REUSE OF ELECTRONIC EQUIPMENT AND SOFTWARE INSTALLED ON THEM – AN EXPLORATORY ANALYSIS IN THE CONTEXT OF CIRCULAR ECONOMY

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Abstract
The transition to a circular economy in which the value of products, materials and resources is maintained as long as possible and the waste is minimized, has led to the creation of new business opportunities and new, innovative and efficient production and consumption models. Over the last few years, the principles of the circular economy have been gradually integrated into several sectors, the consumer electronics industry being such an example. The applicability of the circular economy principles in this sector has been presented in the literature, but these approaches have taken into account, in particular, the physical, tangible components of electronic products, focusing on the existing interrelationships between the circular economy and the production and use of electronic devices and equipment. Given that electronic products often incorporate intangible components, namely the software necessary for their operation, we have chosen to address in this paper the problems of the circular economy from this perspective, the purpose of this paper being to emphasize the relation between the use of software products and the principles of circular economy.

Thus, the paper presents the main opportunities and challenges that circular economy involves for all stakeholders, namely manufacturers of electronic goods and developers of the related software and their users. In order to determine the way consumers capitalize the possibilities to reuse the software components of IT products they use (computers, tablets, mobile phones), we have undertaken an exploratory research that took place between October and November 2017 on the basis of a structured questionnaire posted online and applied to Romanian young people, the number of respondents being 257. Research has shown the respondents easily adapt to new versions of software when they change their phone or laptop and there is a frequent transfer of equipment without considering the possibilities of reuse the software because when the respondents alienate these devices also delete the installed software.

Keywords: circular economy, electronic equipment, software, software license, free and open source software (FOSS).

JEL Classification: L17, L63, L86.

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Introduction

One of the most promising paradigms that has emerged in recent years is the circular economy. Murray, Skene and Haynes (2017) suggest that the circular economy is the latest attempt to conceptualize the integration of economic activity with environmental concerns and the use of resources in a sustainable way. The concept refers to a continuous development cycle that conserves and improves natural capital, optimizes and capitalizes resources, and minimizes risks through efficient management of finished stocks and renewable resource flows (Ellen MacArthur Foundation - EMF, 2015). However, a circular economy is not just a paradigm shift by reference to repairing, reusing, refurbishing, recycling and remanufacturing; it is also about the redesign of the future economy and society through new business models and new consumption behaviors (Tse, Esposito and Soufani, 2015).

While the terminology is relatively new, circular economic practices are well established in some areas, electronics industry being an example (TechUK, 2015). The key players on this market, namely the manufacturers of these devices and hardware components, are becoming more and more concerned about applying circular economy principles throughout reconsidering every element of the design and manufacture of the products and every part of the supply chain, while aiming to extend the life of their products and achieve sustainability targets. The applicability of circular economy principles in this sector has been presented in the literature (Bourguignon, 2016; Pathan et al., 2013; Vijaya Laxmi and Rao, 2015), but these approaches have considered the physical, tangible components of electronic products, focusing on their reuse, recycling and remanufacturing. Given that today almost all electronic products (which are physical goods) are associated with software products (which are intangible goods), the concerns regarding the implementation of the principles of the circular economy should also be directed to software, not just to the hardware components.

In the context of such a problem, this paper aims to highlight the relation between the use and reuse of software products and the principles of the circular economy. Thus, the first part of the paper discusses aspects related to development, use and reuse of the intangible assets related to electronic product, namely software, and the second part presents the results of an exploratory research (survey type) undertaken among Romanian young people to determine their behavior related to the use and reuse of software, especially related to IT products (computers, tablets, mobile phones etc.).

1. Current state of knowledge regarding the reuse of electronic equipment and related software

The electronics sector consists of companies engaged in the manufacturing and distributing of equipment for industries and consumer electronics products. Consumer electronics include devices used for entertainment (TV sets, digital cameras, video players and recorders, game video console etc.), communications (telephones, cell phones, smart phones, laptops, tablets etc.), and home-office activities (desktop computers, printers etc.). The globalized market for end-user electronics offers both challenges and opportunities related to circular economy. There are opportunities for producers and distributors to work together for a greater sustainability, but this can be a considerable challenge because the high complexity of the supply chains within this industry makes it difficult for consumers to make choices based on sustainability, or for producers to make the supply chain more sustainable (Pathan et al., 2013). Applying circular economy principles would, however, require profound changes not only in business models of the hardware manufacturers and software developers, but also in consumer behavior, especially since, with too little knowledge on the potential benefits of

this type of economy (Bourguignon, 2016), consumers tend to be reluctant to adopt some new behavioral patterns (such as choosing the option to repair and reuse a device and update the related software, not replacing it with a new one appeared on the market and buying another compatible software). Certain habits and patterns of behavior deeply rooted in consumer culture make the transition even more difficult. Also, many industries are currently driven by fashion trends, the rapid change of the fashion designers collections, and the frequent releases of the newest mobile phones models by renowned manufacturers are just some examples of the unsustainability that has become a part of today's culture (European Environment Agency, 2014). This type of behavior is prevalent among young people, as they follow current trends in fashion and technology.

From ***the electronics manufacturers' perspective***, there is a high potential in designing modular products (as is the case of the Dutch company *Fairphone*, which launched in 2013 the first modular mobile phone), that can facilitate easier component exchange and can be more easily repaired and recycled; encouraging reuse, shared use, leasing systems or products as services, instead of ownership; providing longer guarantee periods for products and new types of warranties; collection, dismantling and safe recycling of products containing critical materials (such as rare earths in electronic devices) (European Environment Agency, 2014; European Commission, 2015). Major industry companies have integrated the principles of circular economy into their work**.** For example, companies such as Dell, Hewlett-Packard (HP) or Philips facilitate product recycling, design products that allow multiple life cycles with minimal loss of value, quality and energy, and encourage material recovery and reuse (Dell, 2016; HP, 2016; Philips, 2014).

However, not only electronics manufacturers have to follow these directions in approaching the circular economy, as these categories of products are not limited to a physical, tangible component; in order to fulfill the functions for which they were created, intangible goods, namely software products are required. *Software* is a generic term for organized collections of computer data and instructions expressed in a programming language, which together allow the execution of a function or operation required or accepted by the client or user (Armaș, 2010). *System software* and *application programs* are the two main types of computer software. *System software* provides the basic non-task-specific functions of the computer, and *application software* performs a particular function or specific task for the user (Shelly and Vermaat, 2012). The *operating system (OS*) is the best-known example of system software, such as *Windows, Android, iOS (Apple), Linux* etc. The OS manages all the other programs in a computer. Regarding application programs (often just called applications or *apps*) examples (among many possibilities) include browsers (such as *Mozilla, Chrome, Opera, Edge, Internet Explorer*), word processors (*Microsoft Office* - part of *MS Office Suite*) and spreadsheets (*Microsoft Excel* - part of *MS Office Suite*).

Modern electronic devices often contain software that facilitates certain operations, allowing automation, connectivity, remote control and other complex functions. In this case, we are talking about "*embedded software*", namely a component that is not sold as a stand-alone software product but is integrated in a non-software product (Kittlaus and Clough, 2009), as in the case of the mobile phone that has an operating system implemented. When consumers purchase these "software-embedded" products, they become the owner of the hardware components of the device or machine; in contrast, they may only acquire a *license* (a form of legal permission) to use any embedded software during the time of their product ownership. Manufacturers of electronic devices may employ software licensing as a legal mechanism to restrict unauthorized resale of their products (via secondary marketplaces, such as eBay) or to

prohibit product alterations or repairs that they do not formally agree with, ensuring that these operations are done only by partner firms (Yeh, 2016). For this reason, it is extremely important for the users of these products to carefully read the terms and conditions regarding the use of such a product in order to understand, for example, whether and under what conditions they can sell an embedded software product, they may give up that software and install another, they can update the software or find and use compatible complementary application programs.

Also, some electronic products may include *Digital Rights Management (DRM)* technologies that prevent consumers from changing the installed software and help the manufacturer company to control the types of accessories that can be used with purchased electronics, aiming that users call on the companies agreed by the producer. For example, manufacturers have installed DRM technologies in printers to prevent consumers from using non-licensed, generic toner cartridges supplied by companies that are not affiliated with the manufacturer, toners that are usually cheaper and easier to purchase than branded components, authorized by the manufacturer. DRM applications can also be installed in smartphones to prevent the mobile phone from being used in a different network than the one of the mobile operator with which the user has signed a contract for providing mobile telephony services (Yeh, 2016).

Hereby, the software *license terms and conditions* and *DRM technologies* may restrain certain consumer behavior after purchasing the product, as mentioned in the literature (Consumers Union, 2014; Electronic Frontier Foundation (EFF), 2017; McSherry, 2015; Yeh, 2016). This means that the owner of an embedded software product does not have the same rights and freedoms as the owner of any other tangible good. These issues are relevant in the context of circular economy as they may represent limitations on how consumers reuse, resell, modify, repair or replace both their devices and related software.

Also, this issue becomes more important as the number of products that have built-in software or need software to perform certain functions is increasing and is no longer limited to electronic products. A major evolution in the years to come will be the progressive connection of these electronic devices and other physical objects, thus giving rise to the *"Internet of Objects"* or *"Internet of Things" (IoT*). European Commission (2010) defines IoT as a *"great Internet"* that will contain all items daily used, that can be spotted, identified, addressed and controlled via the Internet. Nowadays, we have connected devices that meet our daily needs, *"smart objects"* that monitor our homes, cars, work environment and physical activity (Onete, Pleşea and Albăstroiu, 2017). *"Smart"* or *"intelligent"* is a term increasingly adopted to describe things or processes that have the ability to compute, connect and communicate to differentiate from the machines and equipment working in isolation (Consumers International, 2016). In view of this evolution of the Internet of Things, moving beyond its traditional place in personal computers and corporate servers, nowadays software may be integrated in daily used consumer goods, such as mobile phones, televisions, refrigerators, thermostats, household appliances, printers, automobiles, clothes, as well as personal medical devices (for example, smart, portable and wearable devices that monitor glucose or blood pressure) (Yeh, 2016).

When the required software is not embedded, users can install and use the software without buying it, in the case of *free software* ("*freeware*", that is free of charge for an unlimited period) or must acquire it separately (for example, in the case of "*proprietary software*" – a term used for non-free and "*closed source*" software, with a copyright owner that controls how the program is used). In some situations, the user can appeal to a "*free*" or "*open source*" software. Free does not mean necessary gratis. *Free software* is different from *freeware software* because in the case of *free software* the source code is available, and anyone can

install, use, study, modify and distribute it, while the *freeware software* can be used without paying for it, but the source code is not available, so, it cannot be modified. Also, a *free software* is different from *open source software*, because *open source* means that source code is available, the copyright owner offers the above rights (use, modify, share etc.), but may imposes restrictions, limitations, and rules (Stallman, 2016). The most popular open source program is the *Linux* operating system, and the most popular open source application is the *Mozilla* browser. "*Free software*" focuses on user freedom, while "*open source software*" on the programmer freedom, who has the right (freedom) to restrict some users' freedoms. *OSS (Open Source Software)* is now becoming an important alternative to commercial software when organizations, not only individuals, decide on software acquisition. Credentials to OSS products come from both early adopters and well-known commercial vendors such as IBM (Linux) and Oracle (OpenOffice), with the financial strength to make credible commitments regarding OSS products. Major IT products vendors now offer OSS products, as well as support and maintenance services for OSS applications.

From the ***perspective of software developers***, the issue of free and open source software (FOSS) is relevant in the context of circular economy because it involves some form of software reuse. The literature (Chahal and Singh, 2014; Freeman, 1987) mentions that software reuse refers to the process of creating new software systems from existing ones, rather than build software systems from scratch, and the possibility to be implemented in new applications. The structure of a software is arborescent, with an initial root, which then develops other branches, some improvable, free and gratis distributed to the community, and other more stable and more efficient, developed by teams of specialists and companies, being commercial and distributed for a fee. For example, *Unix* (proprietary, commercial and closed source software, developed in the 1960s by a team of programmers from the American company AT & T Bell Labs) and *Linux* (free and open source operating system, developed independently by the Finnish software engineer Linus Torvalds, starting from the kernel of the Unix system). Although they inherit common features, both have several versions, some being free of charge, others commercial. Also, beyond the development of operating systems derived from others, from the perspective of developers, reuse implies any form of updating and improving operating systems, such as *Windows*, the world's most widespread operating system, launched by *Microsoft* in 1985, with its latest version, Microsoft 10, launched in 2015.

The existence of communities that develop *free and open source programs* (*FOSS*) is an illustration of collaborative and sharing models. These models exploit the greatest opportunities in a circular economy, namely the cycles of reuse (Egerton-Read, 2016). In a context of rapid development of the Internet and mobile technology and a wider acceptance of a changing Business-to-Customer (B2C) relationship, the shift to access to products and services rather than ownership has taken place. Moving from the possession of the good to accessing it is a representative principle for a *"collaborative economy"* (often called *"sharing economy"*), an economic model in which individuals borrow or lease goods from other individuals or organizations that own them; in the same way, companies are competing today for access to assets, not for the possession of assets. The Internet has made the meeting between those who own and those who need these goods easier. Thus, the emergence of a decentralized digital economy has led to a process of transformation of business models and the emergence of new forms of production and consumption. For instance, individual consumers are able to get what they need from one another instead of always appealing to organizations/businesses, which in fact mean collaborative consumption, reinventing individuals' rental, exchange, swapping, bartering, offering, replacement, lending, reusing and sharing behaviors through technology in a manner and extent that was impossible before

the Internet (Botsman and Rogers, 2010). In recent years, digitally-enabled technology solutions that connect individual customers and companies through a mobile application or web platform that provides a cheaper, faster and more convenient product or service, while extending the use of existing products rather than the production of new things, have become very popular. Numerous collaborative services have also emerged, in which it is the community that provides a service or product. Internet sharing and collaboration practices have expanded from transport (classic example being Uber), tourism (Airbnb), financial services (Kickstarter), entertainment (Spotify) to software development (Linux, Drupal).

From the ***users' perspective***, these models mean they can sell second-hand electronics, along with software embedded, or even software licenses (which they no longer use) to other users through *C2C* websites (*consumer-to-consumer*, such as *eBay*) or download intangible assets (software, music, movies, games, books, etc.) via free *P2P networks* (*Peer-to-Peer Networks*, in which each computer can share data and resources equally with each other, based on a certain type of architecture that allows sharing of tasks or information between partners, the partners being equal and each having the same possibilities to initiate communication within network (which explains the use of the term "peer" - equal, similar)). However, the question of legality remains, knowing that trading digital goods or content protected by copyrights, without permissions of the owner is illegal in most countries (Năstase, 2010). However, the information society and new technologies have greatly expanded the area of intellectual creation and implicitly the adaptation of legal approaches to the protection of intellectual property rights (Năstase, G. and Năstase, D.I., 2010).

Regarding the software owner's possibility to alienate, the *second-hand software* issue appears. The term "*second-hand software"* refers to a business model whereby a company purchases from the client of a software manufacturer user licenses that are no longer required for that customer and sells them to various interested buyers. Such a business model generated a legal dispute in Germany between Oracle and UsedSoft GmbH, which was solved by the European Court of Justice through a major decision for the industry, establishing that a legitimate software user can resell the software downloaded from the Internet without violating the distribution rights of the copyright holder, but with the obligation to delete from its own device or to make unusable the copy of the respective program. Instead, the copyright holder of a computer program, such as Oracle in the case mentioned above, is entitled to ensure, by all means at his disposal, that, in the case of the license resale by the original acquirer, the copy of the program becomes unusable for the acquirer (Court of Justice of the European Union, 2012). This fiducial decision creates the premises for a secondary market for the software and, therefore, the possibility of reuse.

Technological progress has actuated the manufacturing companies to launch new products or new versions of older products at very short intervals, so launching such a product often means the need to develop a new software or to improve the existing one. Thus, a complicity has been created between equipment and electronic devices manufacturers and software developers, which have to match the pace imposed by the market. Several supply chains with vertical integration have been formed in this area, where the software developer also produces devices (for example, *Apple*, *Microsoft*, *Google* are vertically integrated companies, operating both in the software and hardware industries).

In particular, young consumers are very receptive to these new trends and willing to replace their mobile phone, tablet or computer with the new ones on the market, even if their own devices are perfectly functional (Green Alliance, 2015; TechUK, 2015; Vijaya Laxmi and Rao, 2016). However, new devices have new embedded software or require updates of the

software used in the old device, if the user wants to reuse it (if this commutation is technically and legally possible). Often, improvements to software programs are not substantial and launching them as completely different versions is just a matter of marketing.

On the other hand, when there is no longer software support for older versions of electronic devices, it is obvious that the user's interest in further using that product (and even that brand) is diminishing. Outdated software means an electronic device with low functionality, limited compatibility, and security vulnerabilities. This reduces opportunities for reuse in the context of consumers claiming to replace an older device when there are no software updates for it. Thus, software upgrades are an important factor in the resale value of a device (Green Alliance, 2015).

2. Research methodology

Following the review of the literature, we can see that young people are the most dynamic consumer category, which is always keen to get acquainted with the latest trends, both in terms of clothing products, but especially when it comes to electronic devices. For this reason, we considered that due to their desire to use the latest equipment, the time to use such products is much shorter among young people. Because of the reduced use time, the products are less used, so they can be reused. At the same time, young people are the age category that most easily embraces the new behavioral tendencies regarding the recycling or reuse of out-of-date products, thus contributing to the dissemination of circular economy concepts in Romanian society, thus contributing to the efficient use of resources.

To identify how this type of Romanian consumer behaves when buying a new phone / tablet or laptop, compared to the one they are giving up, we have conducted a study on the behavior of young consumers in terms of the possibilities for reuse of software and hardware and how they act when they give up old ones.

In order to determine how young Romanians relate to the above-mentioned concepts regarding the circular economy and the ways to re-use electronic products that they no longer use, I have defined the following objectives:

- Identify operating systems and office productivity software installed on phones / tablets and computers that they are currently using;
- Knowing the degree of adaptability to the new software they use;
- Determining the way they keep their personal files;
- Determining behavior in the case of old equipment;
- Establishing how to relate to the terms and conditions of use of software products installed on the electronic devices they use.

Based on the goals and objectives set above, the results highlighted in the research of the literature and the profile of the respondents, we stated the following hypotheses:

H1: Young people use the latest software on personal equipment;
H2: The degree of adaptability to new generations of electronic equipment is high;
H3: Most investigated people prefer to keep their personal files in the cloud;
H4: When transferring equipment to other people, respondents do not delete software;
H5: The persons who participated in this research respect the accepted terms and conditions for the purchase of software products, overwhelmingly.

The research was conducted during October-November 2017 using a structured questionnaire consisting of 11 closed questions posted online. Respondents participated voluntarily so that

we can assume that the questionnaire was self-administered. The questions were both with unique and multiple answers. The elaboration of the questionnaire was based on the study of the established objectives and the validation of the hypotheses mentioned above.

Since the participants in the research have done it voluntarily, we can assume that the researched sample was randomly chosen. This is relevant only because it is made up of young, active, and highly educated people, not a representative one. The research was an exploratory one with a probabilistic sampling of 95% probability of guaranteeing the results of the research, the coefficient corresponding to the probability of guaranteeing the research results is 1.95 and an error margin of ± 5%. The value recorded for the non-percentage weight of the components of the sample possessing the researched feature is 0.75, since it was considered that the degree of adaptability of the youngsters is at least 75%. The number of respondents is 257 people.

The distribution according to the level of graduated education and the status on the labor market is presented in Table no.1. We chose these two socio-demographic variables because they can give us the clearest picture of the set goals.

Table no. 1: Distribution of respondents by level of education and employment

Studies / Employee	Employee	Without a job	Grand Total
High school	21.4%	2.3%	23.7%
Bachelor	54.5%	9.7%	64.2%
Master	5.1%	7.0%	12.1%
Grand Total	80.9%	19.1%	100.0%

The limits of this research are due to the low representativeness of the sample, due to constraints related to the logistical, financial and time resources.

3. Results and discussion

This research was conducted to study if young people behave responsibly with the use of computing equipment (computers, tablets, and smartphones) and software installed on them. Four main components are considered: operating systems used, behavior at the time of disposal of the equipment, reporting to the terms and conditions of use of the software used, and adaptability to the new versions of the software used.

3.1. Operating systems

In order to get a clearer picture of how the surveyed people handle the software they use, in the first part of the research we wanted to identify the typology of the distribution of operating systems and Office productivity software installed on phones/tablets and computers which they currently operate. The purpose of such an analysis was to determine whether users behave responsibly through long-term use of electronic equipment, or, as it can be seen from the literature, young people prefer to use the latest products on the market, having a less sustainable behavior with respect to electronic products.

The analysis was based on two research directions about the hardware devices handled, namely computing equipment and tablets/mobile phones. The common element regarding software solutions was the operating system running on this equipment. Although office productivity tools can run on some smartphones, most allow them only to view documents, not to edit them. For this reason, we considered that the Office package they use is installed on the computer.

As it can be seen in Table no. 2, those surveyed usually use newer software on their equipment. It should be noted, however, that there is a difference between what is installed on computers and on phones/tablets. It is noticed that as regards mobile phones, operating systems, and equipment are newer generation. For Apple products, iOS 9 is a majority. The result is not surprising if we take into account that Apple's policy is to make users to update their equipment and, by default, the operating system and software products running on them. The speed of product renewal is much higher than for other competing companies, and marketing methods are far more aggressive. As a reinforcement of what has been said before, Apple confirms that the batteries with which their phones are equipped are designed to last for a shorter period and the operating system will limit functionality if battery power is low. (Wuerthele, 2017)

For devices using the Android operating system, it is noticed that the distribution is a normal one, mostly older generations of this operating system are used, Android being an open source product, renewal philosophy and the possibilities of implementing newer technologies than the changeover time is longer.

A confirmation that users prefer Android-powered devices is that from the 257 respondents 147 use Android phones, 104 use iOS (Apple), and only four proprietary phone company systems.

Table no. 2: Distribution of office software usage on types of phones Operating Systems

																				Grand Total
	MS Office 2016	MS Office 2003	MS Office 2007	MS Office 2013	MS Office 2016	Other	MS Office 2007	MS Office 2013	MS Office 2016	Open Office	Other	MS Office 2003	MS Office 2007	MS Office 2013	MS Office 2016	MS Office 365	Other	Other	MS Office 365	
Android 4					3									4						7
Android 5			10	5		4				2			5	5	8					39
Android 6			2	7			5	5						5	12	2				38
Android 7			9	6		3		3	2				2	15	20				3	63
Android 8							3								7					10
iOS 7			6					3					4	3						16
iOS 8	2																3			5
iOS 9		2	7	2				7			3		10	16	24			2		73
OS proprietary			2									4								6
Grand Total	2	2	36	20	3	7	8	18	2	2	3	4	21	48	71	2	3	2	3	257

For those who use Windows as an operating system, most use Win 10 or Win 7. When we talk about Windows operating systems the results are normal, because Win 8 was a variant operating system that wanted to be used on both computers and on tablets and phones, which has failed, which has led to the development of distinct products for mobile devices. Noteworthy that our questionnaire included also variants of the response about this smartphone operating system, but there is no respondent to use it, which is why it no longer appears in Table no. 2.

We also find the same consumer behavior with office software (Office). In their case, products from older generations are preferred, the adoption of new variants is rather small. This result can be interpreted by the fact that the basic interface and functionalities have remained the same, adding only new functionalities from one generation to the next, so users prefer psychological comfort to the detriment of productivity. Taking into account the results

presented above, through the analysis of the sustainability of software in order to be reused, we can state that for devices that have Android or Windows operating systems installed, the possibilities of transferring these devices to other users are much higher than in the case of those produced by Apple. Thus, the H1 hypothesis is partially confirmed.

3.2. Adaptability to the new technologies

Once the typologies of software use by respondents are established, it is essential to be checked how well they adapt if newer versions appear. This analysis is necessary because the degree of adaptability can give us a clearer picture of how they react to the new software versions, but it can be an indicator of behavior towards the idea of reuse and sustainability.

At the same time, young people are the youngest age category, which made us think that we will have a large proportion of respondents who will say they are easily adapting to the new product variants. Thus, the H2 hypothesis was confirmed, as shown in Figure no. 1, 95% of respondents said they readily adapt to new software versions.

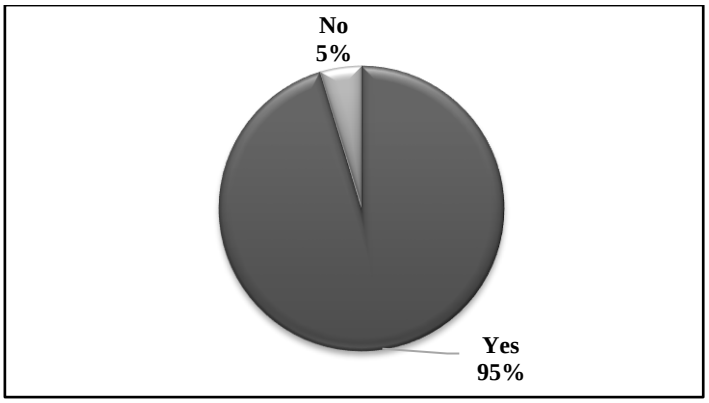

Figure no. 1: Degree of adaptability to new versions of software products

As discussed above, the policies of large software companies over the development of new versions of software and hardware are different. If Apple is promoted through the concept of innovation, being often a pioneer in launching new facilities for their products, the other companies are more traditional, trying to keep as much of the components as they are already used, coming only with new plug-ins to improve existing products.

To validate the result and to see if there is a correlation between the degree of adaptability and the operating system on the mobile phone used by the respondents, we calculated the Pearson coefficient between the two variables with a confidence level of 99%. This is 0.219, which shows that we have a direct correlation, even if it is not very strong, between them.

Another component of how users are adapting to the new technologies is their behavior with the way information is stored. For this, interviewees were asked to specify on what types of devices they retain their personal information. This was a multiple-choice question, and respondents could even choose all the variants. As it can be seen in Table no. 3, those surveyed are quite conservative because they prefer to keep their files on personal devices, and less on external devices. The hypothesis H3 is totally refuted.

Table no. 3: Typology of information storage depending on the status on the labor market and the studies

Device	Storage place	Employee	Without a job	High school	Bachelor	Master
Laptop	81%	65%	15%	20%	51%	10%
Tablet	39%	30%	9%	12%	20%	7%
External device	31%	28%	4%	6%	24%	2%
Cloud	32%	24%	8%	12%	14%	6%

These results seem to invalidate the degree of adaptability stated above, but the degree of confidence in such technologies, more than the degree of adaptability to the new is shown here.

3.3. Behavior in case of equipment alienation

Once it was determined how the surveyed people use software installed on their personal equipment and how they behave when they need to keep their personal files, we can analyse consumption habits if they alienate their software and hardware that they no longer use. As noted above, consumers are quite conservative when it comes to keeping their personal data and they change the software versions only when needed.

In order to determine the behavior when equipment is alienated, the analysis was done in three directions, if they transfer the equipment with all the installed softwares (TransHard), if they transfer/sale the software when they do not use it (TransLic), and if, when they acquire a new computer/PC, they prefer it with or without the preinstalled software (SOPreinstall). The answers of the respondents are centralized in Table no. 4.

Table no. 4: Behavior in case of transfer of licenses and equipment

	Trans Lic	Trans Hard	SO Preinstal
Yes	8.2%	46.3%	77.8%
No	91.8%	53.7%	22.2%

The analysis of the results shows that when they give up the equipment, the ratio of transfer and non-transfer is fairly balanced, yet with a greater share of those who do not transfer the programs installed, too. This trend is explained by the conservatism shown in the case of keeping personal files. This behavior can be more clearly noticed in the case of equipment given up. This is very clear noticed when they were asked if they sell their software licenses when they are not used anymore. To this question most respondents said they did not. Thus, the H4 hypothesis is confirmed.

We also wanted to find how the two behaviors are related. It can be observed (Table 5) that a large number of those who declared that they are transferring the equipment do not also transfer software products already installed.

Table no. 5: The relationship between hardware transfer and software transfer

	TransfLic	No	Grand Total
TransSoft	6.61%	39.69%	46.30%
No	1.56%	52.14%	53.70%
Grand Total	8.17%	91.83%	100.00%

As for the purchase of a new laptop / PC, most prefer a pre-installed one. This result is a little unexpected in the conditions in which a big part of the respondents are students, and Microsoft runs programs that students can use freely (Microsoft's Student Partner) on the duration of their studies. It is very likely that they are not joining the program or not knowing about it.

3.4. Reporting to terms and conditions of use of software products

One last element of our research concerns how the young people surveyed relate to the terms and conditions of use of the software they use. We wanted to find out if they carefully read the terms and conditions of use imposed by the software developer, the terms that they accept at the time of purchase, and whether they comply with these terms after the purchase of the product.

As it can be seen in Figure no. 2, the number of those who do not read carefully these terms is higher than those who read. However, it is worth noting that the number of people who say they read carefully is quite large, which is gratifying. With this result, the H5 hypothesis is confirmed. In the same time, we may notice that there is a category of users who are not at all interested in the terms and conditions of use of the software. They not only do not read these terms but declare that they do not respect them.

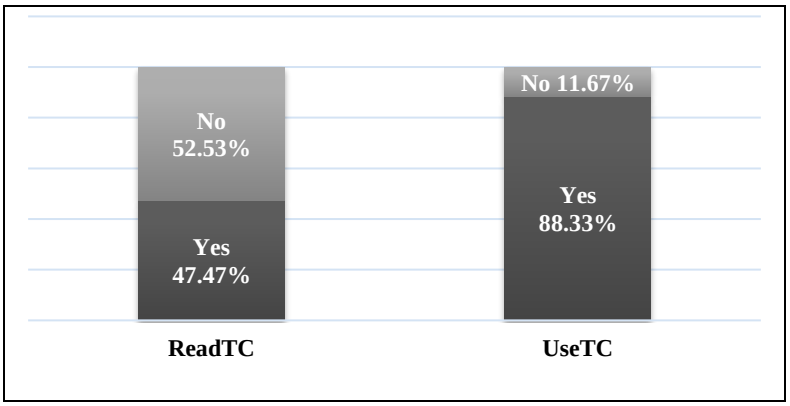

Figure no. 2: The way respondents report to the terms and conditions of use of the software

Conclusions

Circular economy takes effect at the very beginning of a product's life, both the design phase and the production processes have a significant impact on the use of resources and the generation of waste throughout the life of the product. Electronic products have a great importance in this context because of their potential to be designed in order to facilitate dismantling, material recovery, recycling, repair, refurbishment and reuse. However, it should not be forgotten that an electronic product often means a combination of physical, tangible (hardware) components and intangible elements, namely software programs and applications that make it possible to operate the product. Therefore, the application of the circular economy principles is not devolving only on the *manufacturers of electronic equipment and devices,* but also on those who make intangible components. Transforming the circular economy into reality requires long-term involvement at all levels.

Thus, *software developers* must setup the terms and conditions of use for the software license, and configure DRM (Digital Rights Management) technologies so as not to affect certain

consumer behavior after purchasing the product (in the sense of not restricting the repair, modification, replacement of both the device and software), and also not restricting the use of an older version of the device, providing software support for many years after launch, and ensuring better compatibility with new applications, thus stimulating a sustainable behavior of the user.

Consumer involvement is of great importance in this context. The choices that users make are determined by the information they have access to, the range and prices of existing products, the regulatory framework, and the opportunities offered by manufacturers of electronic equipment and devices, as well as developers of the related software programs, in order to extend the life of these products, thus avoiding e-waste. Against the background of such a need, we performed the research presented in this paper, that contributes to the completion of the specialized literature (which relates in particular to the re-use of electronic equipment, and not to the related software) but also to the knowledge of the manner of using the electronic products, the openness to the variants of reuse, the degree of adaptation to new technologies in order to create the prerequisites for manufacturers and distributors of electronic devices and software to stimulate users' sustainable behavior.

Research conducted among young Romanians on the behavior of software reuse, indicated that they are using the latest operating systems, especially for Apple devices, but at the same time preferring stability instead of newer versions. They say they easily adapt to new versions of software when they change their phone or laptop, but at the same time it has been shown that they are conservative with the place where they store their personal files, even if in this way there is a greater chance of losing them. Another element to be specified is that when they alienate their phones or computers, they delete all the software installed on them, which shows that reuse is not possible. In the same time, most of them declare that they comply with the terms and conditions accepted when purchasing software products; there is also a small group declaring that they do not comply with these terms.

Using a larger sample, further research could explore more in-depth the behavior of young people in relation to the way they use their personal equipment, if they are eager to help develop open source products, allowing for a more efficient reuse of existing software solutions.

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