17.4% older adults [48]. This implied that its results may be transferable to similar sociodemographic contexts, but research is needed to validate the hypothesis of the transferability to different contexts.

As the conclusions of this study, it can be stated that the use of the mobile phone was positively associated with the social activity of the elderly, coinciding with Pedro et al. [14] and Luo et al. [16]. It was also possible to identify a high correlation between usability, social activity, and the environment.

The results of this study showed certain limitations that have to be considered. First, it was focused on self-reliant elderly people, which made the representation of bed-ridden elderly groups and those with cognitive or severe psychiatrist issues more difficult. This left a segment of the elderly group outside the sample, even though it did include people aged between 60 and 99. In the same way, the usability, environmental concern, and social life were evaluated from the participants' own answers, which may differ in direct observation by a third party. For this reason, it is suggested to continue this study with complementary techniques like the direct observation of the usability or by triangulating the report about the elderly people's social life with a report of their companions.

A design approach for the elderly could increase satisfaction regarding the use of a product and, as a result, improve communication with their social setting. From an environmental point of view, an indirect relation was seen in the selection of the products and the use and expectations for the end of the service life that were presented.

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