Income inequality and circular materials use: an analysis of European Union economies and implications for circular economy development

Income inequality and circular materials use: an analysis of European Union economies and implications for circular economy development

Marinko Skare - *Faculty of Economics and Tourism Dr. Mijo Mirkovic,*

Juraj Dobřila - *University of Pula, Pula, Croatia and University of Economics and Human Sciences in Warsaw, Warsaw, Poland*

Beata Gavurova - *Faculty of Management and Economics, Center for Applied Economic Research, Tomas Bata University in Zlin, Zlin, Czech Republic*

Martin Rigelsky - *Faculty of Management and Business, University of Prešov, Prešov, Slovakia*

Abstract

Purpose - The purpose of the research was to evaluate the relationship between income and the recycled materials used in order to rate the business related to circular repair services under the burden of economic development in the countries of the European Union.

Design/methodology/approach - The analytical processes explore data from 2010 to 2020. The countries were divided into clusters according to economic maturity (Human Development Index (HDI), real Gross domestic product (GDP) per capita). Subsequently, the relationships were evaluated through the income indicators (for the 13 population groups), and the circular materials use rate indicator. The three indicators decomposed into five specific metrics were employed. The commonly applied characteristics of the descriptive analysis, Pearson's correlation coefficient and the panel regression analysis were engaged in the investigation.

Findings - The results demonstrated the vast disparities between income and circular materials use. In the more economically developed countries, their levels were twice higher as the less-developed countries. However, there is a meaningful positive relationship between them. The greatest attention was paid to the panel regression analysis applied to the relationship between income and circular economy (CE) use. The results showed that in a majority of the cases (different income categories), there is a significant positive relationship. When comparing the outcomes of the regression models between the groups of the countries according to their economic development, a closer relationship was clearly demonstrated in the countries with a lower level of development (Bulgaria, Romania, Croatia, Hungary).

Research limitations/implications - Besides the specific strengths, the study also shows some limitations identified mainly on the data side. The latest data on the consumption of circular materials come from 2020, so they do not cover the period related to the pandemic crisis. It is believed that there may have been some changes in income during the pandemic, and they may have harmed CE. Furthermore, there is to note that some limitations occur in the analytical process. The incompleteness of the data can also be included here as certain data is not available; hence, it was estimated directly by the Eurostat statistical authority.

Practical implications - At the same time, the following are currently considered among the primary barriers: financial restrictions, insufficient infrastructure, weak government support and obstacles on the global market. Consumers, industry leaders and the government are the most influential stakeholder groups in overcoming barriers. Higher demand for repair services will also initiate further development of business activities in this area at various regional levels. Progress in the repair services economy will continue to require extensive efforts in the future. Systematic coordination of activities at multiple levels of government together with manufacturers, designers, educational institutions, community institutions and individuals will be essential.

Social implications - Socioeconomic characteristics such as sex, age and education represent crucial predictors of consumer behavior. Therefore, the authors would like to focus future research on analyzing these characteristics and examine all the conceptual frameworks of consumer behavior and its positioning in detail within CE and the strategies related to the repair service. Discussing this issue through follow-up research will allow for solving complex transformational and political tasks related to the repair service strategies within CE. It will also inspire the discussion frameworks and multidisciplinary solutions to this issue affecting the fields of human geography, sociological, ethnographic and political sciences.

Originality/value - In less-developed countries, wage change can have a more substantial impact on the development of the CE. Also, a closer relationship between business in the field of repair services with income and the use of circular materials was manifested in the same way.

Keywords Circular economy, repair services, circular materials use rate, consumption patterns

1. Introduction

It is widely recognized that the developed countries are characterized by higher service ratios compared to the developing countries. The current development trends are oriented towards the circular economy (CE) principles, which are often impeded by the societal norms that have been established over long periods. The principles of a CE in a society can be simply illustrated by individual behavior toward a product that no longer fulfills expectations. The decision to either repair or replace the product depends on the factors such as repair costs, expected functionality timeframe and the cost of acquiring a new product. If the principles of a CE are integrated into the enterprise's operations, the rate of product repair is expected to increase. However, the influence of societal wealth on the adoption of the CE principles remains an open question. The current study has identified the relations between repair services and circular materials. The findings have important implications for policymakers since the adoption of the CE principles involves challenging established societal norms and behavior. Implementing this change represents a significant challenge for managers with focus on the difficulty in altering the established social norms and behavior.

CE has become an area of solid multidisciplinary research in recent years. It is conditioned not only by the availability of the numerous studies, the concepts, the approaches, the methods and the systems that are applied in the investigation of CE at the organizational level but also by the pressure for a deeper investigation of the determinants of the CE development and the discovery of new causal links necessary for the creation of effective CE policies. Despite the large number of available studies published in recent years on CE, we have to state that the literature about CE is considerably fragmented. The reason for this strong fragmentation is both the numerous research directions, which

the issue of CE touches, as well as the high heterogeneity of the subjects and the interest groups that are directly involved in the development of CE, which requires a multilevel and multidisciplinary review. This situation is also worsened by applying the numerous theoretical frameworks, concepts and models that have their process dynamics and ties to several areas of business and management. This also significantly restricts the process comparability of the study results within the CE activities. The previous research studies and industrial practice findings declare insufficient consideration of socioeconomic dimensions within the CE framework and excessive research orientation on quantifying classic environmental and economic impacts.

Introducing the new dimensions into the evaluation processes within CE is also related to pressure for a multidimensional evaluation of the partial CE strategies. Repairing, refurbishing and remanufacturing are considered the three critical strategies of the CE. These strategies aim to close product cycles and maintain materials and resources in the product cycle as long as possible. Product repair has become an increasingly important element of waste and resource management policies in many countries. In the European Union waste and CE policies, the repair is preferred over recycling or waste to energy transformation (**European Commission, 2019,2020**). Repair services are increasingly seen as a critical sector that will benefit significantly from employment through transition economies to CE. The CE literature critically examines the issue of the development of repair services. Still, the studies are dominated by an instrumental understanding of repairs as a tool to extend the life of products and reduce waste.

The repair services can be considered a priority of the inclusive CE transition. The environmental benefits of repairing can be evaluated through the rate of reduction in demand for the production of new products (**Rogers et al., 2021**), while many studies also declare economic benefits from the repair services in terms of a labor position number growth (**King et al., 2006; Llorente-Gonzalez and Vence, 2020**). These can be compared with the implicit loss of labor positions in the production sphere. The recent calls are appealing to expand the current focus of CE on ecological efficiency, pointing to the need to implement social parameters to intentionally include inclusivity in the transition to CE (**Lekan and Rogers, 2020**). Many social benefits, opportunities for those excluded from the labor market, and increased availability of repairs are also associated with repair services (**Williams et al., 2012; Bovea et al, 2017**).

Although new and numerous studies on CE are being created, studies on the role of repairs and their implementation in the regulatory mechanisms of governments are absent. This is a consequence of the prevailing technocratic perception of repairs as a CE strategy. This restrictive and limited understanding of repairs as part of CE harms the creation of effective strategies for the countries' transition to CE.

The absence of studies investigating the relationships between the repair services and the CE processes creates a significant research gap that restricts the further development of concepts and strategies for the transition to CE through repair services, as well as the creation of effective mechanisms investigating the impact of repair services on the development of CE. Furthermore, taking into account socioeconomic aspects (income in our study) can bring a new perspective on the adaptability of CE concepts through specific strategies and their effects on the dynamic changes related to the quality of the business environment, political and economic stability of the country, and so forth.

This consistent fact motivated us to research to analyze and quantify the relationships between the circular materials use rate, business in the field of repair services and income. In the following research

process, we will examine these relationships within the dimension of economic development of the countries and, thus, create a platform for national and international benchmarking.

This empirical research study investigates the association between income and the adoption of the CE principles. Specifically, this study examines a relation between repair services, circular materials and economic development. Three research questions are formulated and these are expounded upon in the literature review section. The methodology section describes how secondary data analysis of all European Union countries was used to investigate these research questions. The results section presents the outcomes of the panel regression analysis and the cluster analysis. The findings suggest that there is a relationship between income and the implementation of the CE principles. The study conclusion discusses the results and their implications. It also outlines the research limitations and highlights future research directions that could enhance this field.

2. Literature review

CE is currently considered a trendy concept supported by the EU, national governments, businesses and international organizations worldwide. However, the scientific and research content of the CE concept is considered by some authors to be superficial and unorganized (**Korhonen et al, 2018**). The vital interest of the scientific and professional community in the issue of CE makes it a multidisciplinary research area. Also, for that reason, the research studies dealing with this issue are heterogeneous and influenced by the target focus of the research and the research teams. This creates a space for developing new concepts and modifying existing ones, which have to reflect the dynamics of the business environment, globalization influences accompanied by the worldwide crises, and the changes in the national economic and political structures. The available research studies focused on the investigation of CE allow, at the same time to identification of gaps in the methodological processes of CE and point to the need to reveal and investigate the new aspects and levels of CE that can have an impact on the success of the policies as well as the CE strategies. The absence of systematic scientific groundwork will represent a substantial risk for achieving the ambitious goals of the CE strategies.

In the recent period, more and more attention has been drawn to the need to investigate the socioeconomic factors and the social dimension in the research studies focused on CE. This is also confirmed by the analysis of **Neves and Marques** (**2022**), who investigated the circular material use rate as a proxy for the CE. The authors analyzed the 19 European Union member countries for the period of the years 2010-2019. The age distribution of a country has been identified as a significant predictor of a CE. Older people are much more challenged to change their behavior than younger people. Therefore the implications of the authors were directed at creating effective policies aimed at older people to understand the benefits and importance of the CE. Per capita income is also an essential indicator in the population decision-making mechanisms. Income inequality makes it difficult for the country to transition to a better CE state (**De Jong et al, 2016; Preston and Lehne, 2017; Godfrey et al, 2021**). The optimal perception of the CE is typical for the middle-income group. **Boubellouta and Kusch-Brandt** (**2021**) and **Kirakozian** (**2016**) emphasized the importance of investigating social influence on recycling behavior because social impacts negatively affect recycling. Nevertheless, most research studies declare a positive relationship between social influence on proenvironmental behaviors (**McCarthy et al, 2018; Vasilijevic-Shikaleska et al., 2017, Jones and Comfort, 2017; Geissdoerfer et al., 2017; Genovese and Pansera, 2021**).

The investigation of the social aspects is getting more and more attention in link with the three strategies of CE: repairing, refurbishing and remanufacturing. Based on empirical evidence, **Cerqueira et al.** (**2021**) evaluate the importance of the circular link between economic development and ecological policies through renewable resources and recycling. In these strategies of CE repairing, refurbishing and remanufacturing, there is a clear need to investigate and associate the three levels of CE - macro-, meso- and micro-levels. This will support the creation of a suitable comparative platform for quantifying the effects of several circular strategies. This is also evidenced by the study by **Pamminger et al.** (**2021**) that analyzed the environmental impacts of three circular scenarios - repairing, refurbishing and partial remanufacturing, when performed on a typical noncircular smartphone. In the "repairing and refurbishing scenarios, the highest potential for smartphones was demonstrated within CE." Likewise, **Hazen et al.** (**2017**) investigated the issue of access to refurbished products. He drew attention to the importance of researching and understanding consumer attitudes and behavior toward refurbished products. According to several studies, consumers show negative attitudes toward refurbished products (**Sakao and Sundin, 2019**). **Singhal et al.** (**2019**) confirms that the acceptance of remanufactured products by consumers and the appropriate popularization of these products are necessary to achieve the goals of the CE. Refurbishing is in the vital interest of the industry, but substantial scientific support for effective refurbishing is absent in the literature. This is also one of the obstacles to effectively beginning or improving refurbishing processes. Recent research examines consumer attitudes, personal benefits, knowledge, risk perception, subjective norms and market strategies. This calls for the need to associate the investigation of the macro-level with the micro-level also within the repairing, refurbishing and remanufacturing strategies - factors at the price level, government incentives, consumer attitudes, psychological motives, cultural and historical aspects and so forth. It opens up a space for a multidisciplinary solution to this issue. **Khan et al.** (**2022**) identified CSFs in implementing renovation practices to move to a CE. The authors state that it is essential to prepare new strategies to adopt renovation practices effectively. **Korhonen et al.** (**2018**) add that the short-term and long-term environmental impacts of the physical flows of materials and energy should be considered when creating, designing, reusing, remanufacturing and recycling projects. Many of these impacts are currently unknown.

According to the observed scientific sources, the **RQ1** was formulated as follows.

$RQ1$. Is there a relationship between the net income of the individual population groups and the circular materials use rate?

Repairing is one of the basic strategies of CE, enabling the extension of the life of products and materials. It is increasingly being foreshown as a critical sector that will benefit from employment through transitions to CE. However, the approaches to the evaluation of repairing are often criticized as highly technocratic, declaring repair a related process within everyday life. Also, most research focused on this area's macro- and meso-levels. From a procedural point of view, even in repairing strategies, impact research studies to quantify environmental and economic impacts dominate. **Calzolari et al.** (**2022**) criticize this dominant economic dimension and insufficient consideration of social and circularity measurements even within the individual CE strategies. **Wang et al.** (**2022**) list the four significant barriers to circular products: financial constraints, insufficient infrastructure, government inaction and obstacles in the global market. **Dewberry et al.** (**2017**) support this classification. Still, they also consider the lack of know-how in the field of repairs and maintenance and

problems related to product design (known as design prohibiting repairs) a significant barrier, **Bovea et al.** (**2017**), **Turkeli et al.** (**2019**).

Although product lifetime can be effectively extended by repair and reuse, the decision to repair is always the result of user initiative. The motivational systems and the examination of the barriers in this issue create the basement for forming the support mechanisms for the success of CE strategies. The role of users in the CE strategies and the importance of constructing motivational systems for repair development are also analyzed in their studies by **Van der Laan and Aurisicchio** (**2019**), **Selvefors et al.** (**2019**) and others. **Jaeger-Erben et al.** (**2021**) state that although the academic literature highlights the importance of repair as an essential strategy to extend the lifetime of the products, the available research focuses only on the business models and product designs, while the role of the consumer practices and routines is wholly underestimated. The study of **Terzioglu** (**2021**) reflects on this fact, while the author constructed the motivational model of repairs and barriers established based on the 19 factors that are considered the most influencing the behavior of the users during repairs. **Cooper and Salvia** (**2018**) classify the barriers to repairs into three groups: the barriers related to the product and its poor design, the barriers related to the propensity and ability of owners to repair the products that depend on their income, gender, values, skills and knowledge. The third group of barriers is related to the context of the repair services, the economy, the socio-cultural norms and the expectations. In recent years, the role of local initiatives supporting repairs and other creative forms of waste creation prevention has been activated (**Charter and Keiller, 2014; Gwilt, 2014; McLaren and McLauchlan, 2015**).

According to the mentioned sources of the scientific literature, the **RQ2** was designed followingly.

$RQ2.$ Is there a relationship between business related to the repair services and the share of circular material used, and the net income?

Marino and Pariso (**2020**) compared the performance of the 28 European Union member states from 2006 to 2016 to identify a level of achievement of CE goals. The European Union member countries have adopted various strategies, but only some have been sufficiently effective in achieving the purposes of the CE in the European Union. This is also confirmed by the study by **Marino and Pariso** (**2020**), who compared the performance of the 28 European Union member states in the years 2006-2016, and they tried to investigate the level of CE objectives fulfillment. The developments in approaches and metrics create a space for constructing new evaluation dimensions (**Garcia-Barragan et al, 2019; Moraga et al, 2019; Parchomenko etal., 2019; Fellner and Lederer, 2020**). However, their influence on creating new policies for global material use is still unknown. **Bibas et al.** (**2021**) recommend the outputs of the OECD's ENV-Linkages model that examines the economic and environmental impacts of the global material fiscal reform. He appeals to the necessity of creating policies and mechanisms enabling decoupling between economic growth and material use. **Brandt et al** (**2021**) states that amounts of mismanaged electronic waste increase with economic growth up to a particular stage of economic development - known as a breaking point. A unidirectional causal relationship between economic growth to uncollected and unrecycled reused electronic waste was found. **Beccarello and Di Foggia** (**2018**) point to the economic benefits of higher goals in the recycling processes in the form of new labor positions, development of production and growth of added value. **Ibn-Mohammed et al.** (**2021**) emphasize the need for significant structural changes in the economy and, in this context, draw attention to the importance of reassessing the current model of global economic growth supported by profitability, production processes and a linear economy. According to

the authors, it is necessary to define specific sector-specific recommendations for developing CE as an accelerator of global economic growth.

The above-mentioned sources point to the subsequent **RQ3** that was formulated successively.

$RQ3$. Is there a difference in the closeness of the observed relationships compared to the more and less economically developed countries?

The results of the mentioned studies emphasize the importance of the circular connection between the economic development of the countries and the ecological policies. They also highlighted the necessity of an examination and a linkage of the three levels of CE - macro-, meso- and micro-levels. They also drew attention to the insufficient research of the sectoral policies within the CE processes and the inadequate sharing of the research findings and their translation into the active policies.

3. Methodology

The main goal of the research was to analyse and to quantify the relationships between the circular materials use rate, business in the field of repair services and income. Subsequently, the goal was to examine these relationships within the dimension of the economic development of the countries. According to the aim of the research (stated in the theoretical part), the process of the research activities was formulated in the three following research questions.

RQ1: Is there a relationship between the net income of the individual population groups and the circular materials use rate?

RQ2: Is there a relationship between business related to the repair services and the share of circular material used, and the net income?

RQ3: Is there a difference in the closeness of the observed relationships compared to the more and less economically developed countries?

The first research question reveals the relation between income and CE use. This relationship was given the highest attention and was evaluated applying the panel regression analysis. The second research question completes consistency through the correlation analysis of business related to the repair services and the share of circular material used, and the net income. The last research question focused on the assessment of outputs by the groups of the countries with more and less economic development. The countries into the mentioned groups were divided through the cluster analysis according to the variables Gross domestic product (GDP) and Human Development Index (HDI). The differences were identified through to the outputs of the analyses from the previous two research questions.

3.1 Material

The data for the period 2010 to 2020 from all the countries of the European Union represents the input for the analytical processes (Austria (AUS), Belgium (BEL), Bulgaria (BGR), Cyprus (CYP), Czechia (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), Greece (GRC), Hungary (HUN), Croatia (HVR), Ireland (IRL), Italy (ITA), Lithuania (LTU), Luxembourg (LUX), Latvia (LVA), Malta (MLT), Netherlands (NDL), Poland (POL), Portugal (POR), Romania (rOu), Slovakia (SVK), Slovenia (SVN), Sweden (SWE)). Furthermore, to evaluate the economic development of the countries, two variables were applied: the human development index (**United Nations Development Programme, 2022**) and real gross domestic product per capita (**Eurostat, 2022a,b,c,d**). GDP and HDI represent the two fields of economic development whose basement level of development can be relatively reliably determined. GDP fairly reliably captures the basic economic flows that comprise most of the economy. However, GDP is a slight issue in capturing the financial flows as the grey economy exists, volunteer work or other areas where work contribution is not clearly defined. On the other hand, the HDI focuses on the non-financial output of the economy more dominantly (education, life expectancy or income distribution in households). Therefore, relatively accurate and appropriate information about the economic development of individual countries can be obtained through a combination of the two mentioned areas.

The relationships were assessed between the income groups (13 variables) and the circular material use rate. The data declaring net annual income were obtained from the **Eurostat** (**2022a**) databases (in EUR). The purchasing power standard metrics (recalculated purchasing power parities) were applied to mitigate the influence of the price disparities. The following variables were included:

Annual net earnings.

(1) Single person without children earning 50% of the average earning (S Ch0 50%)
(2) Single person without children earning 67% of the average earning (S Ch0 67%)
(3) Single person without children earning 80% of the average earning (S Ch0 80%)
(4) Single person without children earning 100% of the average earning (S Ch0100%)
(5) Single person without children earning 125% of the average earning (S Ch0125%)
(6) Single person without children earning 167% of the average earning (S Ch0167%)
(7) Single person with two children earning 67% of the average earning (S Ch2 67%)
(8) One-earner couple with two children earning 100% of the average earning (C1 Ch2 100%)
(9) Two-earner couple with two children. One earning 100% and the other 33% of the average earning (C2 Ch2 100% and 33%)
(10) Two-earner couple with two children. One earning 100% and the other 67% of the average earning (C2 Ch2 100% and 67%)
(11) Two-earner couple with two children. Both earning 100% of the average earning (C2 Ch2 100% and 100%)
(12) Two-earner couple without children. One earning 100% and the other 33% of the average earning (C2 Ch0 100% and 33%)
(13) Two-earner couple without children. Both earning 100% of the average earning (C2 Ch0 100% and 100%)

Another variable included was the circular material use rate percentage (CM use rate) obtained from the Eurostat database (**Eurostat, 2022b**). This ratio represents a critical indicator and one of the most applied variables in the explored field.

The area of business related to the repair services covers three areas ((1) Repair and installation of machinery and equipment; (2) Wholesale and retail trade and repair of motor vehicles and motorcycles; (3) Repair of computers and personal and household goods). The five metrics were applied in these three areas ((1) Enterprises - number per 100,000 persons; (2) Production value - million euro PER 100 000 PERSONS; (3) Employees - number PER 100 000 PERSONS; Turnover per person employed - thousand euro; (4) Turnover per person employed - thousand euro; (5) Gross value added per employee - thousand euro) (**2022c**).

If society understands the CE correctly and the conditions for its development are created, it will be reflected in the functioning of the repair services sector. Therefore, the mentioned variables can be considered suitable for describing the functioning of the CE in society.

(1) Repair and installation of machinery and equipment Enterprises - number per 100.000 persons
(2) Repair and installation of machinery and equipment Production value - million euros per 100,000 persons
(3) Repair and installation of machinery and equipment Employees - number per 100.000 persons
(4) Repair and installation of machinery and equipment Turnover per person employed - thousand euro
(5) Repair and installation of machinery and equipment Gross value added per employee - thousand euro
(6) Wholesale and retail trade and repair of motor vehicles and motorcycles Enterprises - number per 100,000 persons
(7) Wholesale and retail trade and repair of motor vehicles and motorcycles Production value - million euros per 100,000 persons
(8) Wholesale and retail trade and repair of motor vehicles and motorcycles Employees - number per 100,000 persons
(9) Wholesale and retail trade and repair of motor vehicles and motorcycles Turnover per person employed - thousand euro
(10) Wholesale and retail trade and repair of motor vehicles and motorcycles Gross value added per employee - thousand euro
(11) Repair of computers and personal and household goods Enterprises - number per 100.000persons
(12) Repair of computers and personal and household goods Production value - million euros per 100,000 persons
(13) Repair of computers and personal and household goods Employees - number per 100,000persons
(14) Repair of computers and personal and household goods Turnover per person employed - thousand euro
(15) Repair of computers and personal and household goods Gross value added per employee - thousand euro

3.2 Analytical processing

The analytical processes were focused on the methods for relationship evaluation. In the first stage of these processes, cluster analysis was applied, whose purpose was to divide the countries into clusters according to the economic maturity presented by the human development index and real gross domestic product per capita. This analysis was carried out using the Partitioning Around Medoids (PAM) method using Manhattan Distances, while the number of clusters was estimated using the Silhouette method (**Kassambara, 2017**). Two variables (GDP and HDI) were included in this analysis and PAM appears to be the most suitable technique for the application of the cluster analysis under the given conditions. In this case, the Manhattan distance appears to be a suitable mechanism as there are the significant differences in economic development between the countries and thus, it can work relatively reliably even in the presence of the certain outliers. The essential descriptive and correlation analysis characteristics - Pearson's r coefficient - were also used. The descriptive analysis together with the correlation analysis had the task of emphasizing the basic characteristics of the applied variables. The parametric method of the correlation analysis was selected according to the fact that with the explored data, it can bring more reliable results than a non-parametric alternative. The elementary condition -deviations from the normal statistical distribution was evaluated according to skewness and kurtosis. The most important part of the study was applying panel regression analysis with individual effects (the structure of the countries was taken into account). For this type of analysis, the application of the panel regression analysis is a common and generally accepted procedure. The simple regression models were applied as there was a high level of correlation between the independent variables that would significantly distort the results of the multiple models. Random effect models were applied. As there was significant heteroscedasticity in the relationships, these relationships were estimated using the White 2 estimator. The specific selection of the panel regression model was preceded by an analysis of the conditions, where the F-test for Individual/Time Effects, the Hausman test and the Breusch-Pagan test was applied. The F-test clearly emphasized the necessity of using the panel regression model according to the structure of the countries. The Hausman test confirms the choice of the random effects model, and the Breusch-Pagan test declares the occurrence of significant heteroscedasticity. The mentioned regression model was also enriched with an assessment of the results' robustness by applying instrumental variable regression - Hausman-Taylor's transformation with the help of Baltagi's transformation based on the instrumental variable estimation. Such a succession of steps is desired to demonstrate the analytical outcome as expected according to the set objectives. The analytical processes were carried out in the R language environment – version 4.2.1 (**R Core Team, 2022**) using the R studio application. The packages such as plm, lmtest, Sandwich, cluster, factoextra and ggplot2 were used.

4. Results

This section focuses on a comprehensive description of the outcomes resulting from the main objective of the research, which was to assess the relationship between wage and the ratio of the use of recycled materials under the burden of economic development in the European Union. In the first step of the analytical process, the countries of the European Union were divided into two groups according to their economic development. Subsequently, descriptive and correlational analyses were applied to create a broader picture of the analyzed indicators. At the end of this section, the regression analysis was carried out that pointed out the closeness of the relations between the wage and the ratio of the use of recycled materials. Finally, the analytical processes were carried out for the individual clusters. Based on the results, it is appropriate to recognize the differences between the countries with higher and lower levels of development.

Figure 1 demonstrates the cluster analysis output through the partitioning around medoids method applying the Manhattan distance. The number of clusters was estimated through the silhouette method. The inputs for this analysis are represented by the average values (the average values of the countries were calculated for the individual years 20102020) of the real gross domestic product per capita and the human development index values. The European Union member countries were divided into two clusters according to economic development. The division is done so that the countries in the first cluster are considered the countries with a higher level of development, and those in the second cluster are the countries with a lower level of development. The subsequent analytical processes are divided for both groups of the countries with a higher (cluster 1) and lower (cluster 2) level of development.

Table 1, the basic statistical characteristics of the circular material use indicators and earnings for the specific population groups were calculated. The entire analysis is divided into two clusters, whereby all the indicators with very high disparities can be observed, especially in the statistical characteristics of the central tendency. For example, when looking in detail at the share of circular material use, it was found that the more economically developed countries possess this share approximately once as large as the less-developed countries (circular material use rate %: cluster 1 median is at a level of 10.25%, mean stands at 11.96% $\pm$ 6.92% regarding the confidence interval; cluster 2 median is equal to 4.60%, mean stands at 6.04% ± 4.54%). Similar results were also found in income - in the more economically developed countries; people earn about twice as much as in the less-developed countries. Therefore, the mentioned population groups are divided from the lowest earning groups to the highest ones. At the same time, the characteristics of the children population are also given in these groups, which on the one hand, represent costs, but also income that is determined by the setting of the social policy of the individual countries. For instance, a single resident without children with earnings at 50% of the average income (S Ch0 50%) earns an average of 14,474.2 EUR per year in developed economies.

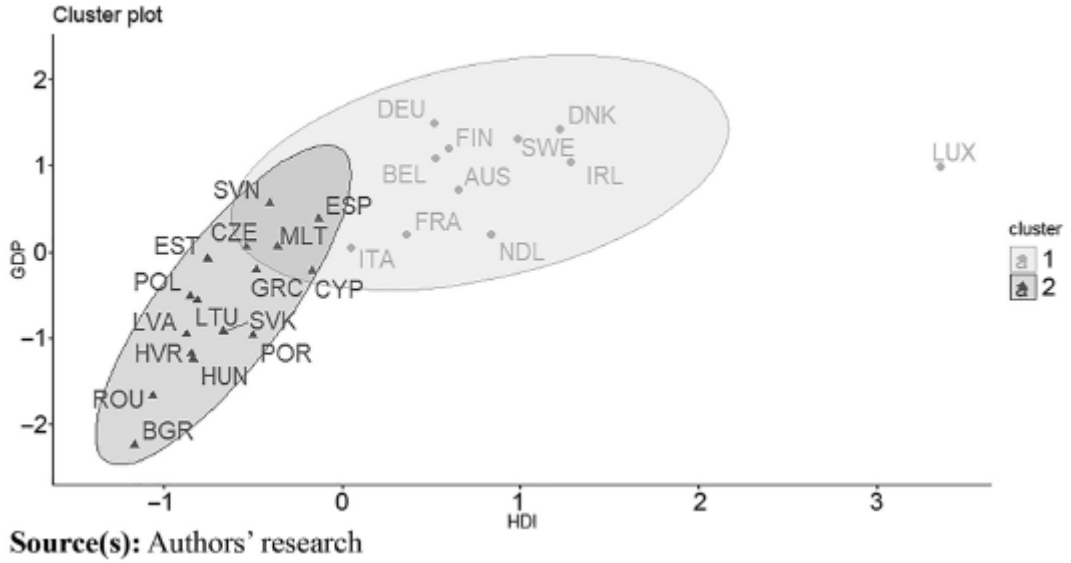


Figure 1. Cluster map

Table 1. Descriptive analysis

Indicator	Mean	Median	Std	Skew	Kurt	25. perc	75. perc
Cluster 1							
CM use rate	11.96	10.25	6.92	0.91	0.33	7.35	16.80
S Ch0 50%	14474.2	14569.5	2734.9	−0.47	0.67	13168.8	16167.5
S Ch0 67%	18051.4	18113.2	3399.3	−0.54	0.81	16637.8	20018.7
S Ch0 80%	20822.6	21070.4	3800.3	−0.64	0.97	19411.2	22870.1
S Ch0 100%	24874.2	25085.3	4334.0	−0.80	1.25	23435.2	27051.9
S Ch0 125%	29612.9	29727.7	5019.1	−0.78	1.27	27857.5	32244.9
S Ch0 167%	37329.2	37105.1	6263.7	−0.72	1.14	35006.6	41123.4
S Ch2 67%	23088.1	23127.4	4836.7	0.08	−0.45	20060.3	26087.3
C1 Ch2 100%	29935.9	29954.4	5991.2	0.21	0.15	26589.5	32959.1
C2 Ch2 100% and 33%	38963.8	38809.6	7802.1	−0.15	0.26	35279.2	42954.1
C2 Ch2 100% and 67%	46461.9	46525.2	8933.1	−0.26	0.43	42732.5	51304.2
C2 Ch2 100% and 100%	53218.8	53481.5	9847.8	−0.43	0.62	49232.8	58321.3
C2 Ch0 100% and 33%	35674.6	35814.0	6887.8	−0.48	0.86	32824.7	39676.3
C2 Ch0 100% and 100%	49879.8	50170.5	8856.0	−0.69	1.17	46870.5	54103.8
Cluster 2							
CM use rate	6.04	4.60	4.54	1.40	1.36	2.50	7.60
S Ch0 50%	7511.5	7035.6	2465.5	0.37	−0.75	5726.5	9504.1
S Ch0 67%	9676.6	9194.9	3068.3	0.37	−0.76	7508.5	11837.6
S Ch0 80%	11314.4	10679.0	3507.7	0.37	−0.75	8792.2	13933.9
S Ch0 100%	13760.7	13025.6	4108.4	0.33	−0.75	10855.9	16977.3
S Ch0 125%	16801.5	16187.8	4849.1	0.31	−0.71	13386.8	20337.6
S Ch0 167%	21824.5	21117.2	6029.6	0.33	−0.53	17593.2	25962.7
S Ch2 67%	11958.3	11206.9	4109.4	0.51	−0.59	8980.0	14225.3
C1 Ch2 100%	16119.8	15799.1	4768.3	0.07	−0.98	12931.7	20036.2
C2 Ch2 100% and 33%	20770.7	19776.9	6276.7	0.19	−0.90	16448.3	25653.5
C2 Ch2 100% and 67%	25220.0	24035.1	7695.5	0.23	−0.92	19908.7	31664.6
C2 Ch2 100% and 100%	29263.9	28418.3	8747.2	0.21	−0.90	23076.8	36599.0
C2 Ch0 100% and 33%	19115.1	17734.5	5997.5	0.32	−0.90	14983.0	23463.2
C2 Ch0 100% and 100%	27725.7	26051.2	8436.7	0.32	−0.88	21711.8	34504.6

***Note(s)**: CM – circular material, S – single, Ch – child, C1 – one-earner couple, C2 – two-earner couple*

***Source**(s): Elaborated according to own calculations in the R software environment*

In contrast, the countries with lower economic development earn an average of only 7,511.5 EUR. Also, the average annual income of a couple with two children, where both earn an average income (C2 Ch2100% and 100%), is € 53,218.8 in the more developed countries and 29,263.9 EUR in the less-developed countries. Skewness and kurtosis in almost all the cases are assigned the values lower than 1 in an absolute way, while the values higher than one were detected only in the case of cluster 2 in the circular material use rate indicator (skewness stands at 1.40, kurtosis at 1.36). According to the above outputs, fundamental deviations from the normal distribution are not found.

Table 2 provides information on the intensity of the bivariate relations between the ratio of circular material use and income. The outcomes of the correlation analysis indicate a moderate correlation between the ratios of the circular materials used generally. In the individual clusters, the association level does not fundamentally alter. The relationships between the income categories were also analyzed, and it was found that there is a robust correlation between these categories - in all the cases, it is higher than 0.9. The income categories represent the independent variables, and a high correlation would cause certain model distortions. It also results in high collinearity. Therefore, in the following

cases, the relationships will be estimated by applying the simple regression analysis with the sole variable appearing as an independent variable.

Table 2. Correlation analysis - Pearson's R

CM use rate %	Cluster 1 Correlation	Cluster 1 Sig	Cluster 2 Correlation	Cluster 2 Sig
S Ch0 50%	0.398	<0.001	0.389	<0.001
S Ch0 67%	0.319	<0.001	0.390	<0.001
S Ch0 80%	0.306	<0.001	0.392	<0.001
S Ch0 100%	0.320	<0.001	0.378	<0.001
S Ch0 125%	0.327	<0.001	0.373	<0.001
S Ch0 167%	0.349	<0.001	0.382	<0.001
S Ch2 67%	0.343	<0.001	0.445	<0.001
C1 Ch2 100%	0.257	0.003	0.429	<0.001
C2 Ch2 100% and 33%	0.312	<0.001	0.410	<0.001
C2 Ch2 100% and 67%	0.329	<0.001	0.394	<0.001
C2 Ch2 100% and 100%	0.339	<0.001	0.383	<0.001
C2 Ch0 100% and 33%	0.295	0.001	0.368	<0.001
C2 Ch0 100% and 100%	0.318	<0.001	0.350	<0.001

***Note(s)**: CM – circular material, S – single, Ch – child, C1 – one-earner couple, C2 – two-earner couple*

***Source(s)**: Elaborated according to own calculations in the R software environment*

The analysis also paid considerable attention to the regression model selection. **Table 3** offers the outputs, which emerged from that the most suitable way is an application of linear regression model for panel data. Specifically, these outputs recommend applying the individual random effect model with the White heteroskedasticity consistent estimator. The F-test for the structure of countries (F-test - country) in all the cases indicates a significant level of the structure of the countries, while on the contrary, the significance did not appear for the structure of years (F-test - year). From the mentioned tests of the conditions to carry out the analysis, it can be said with a relatively high level of certainty that for the given model, it is appropriate to take into account only the structure of the countries. For instance, a model with individual effects will go. The robust Hausman test of consistency in all the cases is assigned a level of statistical significance higher than 0.05, meaning the random effect model is more suitable. The last column demonstrates a constant character of the variability of the residuals revealing present homoscedasticity, and this data can be reliably characterized as heteroskedastic. Therefore, the Sandwich method suitable for random effect models, the White heteroskedasticity consistent estimator, will be applied to estimate the models.

Table 4 demonstrates the main output of the presented research. In this table, the links between the income in the individual population groups and the rate of circular materials use were estimated through the panel individual random effect model with the help of the White 2 estimator. The results in all the cases examined indicated a positive relationship between income and the circular materials use rate. Thus, higher utilization of circular materials can be expected in countries with a higher wage rate. If we focus on the outputs in comparing cluster 1 and cluster 2, it is clear that cluster 2 (the less-developed countries) acquires closer relations than cluster 2 (the more developed countries). This is also observable from the values of the coefficient of determination R^2, for instance. From the above mentioned, we can shape an opinion that income can be understood as one of the factors affecting the CE, and its importance will be more significant in the countries with lower economic development.

It will be more significant primarily because the less-developed countries are also characterized by lower income.

The aforementioned analytical processes were also supported by enriching the regression models with the instrumental variables. This process partially reduced the risk of the endogeneity problem, at least. Furthermore, the regression models were enhanced by income assessment (the calculation of this variable is presented below, as this variable also appears in the following analytical processes) and export of plastics, including rubber out of the European Union in tons per capita with an annual lag (lag equal to —1).

Table 3. Panel regression analysis prerequisites - random model White 2 estimator

Indicators	F test – country	F test – year	Hausman robust	Breusch–Pagan
Cluster 1				
S Ch0 50%	76.11 (<0.001)	0.14 (0.999)	0.38 (0.536)	19.45 (<0.001)
S Ch0 67%	81.18 (<0.001)	0.1 (1)	0.1 (0.755)	21 (<0.001)
S Ch0 80%	82.14 (<0.001)	0.1 (1)	0.06 (0.814)	20.32 (<0.001)
S Ch0 100%	81.33 (<0.001)	0.1 (1)	0.09 (0.77)	17.18 (<0.001)
S Ch0 125%	80.61 (<0.001)	0.1 (1)	0.17 (0.684)	14.28 (<0.001)
S Ch0 167%	79.15 (<0.001)	0.11 (1)	0.23 (0.635)	12.08 (0.001)
S Ch2 67%	84.26 (<0.001)	0.1 (1)	0.01 (0.912)	25.41 (<0.001)
C1 Ch2 100%	85.16 (<0.001)	0.08 (1)	<0.01 (0.965)	9.27 (0.002)
C2 Ch2 100% and 33%	82.47 (<0.001)	0.09 (1)	0.02 (0.898)	16.44 (<0.001)
C2 Ch2 100% and 67%	82.02 (<0.001)	0.09 (1)	0.02 (0.887)	17.04 (<0.001)
C2 Ch2 100% and 100%	81.39 (<0.001)	0.1 (1)	0.03 (0.857)	15.15 (<0.001)
C2 Ch0 100% and 33%	82.33 (<0.001)	0.09 (1)	0.06 (0.813)	19.98 (<0.001)
C2 Ch0 100% and 100%	81.5 (<0.001)	0.1 (1)	0.07 (0.792)	16.92 (<0.001)
Cluster 2				
S Ch0 50%	76.14 (<0.001)	0.05 (1)	0.01 (0.934)	37.38 (<0.001)
S Ch0 67%	75.42 (<0.001)	0.05 (1)	0.01 (0.93)	39.88 (<0.001)
S Ch0 80%	74.58 (<0.001)	0.06 (1)	<0.01 (0.955)	42.07 (<0.001)
S Ch0 100%	73.14 (<0.001)	0.05 (1)	<0.01 (0.966)	43.52 (<0.001)
S Ch0 125%	72.87 (<0.001)	0.05 (1)	0.02 (0.897)	41.86 (<0.001)
S Ch0 167%	72.09 (<0.001)	0.06 (1)	0.07 (0.788)	40.26 (<0.001)
S Ch2 67%	64.98 (<0.001)	0.1 (1)	0.51 (0.477)	36.47 (<0.001)
C1 Ch2 100%	67.22 (<0.001)	0.07 (1)	0.48 (0.487)	32.61 (<0.001)
C2 Ch2 100% and 33%	71.14 (<0.001)	0.06 (1)	0.14 (0.709)	38.02 (<0.001)
C2 Ch2 100% and 67%	72.14 (<0.001)	0.05 (1)	0.06 (0.799)	40.2 (<0.001)
C2 Ch2 100% and 100%	71.74 (<0.001)	0.05 (1)	0.08 (0.78)	41.39 (<0.001)
C2 Ch0 100% and 33%	75.79 (<0.001)	0.06 (1)	0.01 (0.917)	42.26 (<0.001)
C2 Ch0 100% and 100%	75.13 (<0.001)	0.05 (1)	0.01 (0.941)	43.17 (<0.001)

Note(s): CM – circular material, S – single, Ch – child, C1 – one-earner couple, C2 – two-earner couple

Source(s): Elaborated according to own calculations in the R software environment

These variables were selected according to their strong correlation with the independent variable and low correlation with the dependent variable. In all the cases, it was a random effect model based on a one-way individual effect with Hausman-Taylor's transformation and the help of Baltagi's instrumental variable estimation.

The endogeneity issue's significance was assessed by comparing the outputs from **Tables 4** and **5**. The outputs of the partial least squares regression random effect model do not differ significantly from the

output of the model enriched with the instrumental variables. Therefore, according to those mentioned above, it is possible to consider the models sufficiently robust for a qualified estimation of the relationships between income and the circular materials use rate.

Subsequently, attention was paid to the specific countries and their output in the researched area. The individual countries in cluster 1 and cluster 2 were assessed through their average standardized values. In the first step of this process, the data were averaged (the average was shaped by years). After adding the average values for the individual countries for all the variables, the newly created variables were standardized, where 0 represents the lowest value, that is, the worst rating, and 1, on the contrary, the highest value means the best rating. Since there were 13 income variables, the individual standardized income variables were also averaged.

Table 4. PLM model output -dependent variable: circular material use rate percentage (CM use rate)

		Cluster 1		Cluster 2	
Independent var	coef	Estimate	R^2	Estimate	R^2
S Ch0 50%	α	2.947 (0.45)	0.055	1.199 (0.421)	0.129
	β	0.000623 (0.019)		0.000644 (<0.001)	
S Ch0 67%	α	3.193 (0.437)	0.043	1.185 (0.428)	0.123
	β	0.000486 (0.032)		0.0005 (<0.001)	
S Ch0 80%	α	2.668 (0.524)	0.044	1.274 (0.393)	0.116
	β	0.000446 (0.026)		0.00042 (<0.001)	
S Ch0 100%	α	2.242 (0.587)	0.045	1.769 (0.224)	0.091
	β	0.000391 (0.017)		0.000309 (<0.001)	
S Ch0 125%	α	2.909 (0.453)	0.042	1.981 (0.163)	0.084
	β	0.000306 (0.016)		0.000241 (<0.001)	
S Ch0 167%	α	2.523 (0.517)	0.045	2.104 (0.129)	0.083
	β	0.000253 (0.013)		0.00018 (<0.001)	
S Ch2 67%	α	1.558 (0.584)	0.089	3.347 (0.011)	0.061
	β	0.00045 (<0.001)		0.000225 (0.003)	
C1 Ch2 100%	α	2.682 (0.516)	0.043	2.585 (0.059)	0.073
	β	0.00031 (0.028)		0.000216 (0.001)	
C2 Ch2 100% and 33%	α	2.306 (0.563)	0.051	2.039 (0.145)	0.098
	β	0.000248 (0.017)		0.000193 (<0.001)	
C2 Ch2 100% and 67%	α	1.426 (0.711)	0.058	2.031 (0.152)	0.095
	β	0.000227 (0.007)		0.000159 (<0.001)	
C2 Ch2 100% and 100%	α	0.995 (0.795)	0.059	2.296 (0.102)	0.080
	β	0.000206 (0.005)		0.000128 (<0.001)	
C2 Ch0 100% and 33%	α	3.565 (0.404)	0.039	1.395 (0.348)	0.11
	β	0.000235 (0.05)		0.000242 (<0.001)	
C2 Ch0 100% and 100%	α	2.203 (0.593)	0.046	1.793 (0.222)	0.089
	β	0.000196 (0.018)		0.000153 (<0.001)	

***Note(s)**: CM – circular material, S – single, Ch – child, C1 – one-earner couple, C2 – two-earner couple*

***Source(s)**: Elaborated according to own calculations in the R software environment*

The described process resulted in two new variables - firstly, average earnings - evaluation and secondly, circular material use rate - evaluation. Their outputs are shown in **Figure 2**.

Both cluster maps also demonstrate a trend, but they do not possess a high level of reliability in assessing the countries, as 12 fell into cluster 1 and 15 belong to cluster 2. However, even from this point of view, an increasing linear trend is apparent. The position of the individual countries has the maximum added value. The lower left corner presents the lowest and the right corner the highest assessment of the selected variables. Focusing on

cluster 1, it can be seen that Slovenia has the lowest income rating and an approximately average rating for circular materials use. In this field, an increase in income could positively affect the circular materials use.

On the contrary, in the countries like Luxembourg or the Netherlands, an increase in income would be difficult. As mentioned above, the relationship between income and the circular materials used in the economy was more fundamental in the countries with lower economic development, that is, belonging to cluster 2. In these countries, the increase in income in the countries such as Bulgaria, Romania, Lithuania, Slovakia and Latvia could have the most significant impact on the development of the CE.

The last part of the research was devoted to the association of the business in the field of repair service with the ratio of the circular material use and the evaluation of the income. Spearman's correlation coefficient was applied to evaluate this relationship as skewness and kurtosis, as well as normality tests, showed certain deviations from the expected state.

Table 5. Robustness testing of regression model: Baltagi's instrumental variable estimation -dependent variable: circular material use rate percentage (CM use rate)

		Cluster 1		Cluster 2	
Independent var	coef	Estimate	R^2	Estimate	R^2
S Ch0 50%	α	2.20 (0.570)	0.084	2.376 (0.130)	0.107
	β	0.00067 (0.006)		0.00053 (<0.001)	
S Ch0 67%	α	0.353 (0.757)	0.065	2.339 (0.140)	0.103
	β	0.00059 (0.008)		0.00041 (<0.001)	
S Ch0 80%	α	0.864 (0.85)	0.064	2.307 (0.147)	0.098
	β	0.00053 (0.008)		0.00036 (<0.001)	
S Ch0 100%	α	0.663 (0.887)	0.063	2.256 (0.162)	0.077
	β	0.00045 (0.008)		0.0003 (<0.001)	
S Ch0 125%	α	0.907 (0.843)	0.059	2.30 (0.154)	0.071
	β	0.00037 (0.008)		0.00024 (<0.001)	
S Ch0 167%	α	0.593 (0.899)	0.06	2.382 (0.137)	0.071
	β	0.0003 (0.060)		0.0002 (<0.001)	
S Ch2 67%	α	2.581 (0.492)	0.119	3.214 (0.026)	0.054
	β	0.00041 (0.004)		0.00027 (0.001)	
C1 Ch2 100%	α	0.235 (0.960)	0.065	2.754 (0.072)	0.061
	β	0.0004 (0.006)		0.00023 (<0.001)	
C2 Ch2 100% and 33%	α	1.026 (0.817)	0.073	2.758 (0.069)	0.083
	β	0.00028 (0.007)		0.00018 (<0.001)	
C2 Ch2 100% and 67%	α	0.658 (0.888)	0.064	2.674 (0.082)	0.078
	β	0.00023 (0.008)		0.00015 (<0.001)	
C2 Ch2 100% and 100%	α	0.683 (0.881)	0.079	2.635 (0.090)	0.066
	β	0.00021 (0.007)		0.00013 (<0.001)	
C2 Ch0 100% and 33%	α	1.234 (0.78)	0.061	2.283 (0.155)	0.093
	β	0.0003 (0.008)		0.00022 (<0.001)	
C2 Ch0 100% and 100%	α	0.659 (0.888)	0.064	2.228 (0.171)	0.075
	β	0.00023 (0.008)		0.00015 (<0.001)	

***Note(s)**: CM – circular material, S – single, Ch – child, C1 – one-earner couple, C2 – two-earner couple*

***Source(s)**: Elaborated according to own calculations in the R software environment*

When describing **Table 6**, let us focus firstly on everything on a level of significant relations. Most cases appear to be substantial. When defining the values and direction of the correlation coefficients, it is impossible to discuss a positive approach unambiguously, as in the previous analytical processes. When focusing on circular material use, it can be said that cluster 2 (the economically less-developed

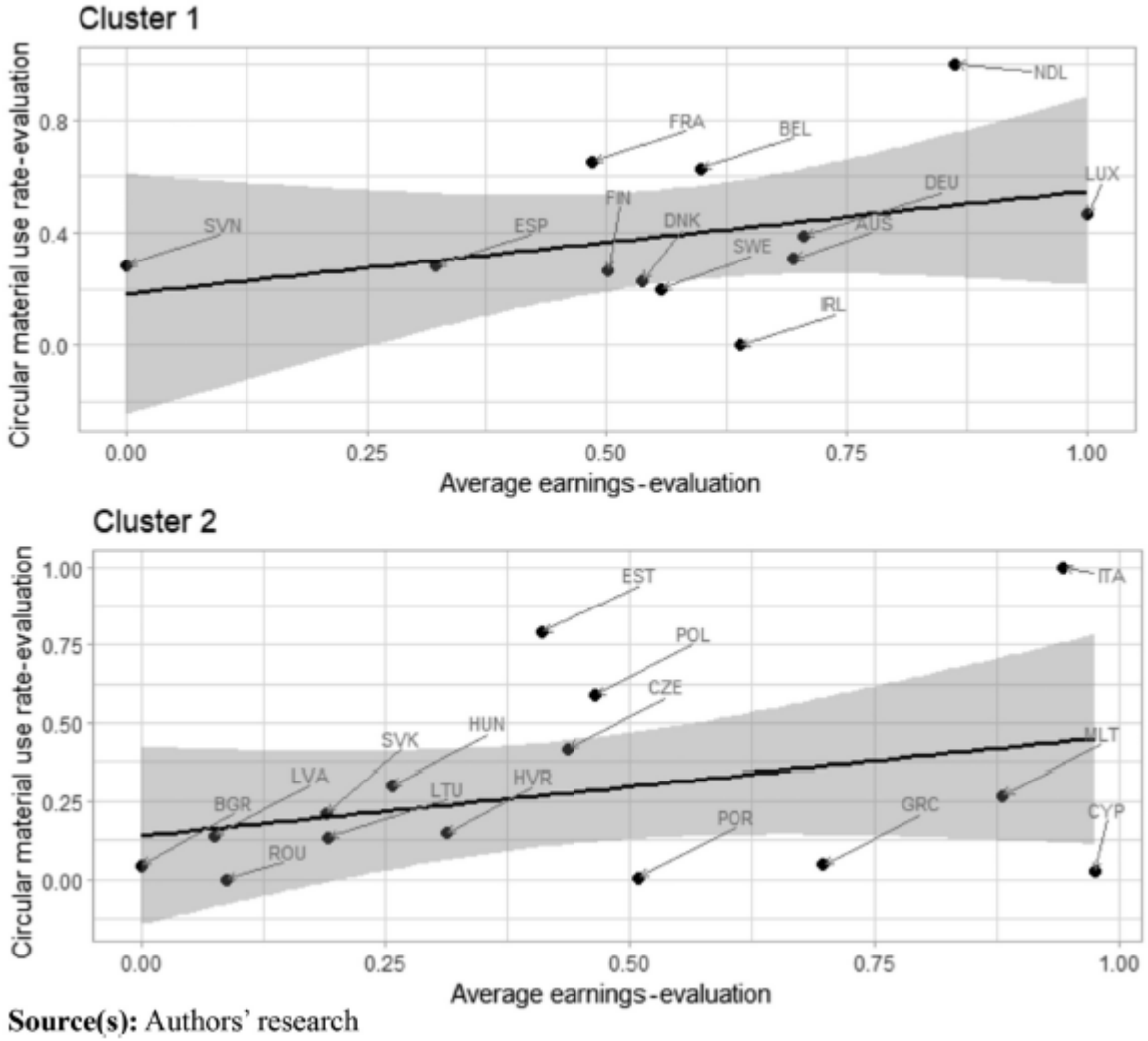
countries) demonstrated a higher level of positive connection than cluster 1. Similar results are also evident in the case of association business with income. In the less-developed countries, one can generally perceive a higher level of association of business in the field of repair services with income than in the more developed countries. When focusing on the specific areas of business, the highest level of association was manifested in repairing and installing machinery and equipment.

5. Discussion

The study's main goal was to analyze and quantify the relationships between the circular materials use rate and business in the repair services field and the income within the European Union member countries.

In the first step, the European Union member countries were divided into two clusters according to a level of economic development (human development index and real gross domestic product per capita). The countries with a higher level of development are represented by, for instance, Luxembourg, Denmark, Ireland and Sweden, and the less-developed countries by Bulgaria, Romania, Croatia or Hungary. The descriptive analysis of the investigated indicators pointed to the significant disparities between the studied parameters.

Figure 2. Clusters map -evaluation of average earnings and circular material use rate



Source(s): Authors' research

As in the ratio of the circular material use, as well as in the income, the outputs of the countries with the more developed economies were approximately twice large as the outputs of the countries with a lower level of development.

The results of the correlation analysis embody the existence of positive relations between the circular materials use rate and income. The relationships in clusters 1 and 2 are not assigned the fundamentally different measures of Pearson's r.

5.1 Panel regression model outcome

The results of the panel regression model confirmed the assumption that there is a significant positive relationship between income and the ratio of circular material use. This means that the higher the population's income, the more circular resources are spent in the economy. The assumption about the difference in the effects between the more and less-developed countries was also verified. Attention was focused on the coefficient of determination that shows a value for the less-developed countries twice higher as for, the more developed countries. In most cases, a closer relationship between income and the ratio of circular materials use was identified precisely in less-developed countries. Therefore, it is possible to presume that the changes in income in the less-developed countries will possess more substantial impacts on circular material use than in the more developed countries. According to the p and a convergence, the less-developed countries show more potential through increasing incomes. The only case where the coefficient of determination was higher in the more developed countries was found in a single individual with two children with 67% of the average income.

An appropriate social policy can regulate this discrepancy because it is an individual with two children with a below-average income.

In the last section of the analytical processes, attention was focused on assessing the income relations and the circular materials used among the countries. The countries with the highest and lowest ratings in the studied areas were identified by examining the relations between the mentioned variables. In cluster 1, Slovenia demonstrated the lowest level of income. This country also showed an average circular materials use rate. Ireland embodied the most inferior circular materials use rate. In cluster 2, where the less economically developed countries were included, a relatively substantial decline can be observed in the countries with a low rate of income but also with a more inferior circular materials use rate. These countries include Bulgaria, Romania, Lithuania, Slovakia, Latvia, Hungary and Croatia. Here, an increase in income could lead to a higher circular materials use rate.

There is a greater probability that in the countries with a higher level of business in the field of repair services, there will also be a higher rate of circular material use in the less-developed countries. Similar results were demonstrated in the association between business and income. In the less-developed countries, a higher relationship between business in the field of repair services and income was shown than in the more economically developed countries. Similarly, in less-developed countries, it is more likely that higher income can be associated with the more advanced business. These results correlate with the findings of the study by **Korhonen et al.** (**2018**).

When summarizing the findings, it is possible to emphasize the importance of the changes in the field of business and the population's income due to the consumption of circular material. The changes leading to an increase in income and the initiatives leading to the development of business related to repair services will impact a higher level of circular material use. These findings are significant for constructing effective strategies and policies related to repair services within CE.

Table 6. Linking the outputs of the repair sector of business with the circular material use rate and the income assessmen

Indicator		Cluster 1		Cluster 2	
		CM use rate	Av Ern - eval	CM use rate	Av Ern - eval
Repair and installation of machinery and equipment	Enterprises	−0.259 (0.003)	−0.487 (<0.001)	0.719 (<0.001)	0.214 (0.007)
	Production value	0.462 (<0.001)	0.417 (<0.001)	0.682 (<0.001)	0.545 (<0.001)
	Employees	0.091 (0.31)	−0.314 (<0.001)	0.46 (<0.001)	0.019 (0.819)
	Turnover per person employed	0.55 (<0.001)	0.792 (<0.001)	0.486 (<0.001)	0.714 (<0.001)
	Gross value added per employee	0.23 (0.009)	0.754 (<0.001)	0.317 (<0.001)	0.882 (<0.001)
Wholesale and retail trade and repair of motor vehicles and motorcycles	Enterprises	−0.131 (0.134)	−0.226 (0.009)	0.04 (0.612)	0.47 (<0.001)
	Production value	0.35 (<0.001)	0.628 (<0.001)	0.522 (<0.001)	0.613 (<0.001)
	Employees	−0.03 (0.73)	0.547 (<0.001)	−0.153 (0.051)	−0.285 (<0.001)
	Turnover per person employed	0.236 (0.007)	0.515 (<0.001)	0.645 (<0.001)	0.553 (<0.001)
	Gross value added per employee	0.225 (0.01)	0.495 (<0.001)	0.484 (<0.001)	0.824 (<0.001)
Repair of computers and personal and household goods	Enterprises	0.077 (0.383)	−0.524 (<0.001)	0.128 (0.102)	0.109 (0.176)
	Production value	0.114 (0.193)	−0.177 (0.043)	0.544 (<0.001)	0.542 (<0.001)
	Employees	−0.204 (0.019)	−0.548 (<0.001)	0.102 (0.191)	−0.42 (<0.001)
	Turnover per person employed	−0.107 (0.224)	0.192 (0.028)	0.417 (<0.001)	0.522 (<0.001)
	Gross value added per employee	0.28 (0.001)	0.264 (0.002)	0.305 (<0.001)	0.772 (<0.001)

***Note(s)**: CM use rate: Circular material use rate percentage; Av Ern – eval: Average earnings – evaluation*

***Source(s)**: Elaborated according to own calculations in the R software environment*

The development of businesses in the repair services field is also directly influenced by the demand for these services. The role of the consumer and the factors that determine the decision-making processes have come to the forefront. Also, **Camacho-Otero et al.** (**2018**) state that the main factors affecting participation in the CE processes will be based on the characteristics of consumers, their personality characteristics, values and ideologies. The results of the studies also confirm these aspects by **Wieser and Troger** (**2016**), **Van der Laan and Aurisicchio** (**2019**), and others. Consequently, we consider the targeting of the policies and the strategies to specific demographic groups (by age, income, sex and education) significant to support the strategic goals of CE.

Besides the socioeconomic aspects, the development of CE in the countries will also be influenced by geographical elements. This fact is also pointed out by the study by **Ramos et al.** (**2020**), **Deutz et al.** (**2020**), **Lekan et al.** (**2021**) and others. Our study compared the investigated relationships within the more and less economically developed countries. The barriers related to introducing environmental

policies, efficient investments, social inclusion and public awareness represent the significant barriers in countries with middle and low incomes. Therefore, efficient tools should be sought to overcome them nowadays. This is also confirmed by the study of **Ferronato et al.** (**2019**). On the other hand, the developed countries should help the less-developed countries to solve their environmental problems related to waste reuse, waste management transfer and recycling technologies, investment in research and development, and training of local employees to mitigate potential environmental risks (**Liu et al., 2018**).

5.2 CE use policymaking

The results obtained in our study represent a strong appeal for policymaking that would increase understanding of public perception, attitudes and behavior regarding repair as an option for consumers, as well as an opportunity for potential employment. It is also important to initiate research that will make it possible to identify the locations in the countries where higher effects from the development of the repair economy can be expected. The study by **Rogers et al.** (**2021**) conducted in Northeast England can also be an inspiration. It is also necessary to carry out empirical and conceptual research focused on consumer perception, attitudes and behavior toward the repair economy in European countries, thus helping to create a profile of the demographic and value orientation of the participants in the repair processes. It will support the development of the interdisciplinary aspect of the repair economy. The significance of this research is also confirmed by the fact that there has been a significant increase in support for repair services in Europe as well as in North America in recent years that was also reflected in the active policies, the legislation changes, and the tax redistribution processes (**Rogers et al., 2021**). This created considerable scope for multidisciplinary research in the field of CE. The activity of the participating parties will also be necessary, besides consumers and industry representatives, governments and international institutions. The European legislation actively supports the repairing activities as evidenced by the new measures adopted by the European Commission (EC, 2019,2020). As stated by **Rreuse** (**2017**), some activities of the national governments use tax reliefs to stimulate repair activities (Sweden, 50% of labor costs for repairs are tax deductible, and Austria now reimburses 50% of repair labor costs up to 600 EUR per year) that can represent one of the ways of the active government support and the incentives. It is also essential to appeal to the creation of national and international databases and to share knowledge from the repair services activities, even though the available studies demonstrate a strong reluctance of the manufacturers to share this information due to the potential business risks (**Svensson etal., 2018; Gharfalkar et al., 2016**). This can limit the creation of active policies and effective strategies within the repair services in CE.

Through public policies, national governments should actively influence consumers to favor CE strategies. The consumers' attitudes, the individual characteristics of consumers, as well as the socioeconomic factors - sex, age and education, can be considered the critical predictors of consumer behavior also within CE. This is also confirmed by the research findings of the authors **Camacho-Otero et al.** (**2018**), **Hazen et al.** (**2017**) and others. Several studies have declared age a significant predictor of consumer behavior toward repairs (**McCollough, 2010; Wieser and Troger, 2016; Camacho-Otero et al, 2018**). However, these studies indicate some trends in the individual characteristics of consumers. Mainly from the point of view of the technocratic perspective of CE, consumers are primarily perceived as rational economic consumers. However, in the available studies, an accurate evaluation of the influence of the individual nature as the actors responsible for decision-making about the repairs linked to the specific contexts (spatial, cultural, social, political, economic) is absent.

Therefore, further research into the demographic factors related to the adoption of the CE strategies is necessary, as well as consumer contextualization, to create an efficient stimulating strategy.

Besides the specific strengths, the study also shows some limitations identified mainly on the data side. The latest data on the consumption of circular materials come from 2020, so they do not cover the period related to the pandemic crisis. Nevertheless, it is believed that there may have been some changes in income during the pandemic, and they may have harmed CE.

6. Conclusion

The study's main goal was to analyze and quantify the relationships between the circular materials use rate, business in the field of repair services and income within EU countries. The results of the analyses pointed to significant differences between incomes and the circular material use rate. The income level in more economically developed countries was twice as high as the circular material use rate. It was found that there is a significant positive relationship between income and the circular materials use rate. The higher circular materials use rate was also declared in countries with higher income rates. It has been proven that in economically less-developed countries, there is a closer connection between the examined parameters than in developed countries. It is possible to assume that in less-developed countries, changes in income can have a more substantial impact on the development of the CE than in more developed countries. On an aggregate scale, it can be concluded that the success of policies and strategies aimed at the successful introduction of CE in individual EU countries will depend on many factors. At the same time, the following are currently considered among the primary barriers: financial restrictions, insufficient infrastructure, weak government support and obstacles on the global market. Consumers, industry leaders and the government are the most influential stakeholder groups in overcoming barriers. Higher demand for repair services will also initiate further development of business activities in this area at various regional levels. Progress in the repair services economy will continue to require extensive efforts in the future. Systematic coordination of activities at multiple levels of government together with manufacturers, designers, educational institutions, community institutions and individuals will be essential. Although it is assumed that individual motivations for repairs will vary and the contexts of management processes will constantly change, a critical process will be the continuous formation of individual and collective perceptions of repairs and the support of the operations of development of CE strategies by entrepreneurs as well as consumers. The national governments can significantly influence consumer behavior and opinions on repairs through public policies. Socioeconomic characteristics such as sex, age and education represent crucial predictors of consumer behavior. Therefore, we would like to focus future research on analyzing these characteristics and examine all the conceptual frameworks of consumer behavior and its positioning in detail within CE and the strategies related to the repair service. Discussing this issue through follow-up research will allow for solving complex transformational and political tasks related to the repair service strategies within CE. It will also inspire the discussion frameworks and multidisciplinary solutions to this issue affecting the fields of human geography, sociological, ethnographic, and political sciences. A qualitative approach is also necessary to test available theories and the effectiveness of adopted policy recommendations within a regional, national, political and regulatory context. The measurable impacts of the CE benefits are mostly quantified in the research studies through economic parameters. We would like to focus future research on investigating the social effects and the impacts of the critical policy documents within the CE framework on increasing countries' competitiveness.

Furthermore, there is to note that some limitations occur in the analytical process. Finally, the incompleteness of the data can also be included here as certain data is unavailable; hence, it was

estimated directly by the Eurostat statistical authority. Nevertheless, this incompleteness occurred only very rarely for the individual variables. A specific limitation is that the analytical procedures were carried out on the cross-sectional data. Thus, the outputs cannot be viewed as purely causal. Future research will focus on a comparison of the CE income-output relationships in the current post-crisis period.

Our ambition is also the development of critical benchmarking indicators in the field of repair services strategies at the national and international levels and to construct a platform for comparative system analyses. In this context, we also appeal to creating international databases and sharing research results in global research networks. These processes will also support the creation of effective strategies and active policies in the interest of CE development and the sustainability of economies.

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