# Remanufactured products – study case of bucharest employees

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**Abstract:** *The current paper wants to showcase a study referring to the remanufactured products. In this study it is analyzed the concept of remanufactured products with a focus on consumers' perception over this concept. In the 4th chapter of the article I presented the main results of the questionnaire which was taken with more than 50 employees of a Romanian company with a focus on Tourism domain (for the purpose of this research, the name of the company shall remain anonymous). The questionnaire had 3 important sections through which I analyzed the market for remanufactured products and the willingness of different groups of people (mainly individuals with a low income) to purchase such goods.*

**Key words:** remanufactured products, sustainability, Pearson Chi-Square Tests
**JEL: O14, L15, L63, F63, F64**

## 1. Introduction

A major interest in the 1990s was represented by the activities of economic agents in relation to the environment (Seuring, et al., 2008). In the context of the supply chain, various measures have been taken to study environmental issues (Carter and Rogers, 2008; Hassini, et al., 2012; Seuring, 2013; Seuring and Müller, 2008; Srivastava, 2007). The concept of closed loop supply chain (CLSC) has been a major interest for both researchers and people specializing in the field (Guide and Van Wassenhove, 2009; Ilgin and Gupta, 2010; Pokharel and Mutha, 2009; Rubio, et al., 2008). Examining the CLSC concept is a challenge that must be researched and analyzed in its relations with the market and consumers - most of the issues analyzed in the literature have been addressed from the end-of-life (EOL) and end-of-use (EOU) product offer. Numerous research papers are focused on the flow of goods from the consumer back to the manufacturer or the recovery agent, for example, EOU collection, return, value recovery, 3-R (reduction, reuse, recycling), inventory management, etc. But there have been little studies in issues such as the marketing of recovered products, their acceptance by consumers, the existence of new markets for these products and how companies can promote these markets, what marketing strategies are best for this purpose or what type of consumer should be targeted.

This research paper aims to provide a contribution by analyzing the consumer behavior of a remanufactured product and their willingness to contribute with a positive impact on the environment by raising awareness of CLSC and educating them on these alternative products. To this end, a survey was conducted of potential consumers of a remanufactured product (laptops and mobile phones), the aim being to identify the key factors that "define" a profile for this type of consumer, from which companies can design and implement the most appropriate marketing strategies.

## 2. Literature review

The circular economy (EC) can be outlined as a concept whose implementation results in reduced consumption of raw materials, thinking and design of products so that they can be easily disassembled and reused after use (ecological design), extending the life of products by maintenance and repairs, the use of recyclable materials in products and the recovery of raw materials from the waste stream (van Buren, et al., 2016) with a special focus on urban and industrial waste, in order to achieve a better balance and harmony between economy, environment and society (Ghisellini, et al., 2016) and business excellence (Toma and Naruo, 2017; Toma and Marinescu, 2018; Tohanean and Toma, 2018). Remanufacturing and similar concepts are included in the broader topic of the circular economy, EC analyzing resource and waste flows within and across supply chains (Genovese, et al., 2017). The concept of remanufacturing represents a sustainable production strategy while impacting the environment at a minimum and can benefit different stakeholders. Numerous brands such Apple, Boeing, Cisco, Caterpillar and others have successfully integrated remanufacturing into their operations and supply chain management (Krikke, et al., 2004; Ovchinnikov, et al., 2014; Qian, et al., 2019), but not all consumers believe in the quality of remanufactured products – this represents a barrier to advancing remanufacturing on the economic market. (Zhang, et al., 2011; Shaharudi,n et al., 2015; Khora and Hazen, 2017).

### 3. Research methodology

Online research is research based on non-probabilistic sampling methods. This means that they do not start from a pre-established sampling base that ensures representativeness. From the point of view of the sampling technique, guided sampling is used, through which the researcher consciously includes in the sample, the units subjectively chosen according to the known characteristics of the population from which the sample is to be extracted. In the case of online surveys, one method of guided sample formation is the voluntary method. The inclusion in the sample is made on the basis of the voluntary option of the subjects to participate in the research. Basically, the method consists in publishing an online questionnaire form and an invitation to respond. Under these conditions, there is the problem of statistical inference, which becomes impossible to achieve since the bias selection method is present and the representativeness of those who responded cannot be known. Thus, the research results will not be able to be extrapolated to the whole community. However, although the risk of misestimating the real parameters of the population is impossible to calculate, we can rely on this kind of research to obtain indications instead of estimators, regarding the real population (Callegaro, Manfreda, and Vehovar, 2015 ). Given all these methodological limitations, in recent years, research through online surveys has become quite common. The literature mentions as main advantages access to unique populations, time savings, low costs (Wright, 2005). Although we cannot extrapolate the results to the entire population of young people in Romania, we believe that this study can be a starting point for new research directions to address the issue of product remanufacturing.

The systematization of the survey data is done with the help of frequency tables. These will show the distribution of the answers both as frequency (number) and as Percentage, the graphical representation of the results is done with the help of bar graphs.

In the following section, it is presented the objectives and hypotheses of the paper.

**Objectives**

1. Given this context, the principal objective of the present work is to make a first approach to determining basic characteristics of the profile of potential consumers of remanufactured products, so that interested firms may have a solid base of information on which to establish their policies for the development and strengthening of these markets.

2. Thereby, one will not only be endowing the process of recovery of EOU products with economic meaning (financial profit, remanufacturing to sell), but also actually closing the CLSC cycle by putting recovered products back on the market.

3. Overall awareness of remanufactured products. Comparison with usual products.

**Hypotheses:**

1. A favorable attitude towards purchasing a remanufactured laptop will positively influence the purchase intention for that class of remanufactured product. (To measure this variable, the respondents were asked to score on a 5-point Likert scale their predisposition to purchasing this type of product.)

2. A favorable Subjective Norm towards purchasing a remanufactured laptop will positively influence the purchase intention for that class of remanufactured product. (The variable Motivations (M) was evaluated by a scale based on a review of the literature identifying the main

reasons that might influence the consumption of remanufactured products: technology, price, environment)

3. The level of Motivations towards purchasing a remanufactured laptop will positively influence the purchase intention for that class of remanufactured product. For the Marketing Mix Variables (MMV), the respondents were asked to indicate what level of importance the four indicators used in this scale (price, product, promotion, and distribution) had for them.

4. There is a relationship between the Marketing Mix Variables for remanufactured laptop marketing and the purchase intention for these remanufactured products.

5. Perceived value associated with remanufactured products positively influences intention to purchase remanufactured products.

6. Knowledge regarding the lower cost of remanufactured Products is positively related to perceived value of remanufactured products.

### 4. Results and discussion

When the data made available to the researcher is survey data, the link between them can be highlighted with the help of association tables, or contingency tables.

We refer to the association when analyzing the simultaneous distribution of statistical observations by two or more qualitative characteristics that can be nominal or ordinal (Rotariu, Culic and Bădescu 2006.) The matrix of frequency distributions for the observed variables can be called contingency table or association table. Contingency tables thus allow us to analyze the behavior of the observed units (individuals, in the case of survey data) by a certain variable. The purpose of the analysis is to identify and describe the link between the variables included in the contingency table. Between two categorical variables, nominal or ordinal, we can say that there is an association, a link, when the distribution of the response variable changes with the change of the explanatory variable (Asandului 2010).

In the case of bivariate analysis (we consider the connection of two variables), it is important that before the actual analysis, to distinguish between the dependent variable (response variable) and the independent variable (explanatory variable). The dependent variable is the variable whose categories are compared. As a rule, in the contingency table it will make up the columns. The independent variable is the variable that, we assume, can explain the variation of the response variable. It will form the rows of the contingency table.

When distinguishing between the dependent variable and the independent variable, conditional probabilities are formed for the categories of the dependent variable. The sum of the conditional probabilities on each line is 1 or 100%. When the existence of an association is established between two variables, it means that the probabilities of occurrence of a certain result in the dependent variable depend on the value of the independent variable. There is an association between two vector variables if a certain value of one variable is more likely to occur in case of certain values of the other variable (Asandului, Statistical methods of analysis of categorical data 2010). It should be noted that the association between two variables is not equivalent to the existence of a causal relationship between the two variables (Agresti, 1996).

Two variables are considered to be statistically independent if the conditional distributions of the dependent variable are identical at each level of the independent variable. When two variables are independent, the probability of a certain result of column j is the same in each row (Agresti, 1996).

A common procedure for testing the independence of two categorical variables is to calculate Pearson test statistics $\chi 2$ (Chi-Square). The test was first created by statistician Karl Pearson in 1900. The null hypothesis of the independence test is given by comparing the observed frequencies with the expected frequencies:

To estimate the expected frequencies, the proportion of the sample for unknown marginal probabilities is replaced by providing:

$$\hat{\mu}_{ij} = np_{i+}p_{+j} = n\left(\frac{n_{i+}}{n}\right)\left(\frac{n_{+j}}{n}\right) = \frac{n_{i+}n_{+j}}{n}$$

This is the total of the lines for the cell multiplied by the total of the column for the cell, divided by the total size of the sample. {μij} are called estimated expected frequencies. They have the same values for total rows and total columns, but display a pattern of independence.

To test the independence of variables in IxJ form contingency tables, Person statistics are calculated according to the formula.

$$X^2 = \sum \frac{(n_{ij} - \hat{\mu}_{ij})^2}{\hat{\mu}_{ij}}$$

It is important to note that the test statistic $\chi 2$ does not provide information on the size or nature of the association between the variables. It also treats the variables as nominal ignoring the information related to the order (Asandului 2010, Agresti 1996). Therefore, in the case of survey data, in which the answers are recorded by ordinal scales to use coefficients specific to the ordinal variables. In the case of these types of data, a trend component is also present, as the level of the explanatory variable increases, the responses of the dependent variable tend to decrease to lower levels (Agresti, 1996).

The non-parametric Spearman correlation coefficient, also called the rank correlation coefficient, is calculated to describe the intensity and direction of the association between two ordinal categorical variables.

In interpreting this indicator we can talk about the existence of a sign that denotes the nature of the association and a size as an indicator of the intensity of the connection. The range of variation of the coefficient values is [-1, +1], where the value 1 means that there is no discrepancy and the value -1 when the number of concordances is 0. When the number of concordances is equal to the number of discrepancies the value of the coefficient is 0 ( Rotariu, Culic and Bădescu, 2006; Asandului 2010). This situation is equivalent to the independence between the two variables.

*Hypothesis 1: there is a positive relationship between the degree of study and question no. 3 and no. 6 (section 3)*

| | | Education level | | | | | | | | |
| | | Less than high school degree | | High school degree | | Some college | | Bachelor's degree | | Master's degree or higher | |
| | | Count | Column N % | Count | Column N % | Count | Column N % | Count | Column N % | Count | Column N % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | no | 0 | 0.0% | 0 | 0.0% | 1 | 20.0% | 5 | 11.9% | 5 | 9.8% |
| | Yes | 0 | 0.0% | 6 | **85.7%** | 3 | 60.0% | 26 | 61.9% | 33 | 64.7% |
| | I am not sure. | 0 | 0.0% | 1 | 14.3% | 1 | 20.0% | 11 | 26.2% | 13 | 25.5% |
| Do you consider the remanufactured product as reliable? | Strongly agree | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 2.4% | 1 | 2.0% |
| | Agree | 0 | 0.0% | 3 | 42.9% | 0 | 0.0% | 9 | 21.4% | 16 | 31.4% |
| | Slightly agree | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Neither agree or disagree | 0 | 0.0% | 3 | **42.9%** | 3 | **60.0%** | 23 | **54.8%** | 24 | 47.1% |
| | Slightly disagree | 0 | 0.0% | 1 | 14.3% | 2 | 40.0% | 8 | 19.0% | 9 | 17.6% |
| | Disagree | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 2.0% |
| | Strongly disagree | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 1 | 2.4% | 0 | 0.0% |

The percentages at the level of variables are interpreted where a higher value is observed in bold.

The evaluation of the association between ordinal categorical variables is done using the Chi-Square independence test.

*Pearson Chi-Square Tests*

| | | Education level |
|---|---|---|
| After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | Chi-square | 2.217 |
| | df | 6 |
| | Sig. | .899[a,b] |
| Do you consider the remanufactured product as reliable? | Chi-square | 7.445 |
| | df | 15 |
| | Sig. | .944[a,b] |

Results are based on nonempty rows and columns in each innermost sub table.

a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

b. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

For the Pearson Chi Square independence test we note that P> 0.05 there is no link between the level of education and the variables analysed.

To establish the direction and intensity of the relationship, the correlation coefficient of the Spearman ranks is used.

For the Spearman correlation coefficient, we notice that P> 0.05 there is no connection between the level of education and the analysed variables.

| | | | After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | Do you consider the remanufactured product as reliable? |
|---|---|---|---|---|
| Spearman's rho | Education level | Correlation Coefficient | .031 | -.078 |
| | | Sig. (2-tailed) | .751 | .429 |
| | | N | 105 | 105 |

Hypothesis 1 is not validated.

*Hypothesis 2: there is a positive relationship between the respondents' degree of education and question no. 9 (section 3)*

| | | | Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? | | | |
|---|---|---|---|---|---|---|
| | | | 0 | Yes | No | Maybe |
| Education level | Less than high school degree | Count | 0 | 0 | 0 | 0 |
| | | Column N % | 0.0% | 0.0% | 0.0% | 0.0% |
| | High school degree | Count | 0 | 2 | 0 | 5 |
| | | Column N % | 0.0% | 28.6% | 0.0% | 71.4% |
| | Some college | Count | 0 | 2 | 0 | 3 |
| | | Column N % | 0.0% | 40.0% | 0.0% | 60.0% |
| | Bachelor's degree | Count | 4 | 25 | 0 | 13 |
| | | Column N % | 9.5% | 59.5% | 0.0% | 31.0% |
| | Master's degree or higher | Count | 3 | 30 | 0 | 18 |
| | | Column N % | 5.9% | 58.8% | 0.0% | 35.3% |

**Pearson Chi-Square Tests**

| | | Education level |
|---|---|---|
| Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? | Chi-square | 6.090 |
| | df | 6 |
| | Sig. | .413[a,b] |

Results are based on nonempty rows and columns in each innermost sub table.

a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

b. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

For the Pearson Chi Square independence test we notice that P> 0.05 there is no connection between the level of education and the analysed variables.

| | | | Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? |
|---|---|---|---|
| Spearman's rho | Education level | Correlation Coefficient | -.092 |
| | | Sig. (2-tailed) | .353 |
| | | N | 105 |

For the Spearman correlation coefficient, we notice that P> 0.05 there is no connection between the level of education and the analysed variables.

Hypothesis 2 is not validated.

*Hypothesis 3:*

*Option A: there is a positive relationship between how much respondents spend on a laptop phone (in 5 and 6 section 2) of respondents and their decision to buy a remanufactured product (in no. 3 section 3).*

| | | After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | | |
|---|---|---|---|---|
| | | No | Yes | I am not sure. I have to read more about this subject. |
| | | Column N % | Column N % | Column N % |
| How much money have you spent on a phone? | <200 euro | 0.0% | 0.0% | 0.0% |
| | 200 – 400 euro | 54.5% | 55.9% | 76.9% |
| | 400 – 600 euro | 36.4% | 25.0% | 15.4% |
| | >600 euro | 9.1% | 19.1% | 7.7% |
| How much money have you spent on a laptop? | <200 euro | 0.0% | 2.9% | 0.0% |
| | 200 – 400 euro | 36.4% | 16.2% | 53.8% |
| | 400 – 600 euro | 36.4% | 51.5% | 30.8% |
| | >600 euro | 27.3% | 29.4% | 15.4% |

*Pearson Chi-Square Tests*

| | | After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? |
|---|---|---|
| How much money have you spent on a phone? | Chi-square | 4.909 |
| | df | 4 |
| | Sig. | .297a |
| How much money have you spent on a laptop? | Chi-square | 14.537 |
| | df | 6 |
| | Sig. | .024a,*,c |

Results are based on nonempty rows and columns in each innermost sub table.

*. The Chi-square statistic is significant at the 0.05 level.

a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

c. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

For the Pearson Chi Square independence test we notice that P> 0.05 there is no connection between the variable "how much money have you spent on a phone" and the decision to buy.

There is, however, an association between how much they are willing to spend for a laptop and the decision to buy: Chi-square = 14,537, p <0.05 the Spearman correlation coefficient allows us to see the meaning of the connection between the amount spent on a laptop and the decision to buy (rho = - 0.195, p <0.05) There is a negative link of low intensity between the purchase decision and how much they would be willing to spend for a laptop.

The more they are willing to spend, the more undecided they are to buy a manufactured product.

| | | | How much money have you spent on a laptop? | How much money have you spent on a phone? |
|---|---|---|---|---|
| Spearman's rho | After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | Correlation Coefficient | -.195* | -.159 |
| | | Sig. (2-tailed) | .046 | .105 |
| | | N | 105 | 105 |

Hypothesis 3 has been partially validated.

*Hypothesis 4*

*Option B: It means that those who have a lower income (the question in section 1 about income can also be considered) are more likely to look for information / to buy remanufactured products (another correlation may be between item No. 6, section 1 and in no. 9 section 3).*

| | | Income | | | | |
|---|---|---|---|---|---|---|
| | | <500 euro Column N% | 500 -1000 euro Column N% | 1000- 1500 euro Column N % | >1500 euro Column N% | NA Column N% |
| After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | no | 0.0% | 11.9% | 11.1% | 0.0% | 13.3% |
| | Yes | 63.6% | 65.7% | 77.8% | 100.0% | 46.7% |
| | I am not sure. I have to read more about this subject. | 36.4% | 22.4% | 11.1% | 0.0% | 40.0% |
| Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? | 0 | 0.0% | 6.0% | 11.1% | 0.0% | 13.3% |
| | Yes | 63.6% | 56.7% | 66.7% | 66.7% | 40.0% |
| | No | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| | Maybe | 36.4% | 37.3% | 22.2% | 33.3% | 46.7% |

**Pearson Chi-Square Tests**

| | | Income |
|---|---|---|
| After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? | Chi-square | 6.881 |
| | df | 8 |
| | Sig. | .550[a,b] |
| Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? | Chi-square | 4.215 |
| | df | 8 |
| | Sig. | .837[a,b] |

Results are based on nonempty rows and columns in each innermost sub table.

a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

b. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

| | | | Are you willing to research about remanufactured products and take them into consideration before purchasing a mobile phone and/or laptops? | After reading the definition above, do you think it is better to purchase a product that affects the environment less than a product which has the same specifications, but requires more virgin raw materials? |
|---|---|---|---|---|
| Spearman's rho | Income | Correlation Coefficient | -.024 | -.037 |
| | | Sig. (2-tailed) | .804 | .707 |
| | | N | 105 | 105 |

For the Pearson Chi Square independence test we notice that P> 0.05 there is no connection between the income level and the analysed variables. For the Spearman correlation coefficient, we notice that P> 0.05 there is no connection between the income level and the analysed variables.

Hypothesis 4 B is invalidated.

*Hypothesis 5: there is a positive relationship between the decision makers to buy a product (entry No. 7, section 2) and consumer confidence in remanufactured products (entry No. 6, section 3 or question No. 7 section 3, by that I want to show the consumers' perception of the different characteristics that remanufactured products have).*

*Hypothesis 5: there is a positive relationship between the decision makers to buy a product (entry No. 7, section 2) and consumer confidence in remanufactured products (entry No. 6, section 3 or question No. 7 section 3, by that I want to show the consumers' perception of the different characteristics that remanufactured products have).*

| | | Do you consider the remanufactured product as reliable? | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | | Strongly agree | Agree | Slightly rae | Neither agree or disagree | Slightly disagree | Disagree | Strongly disagree |
| | | Column N % | Column N % | Column N % | Column N % | Column N % | Column N % | Column N % |
| Product sustainability over time | 1 | 0.0% | 0.0% | 0.0% | 3.8% | 5.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 0.0% | 0.0% | 7.5% | 0.0% | 0.0% | 100.0% |
| | 3 | 50.0% | 25.0% | 0.0% | 13.2% | 20.0% | 0.0% | 0.0% |
| | 4 | 0.0% | 25.0% | 0.0% | 28.3% | 25.0% | 0.0% | 0.0% |
| | 5 | 50.0% | 50.0% | 0.0% | 47.2% | 50.0% | 100.0% | 0.0% |
| Price | 1 | 0.0% | 3.6% | 0.0% | 0.0% | 0.0% | 0.0% | 100.0% |
| | 2 | 0.0% | 0.0% | 0.0% | 3.8% | 10.0% | 0.0% | 0.0% |
| | 3 | 0.0% | 14.3% | 0.0% | 24.5% | 20.0% | 0.0% | 0.0% |
| | 4 | 50.0% | 50.0% | 0.0% | 34.0% | 30.0% | 0.0% | 0.0% |
| | 5 | 50.0% | 32.1% | 0.0% | 37.7% | 40.0% | 100.0% | 0.0% |
| Product specifications | 2 | 0.0% | 3.6% | 0.0% | 3.8% | 5.0% | 0.0% | 100.0% |
| | 3 | 0.0% | 3.6% | 0.0% | 11.3% | 25.0% | 0.0% | 0.0% |
| | 4 | 50.0% | 21.4% | 0.0% | 39.6% | 35.0% | 0.0% | 0.0% |
| | 5 | 50.0% | 71.4% | 0.0% | 45.3% | 35.0% | 100.0% | 0.0% |
| Customer reviews | 1 | 0.0% | 0.0% | 0.0% | 1.9% | 5.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 7.1% | 0.0% | 13.2% | 10.0% | 0.0% | 100.0% |
| | 3 | 0.0% | 25.0% | 0.0% | 17.0% | 20.0% | 100.0% | 0.0% |
| | 4 | 0.0% | 28.6% | 0.0% | 45.3% | 35.0% | 0.0% | 0.0% |
| | 5 | 100.0% | 39.3% | 0.0% | 22.6% | 30.0% | 0.0% | 0.0% |
| Build quality | 1 | 0.0% | 0.0% | 0.0% | 0.0% | 5.0% | 0.0% | 100.0% |
| | 2 | 0.0% | 0.0% | 0.0% | 5.7% | 10.0% | 0.0% | 0.0% |
| | 3 | 0.0% | 10.7% | 0.0% | 13.2% | 20.0% | 0.0% | 0.0% |
| | 4 | 50.0% | 50.0% | 0.0% | 41.5% | 45.0% | 100.0% | 0.0% |
| | 5 | 50.0% | 39.3% | 0.0% | 39.6% | 20.0% | 0.0% | 0.0% |
| Brand | 1 | 0.0% | 3.6% | 0.0% | 7.5% | 0.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 10.7% | 0.0% | 13.2% | 25.0% | 0.0% | 100.0% |
| | 3 | 0.0% | 39.3% | 0.0% | 24.5% | 25.0% | 0.0% | 0.0% |
| | 4 | 50.0% | 32.1% | 0.0% | 32.1% | 30.0% | 0.0% | 0.0% |
| | 5 | 50.0% | 14.3% | 0.0% | 22.6% | 20.0% | 100.0% | 0.0% |

*Pearson Chi-Square Tests*

| | | Do you consider the remanufactured product as reliable? |
|---|---|---|
| Product sustainability over time | Chi-square | 28.944 |
| | df | 20 |
| | Sig. | .089[a,b] |
| Price | Chi-square | 61.665 |
| | df | 20 |
| | Sig. | .000[a,b,*] |
| Product specifications | Chi-square | 31.906 |
| | df | 15 |
| | Sig. | .007[a,b,*] |
| Customer reviews | Chi-square | 22.567 |
| | df | 20 |
| | Sig. | .311[a,b] |
| Build quality | Chi-square | 61.240 |
| | df | 20 |
| | Sig. | .000[a,b,*] |
| Brand | Chi-square | 17.294 |
| | df | 20 |
| | Sig. | .634[a,b] |

Results are based on nonempty rows and columns in each innermost sub table.

*. The Chi-square statistic is significant at the .05 level.

a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid.

b. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

For the Pearson Chi Square independence test we notice a P> 0.05 for Price, Product specifications, Build quality, there is an association between the belief that remanufactured products are reliable and these 3 factors.

| | | Do you consider that such products contain different features than the usual ones? | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Strongly agree Column N % | Agree Column N % | Slightly agree Column N % | Neither agree or disagree Column N % | Slightly disagree Column N % | Disagree Column N % | Strongly disagree Column N % |
| Product sustainability over time | 1 | 0.0% | 0.0% | 0.0% | 3.0% | 4.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 0.0% | 0.0% | 6.1% | 0.0% | 14.3% | 0.0% |
| | 3 | 0.0% | 14.3% | 0.0% | 18.2% | 24.0% | 0.0% | 0.0% |
| | 4 | 0.0% | 42.9% | 0.0% | 25.8% | 24.0% | 14.3% | 0.0% |
| | 5 | 0.0% | 42.9% | 0.0% | 47.0% | 48.0% | 71.4% | 0.0% |
| Price | 1 | 0.0% | 14.3% | 0.0% | 0.0% | 0.0% | 14.3% | 0.0% |
| | 2 | 0.0% | 14.3% | 0.0% | 1.5% | 8.0% | 0.0% | 0.0% |
| | 3 | 0.0% | 14.3% | 0.0% | 21.2% | 24.0% | 0.0% | 0.0% |
| | 4 | 0.0% | 14.3% | 0.0% | 40.9% | 32.0% | 42.9% | 0.0% |
| | 5 | 0.0% | 42.9% | 0.0% | 36.4% | 36.0% | 42.9% | 0.0% |
| Product specifications | 2 | 0.0% | 14.3% | 0.0% | 1.5% | 8.0% | 14.3% | 0.0% |
| | 3 | 0.0% | 0.0% | 0.0% | 12.1% | 16.0% | 0.0% | 0.0% |
| | 4 | 0.0% | 42.9% | 0.0% | 39.4% | 24.0% | 0.0% | 0.0% |
| | 5 | 0.0% | 42.9% | 0.0% | 47.0% | 52.0% | 85.7% | 0.0% |
| Customer reviews | 1 | 0.0% | 0.0% | 0.0% | 1.5% | 4.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 14.3% | 0.0% | 13.6% | 0.0% | 28.6% | 0.0% |
| | 3 | 0.0% | 28.6% | 0.0% | 16.7% | 24.0% | 28.6% | 0.0% |
| | 4 | 0.0% | 0.0% | 0.0% | 37.9% | 52.0% | 14.3% | 0.0% |
| | 5 | 0.0% | 57.1% | 0.0% | 30.3% | 20.0% | 28.6% | 0.0% |
| Build quality | 1 | 0.0% | 0.0% | 0.0% | 1.5% | 0.0% | 14.3% | 0.0% |
| | 2 | 0.0% | 14.3% | 0.0% | 4.5% | 4.0% | 0.0% | 0.0% |
| | 3 | 0.0% | 0.0% | 0.0% | 16.7% | 12.0% | 0.0% | 0.0% |
| | 4 | 0.0% | 42.9% | 0.0% | 45.5% | 48.0% | 28.6% | 0.0% |
| | 5 | 0.0% | 42.9% | 0.0% | 31.8% | 36.0% | 57.1% | 0.0% |
| Brand | 1 | 0.0% | 0.0% | 0.0% | 7.6% | 0.0% | 0.0% | 0.0% |
| | 2 | 0.0% | 0.0% | 0.0% | 16.7% | 16.0% | 14.3% | 0.0% |
| | 3 | 0.0% | 42.9% | 0.0% | 24.2% | 28.0% | 42.9% | 0.0% |
| | 4 | 0.0% | 28.6% | 0.0% | 31.8% | 28.0% | 42.9% | 0.0% |
| | 5 | 0.0% | 28.6% | 0.0% | 19.7% | 28.0% | 0.0% | 0.0% |

Regarding the variable "Do you consider that such products contain different features than the usual ones? "

No association relations are identified with the factors, p> 0.05 for each of the 6 factors, hypothesis 5 is invalidated.

*Pearson Chi-Square Tests*

| | | Do you consider that such products contain different features than the usual ones? |
|---|---|---|
| Product sustainability over time | Chi-square | 7.438 |
| | df | 12 |
| | Sig. | .827[a,b] |
| Price | Chi-square | 20.729 |
| | df | 12 |
| | Sig. | .054[a,b] |
| Product specifications | Chi-square | 12.642 |
| | df | 9 |
| | Sig. | .179[a,b] |
| Customer reviews | Chi-square | 14.637 |
| | df | 12 |
| | Sig. | .262[a,b] |
| Build quality | Chi-square | 12.222 |
| | df | 12 |
| | Sig. | .428[a,b] |
| Brand | Chi-square | 8.283 |
| | df | 12 |
| | Sig. | .763[a,b] |

Results are based on nonempty rows and columns in each innermost sub table.

a. More than 20% of cells in this subtable have expected cell counts less than 5. Chi-square results may be invalid.

b. The minimum expected cell count in this sub table is less than one. Chi-square results may be invalid.

I have also calculated the Spearman correlation coefficient to identify the nature and intensity of the association between the variables.

The scale for measuring the importance of the factors is from 1 to 5 with 5 the highest value, and to measure the agreement a Likert scale was used from 1 to 7 with 1 being total agreement and 7 total disagreement.

Therefore, a high score for importance corresponds to a low score for agreement which means that in the correlation table below the correlations will have the minus sign - which will mean in relation to our data a positive association.

To conclude:

Those who consider remanufactured products to be reliable will give more importance to:

Produc specifications (rho = -0.271, p <0.05) and,

Brand Quality (rho = -0.229, p <0.05)

These are the only significant correlations identified, the hypothesis partially validated.

| | | Product sustainability over time | Price | Product specifications | Customer reviews | Build quality | Brand |
|---|---|---|---|---|---|---|---|
| Do you consider the remanufactured product as reliable? | Correlation Coefficient | -.022 | -.043 | -.271** | -.162 | -.229* | -.019 |
| | Sig. (2-tailed) | .822 | .663 | .005 | .098 | .019 | .846 |
| | N | 105 | 105 | 105 | 105 | 105 | 105 |
| Do you consider that such products contain different features than the usual ones? | Correlation Coefficient | .051 | .006 | .077 | -.080 | .068 | -.001 |
| | Sig. (2-tailed) | .608 | .951 | .434 | .415 | .491 | .990 |
| | N | 105 | 105 | 105 | 105 | 105 | 105 |

Hypothesis 6: There is a positive (awareness / knowledge) relationship between question no. 1 and no. 2 (both section 3)

"Awareness" is a variable with multiple answers that is not suitable for a correlation analysis. Association tables can be made.

| | | Have you heard of this concept before? | | |
|---|---|---|---|---|
| | | no | yes | maybe |
| | | Column Response % (Base: Count) | Column Response % (Base: Count) | Column Response % (Base: Count) |
| $DEFINITIONS | Refurbished | 20.0% | 44.4% | 16.0% |
| | Recondition | 48.6% | 57.8% | 48.0% |
| | Restore | 37.1% | 31.1% | 32.0% |
| | Re-used / Used | 28.6% | 13.3% | 24.0% |
| | Repair | 37.1% | 37.8% | 24.0% |
| | Recycled | 20.0% | 24.4% | 40.0% |
| | Upgrade / Upcycling to state-of-art technology / Rebuilt | 31.4% | 26.7% | 48.0% |

### 5. Conclusions

This paper sought to analyse consumers' perceptions of remanufactured electronic products, specifically mobile phones and laptops, and their willingness to consider them to protect the environment (as a triggering factor). In addition to demographic factors (age, gender, level of education), I considered some questions about the costs they incurred when buying new products versus remanufactured products (if any), factors they take into consideration when deciding to buy electronic products, if they have heard about the concept of remanufacturing, etc. Because of the lack of respondents, many hypotheses were invalidated, therefore future research should seek to incorporate longitudinal or event studies to gain added insights into consumer perceptions of remanufactured product quality in before-and-after scenarios that introduce additional phenomena.

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