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# The perception of European workers on the adoption of telework during and after the Covid-19 Pandemic: The use of supervised and unsupervised learning techniques

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## ABSTRACT

*Globally, 2020 began with unprecedented changes. With the worldwide declaration of the COVID-19 pandemic, the transition to teleworking took place instantly, becoming one of the largest historical experiments. The objectives of this study are to identify a limited number of characteristics of European workers regarding telework trends, to find typologies of groups of European countries where workers similarly perceive the forced adoption of telework imposed by the COVID-19 pandemic, and to find common patterns between Romanian and other European workers. At the same time, the research aims to predict the behaviour of European workers after the COVID-19 pandemic and how the attrition towards working from home can be improved. The Eurofund 2020 survey was used to conduct quantitative research. To achieve the first objective, unsupervised learning techniques (principal component analysis) were used to highlight the types of European workers. and how they have been affected by telecommuting. The results showed groups of European workers who were deeply affected in terms of isolation, personal life or work satisfaction, but also groups of European workers who can claim to be gainers as a result of remote work. For the second and*

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*third objectives, cluster analysis was selected as the method. The similarities and differences between the perceptions of European workers regarding the adoption of teleworking were assessed, with Romanian citizens having the same concepts as Poles and Irish. For the objective of predicting the high attrition of home work, following the results from the first objectives of the analysis, workers from European countries were divided into home workers and office workers and based on these, using supervised learning (logistic regression) one can predict which component should be improved in order to have a greater attrition regarding home workers.*

**Keywords:** telework, European workers, principal component analysis, clustering, unsupervised learning, COVID-19

**JEL Classification:** A130, C150, J440

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## INTRODUCTION

Telework is defined as the use of communication technologies to perform work outside the employer's premises (Vega et al., 2014). In recent years, information technologies have developed extremely rapid, and with them, also the ways of communication (World at work, 2011). In this context, telework has become a strategic field as it has the opportunity to develop very quickly, has a very wide potential, can influence the lives of workers for the better and most importantly, it becomes one of the main components of new scientific and technological revolutions that the society pursues (Bailey and Kurland, 2002), (Baruch, 2002).

Contrary to all the positive aspects, telework can generate marginalization and isolation (O'Neill et al. 2014), can increase stress for workers and can favour their exploitation (Loukidou et al., 2009). Although it can improve working methods, it can strengthen inequalities in the labour market in certain social groups (Belzunegui-Eraso and Erro-Garcés, 2020).

The year 2020 produced unprecedented changes in the global economy, on March 11 the World Health Organization (WHO) declared the new global pandemic coronavirus urging all governments around the world to take the necessary measures to protect themselves, so the first drastic measure was to block borders at the level of each country. This measure was followed by restrictions such as staying at home which directly influenced telework and all that it represented up to that point. In a scenario such as the COVID-19 pandemic, working from home was a very important aspect of ensuring business continuity, while normally the main benefits of teleworking would be reduced commuting time (Duxbury, Higgins and Neufeld, 1998) and the possibility of a better balance between family and professional life (Daniels et al., 2000). Under these conditions, the transition to telework was made instantly, without accommodation time, becoming one of the largest experiments in history.

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The aim of this paper is to find common patterns in the perception of European workers regarding the adoption of remote work imposed by the COVID-19 pandemic, using unsupervised learning techniques. After applying unsupervised learning, supervised learning is applied to see which components can be improved considering telecommuting behavior during the COVID-19 pandemic in order to increase post-Pandemic adoption of home working among selected European countries in the analysis. The research is based on data from the Eurofound Selective Survey (2020) and provides an overview of what remote working has meant for European workers.

The research begins with the analysis of European workers most severely affected by the adaptation to telework imposed by the COVID-19 pandemic. The use of unsupervised learning techniques creates the premise of highlighting common patterns in the perception of European workers. At the level of each pattern of European workers, we aim to find typologies of groups of European countries where workers similarly perceive the forced adoption of telecommuting imposed by the COVID-19 pandemic and how affected or unaffected they were by it. Finally, Romanian workers are placed in a common pattern with other European workers. Supervised learning helps to predict the behaviour already defined by unsupervised learning and which components of the components defined by unsupervised learning it should improve to frame the groups in the adoption of work from home.

## **1. SCIENTIFIC LITERATURE REVIEW**

### **1.1 Benefits and limitations of telework (aspects regarding productivity and well-being)**

The literature reports numerous benefits of telework for both workers and organizations. The main organizational benefits include savings on real estate costs, savings on electricity and savings on parking spaces (Alizadeh, 2013). Employee benefits include better time management, better work-life balance, and the elimination of transportation costs for office travel (Baker and Avery, 2007). Job satisfaction and productivity are positively associated with telework (Pyoria, 2011). Contrary to these benefits, there are many limitations associated with teleworking. An example would be the limitations in terms of organizational management that include difficulties in managing tasks (Ruth, 2009). Previous studies indicate that social exclusion is a very important concern that has a negative impact on the productivity of teleworkers (Shadler, 2016). This, together with limited interaction with colleagues, can affect the long-term promotion and career progression of certain patterns of workers.

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Telework could increase organizational and individual productivity (Silva, 2007). However, expectations for higher productivity from teleworkers are often created without a careful analysis of how managers perceive productivity. At the same time, the lack of an adequate measurement tool to effectively monitor productivity can often lead to inconclusive or even erroneous results from managers (Troup and Rose, 2012). According to the study (Westfall, 2004) four key factors are proposed that should be taken into account when measuring productivity: labour intensity, workload, work efficiency and organizational costs. In addition to these essential factors, others that have a positive impact on individual productivity should be included, such as: frequency of social interactions, completion of tasks, and managers' view of individual productivity (Warr, 2015).

Teleworking contributes significantly to the balance of workers in terms of work, personal life and family (Shadler, 2016). Worker well-being can be affected by work-related characteristics such as: level of difficulty and stress, task requirements, level of autonomy and social support (Alizadeh, 2013). These findings suggest that individual well-being is positively influenced by job perceptions and is consistent with flexibility in the workplace. Some studies on this concept focus on topics such as: work-life balance (Baker, 2007), teleworking trends, well-being, productivity (Vega, 2015), and the impact of culture on telework (Westfall, 2004).

### **1.2 The impact of telework upon professional activity**

With the spread of COVID-19 worldwide, the impact of the pandemic on the labour market has become increasingly widespread, with the imposition of restrictions affecting most workers (Bick, 2020). For many of them, the introduction of physical distance measures has had major consequences such as reduced wages, increased working hours, introduction of additional sessions and even job losses (Reisenwitz, 2020). For a significant segment of the active population, the pandemic has led to a sharp increase in workload, as well as considerable changes in working conditions. Although a large proportion of employees have been able to continue working through telework, a very large number of work-related issues should be considered to ensure the safety and health of employees (Mullen, 2020). The European Framework Agreement on Telework provides guidance on the organization of personal work, which indicates that workload and performance standards must be the same for both teleworkers and employers' workers (ETUC, 2002). Teleworkers enjoy the same legal protection and have the same responsibilities regarding data protection, confidentiality, and access to training, safety, and work organization.

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Telework research has repeatedly shown that employees working from home tend to work more hours than when working at the employer's premises (Mullen, 2020). The main reasons would be to replace travel time with work-related activities and to change the routine regarding the boundary between professional and personal life (John, 2019). Specific research on the working hours of employees working from home due to the COVID-19 pandemic has shown that 38% of them are willing to work overtime in the evenings or on weekends (McCulley, 2020). Employees who have children or other careers need to find extra time on their working day to do their homework, either starting work much earlier or working late into the evening. Also, the work schedule during the day may suffer an interspersed segmentation with short breaks dedicated to childcare or household chores (Kolakowski, 2019).

With no previous teleworking experience or only very limited experience, companies that worked from home in 2020 experienced a lack of clarity about the priorities and tasks they need to perform (McCulley, 2020). Many organizations, where teleworking was non-existent, had to instantly adapt to an unknown work system (Eurasia Review, 2020). Isolation creates uncertainty among workers, leading to specific issues such as shyness in approaching other colleagues or shyness in asking for specific support.

## **2. RESEARCH METHODOLOGY**

For the analysis of workers who have been severely affected by the adaptation to telework, data on European workers was used (Eurofound, 2020). The Eurofound selective research (2020) collected data in two stages, during the lockdown period and immediately after the lifting of the lockdown to discover the living and working conditions during the pandemic. The analysis includes two important aspects of the telework period, professional life, and personal life. There were questions about employment and quality of life, looking at the level of telework satisfaction from the workers' point of view. Eurofound (2020) identifies the most important areas of work affected by the COVID-19 pandemic, providing data on material aspects.

Information on teleworking and how it has been perceived by European workers is numerous and often contradictory. Techniques specific to unsupervised learning are intended to reduce chaotic informational content by finding common features (Chapelle et al., 2006). Unsupervised learning is a machine learning technique in which the presence of users during the process is not required (Pedrycz and Reformat, 2006). This allows the model to work on its own to discover patterns and pieces of information that were not previously detected (Girolami, 2002). Specific algorithms for unsupervised

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learning are clustering, anomaly detection, neural networks, and principal component analysis. These allow the performance of very complex processing tasks compared to algorithms specific to supervised learning (Karpathy et al., 2014).

One of the main techniques used in the study is principal component analysis. This technique is relevant because it significantly reduces the number of dimensions without losing important information (Smith, 2002). It applies to a single set of variables that form different independent subsets. Variables that are correlated with each other (but are largely independent of other sets of variables) are combined and given the name of factors (Gorunescu, 2006).

The second unsupervised learning technique used in the study is clustering. It mainly deals with finding a structure or patterns from an uncategorized data collection. Clustering-specific algorithms process data and find the groups that can be formed.

Supervised learning methods are also used in the analysis Logistic Regression, defined as one of the most powerful supervised learning algorithms, being an extension of the general regression model. Logistic regression identifies the possibility that a new observation belongs to classes 0 or 1. Logistic regression works on the basis of probability: if the probability value is greater than 0.5 then it will fall into class 1, if it is less than 0.5, then it is observed, will fit into box 0. (Uddin S. 2019).

The research challenges referred to:

- P1: Identify a small number of characteristics of European workers with regard to forced adoption of telework.
- P2: Finding typologies of groups of European countries in which workers similarly perceive the forced adoption of telework imposed by the COVID-19 pandemic.
- P3: Placing Romanian workers in a common pattern with other European workers.
- P4: Deciding the components that need to be improved for some European countries that did not fall under the favour of working from home in order to favour it.

To meet the first challenge, the principle component analysis method was considered the most appropriate, as it reduced the number of variables and obtained a small number of key factors based on which were able to identify the characteristics of European workers.

Regarding the principal component analysis, the table specific to the descriptive analysis was obtained, respectively the mean and the standard deviation. For the whole data set, the covariance matrix was generated in order to illustrate the correlations useful for the study. To get principal components, the table of eigenvalues and the scree plot graph were analysed.

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To achieve the next two challenges, the hierarchical clustering method was used. This offers the possibility to find certain typologies of groups of European countries in which workers similarly perceive the forced adoption of telework imposed by the COVID-19 pandemic, as well as the placement of Romanian workers in a common pattern with other European workers. The hierarchical clustering method is achieved by running the clustering algorithm and interpreting the results.

For the last point, after obtaining the main components from the principal components analysis, using the descriptive analysis together with the clustering on the resulting components, the components will be divided into countries with affected components and unaffected components. Clustering will be applied again on the new recoded database and a new column will be created with home workers and office workers, the column created again with the help of clustering. At the end, based on new columns and the data that built the column with the help of logistic regression, it will be predicted for certain countries that have not entered the class of home workers which component should be improved in order to favour home work in the future

### **3. RESULTS AND DISCUSSION**

#### **3.1. Statistical analysis regarding the influence of COVID-19 pandemic on telework**

Most European countries have been negatively affected by the unemployment rate. During the pandemic period imposed by COVID-19, 28.1% of workers were negatively affected by the pandemic, ending up losing their job permanently or temporarily. Looking individually, at each country, it is observed that most workers who became inactive on the labour market during the pandemic are found in Greece (46.1%), followed by Cyprus (43.5%) and Slovenia (42%). There are also countries such as Denmark (10%), Sweden (11.4%) and the Netherlands (13%) that have managed differently the quarantine period of spring 2020 suffered globally, and which have managed to keep the unemployment rate lower by comparison with other European countries.

European lower-educated workers had a 4% higher job loss rate than those with higher education. This finding can be partly explained by analysing the type of employment contract; for example, 81% of workers have an indefinite (permanent) term, 16% a limited contract and 3% an agency or apprenticeship contract. According to data from the first quarter of 2020 taken from Eurostat, it is observed that among young people, 15-24 years, 45.6% have a temporary employment contract, while among those older than 55 years or over, 5,1% fall into the same category.

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During the COVID-19 pandemic, most employees underwent changes in terms of workload. Eurofound (2020) data on the lockdown period show that 49% of all workers indicated a decrease in working hours. This situation has partially improved after lockdown was lifted where 37% reported that the number of working hours decreased. Moreover, a large number of workers (26%) stated that their work schedule had increased significantly. Official statistics show a decrease in working hours, according to Eurostat (2020) the number of working hours decreased by 3.7% in the euro areas in the first quarter of 2020, compared to the previous quarter.

States such as Italy (-9.7%), Slovakia (-8.7%), Greece (-7.9%) and Austria (-7.8%) recorded a decrease in the index of hours worked in the workplace in terms of comparison between the last quarter of 2019 and the first quarter of 2020, but there are also countries such as Finland that have seen an increase in hours worked during this period (+ 3%) (Labour Force Statistics, 2020).

In order to be able to observe the influences produced by telework during the COVID-19 pandemic on European workers, 121 indicators with a large influence on telework were analysed (Eurofound, 2020). These indicators refer to changes in working hours, fatigue felt after teleworking, the power of concentration of workers working from home, job insecurities, the type of contract held, and the emotional balance felt after telework. These indicators can be split into three groups, the first reveals the situation of the workers in terms of financial security felt, the second the balance between personal and professional life, and the third the changes in workload and performance. All these indicators are very relevant for the analysis, but the goal is to get the most accurate conclusions, so the factor analysis was used to reduce the number of indicators. Factor analysis uses a wide range of statistical techniques to represent a small number of variables.

The 121 indicators are processed in SPSS (Statistical Package for the Social Sciences). Data are collected at the level of European countries and do not require standardization because they are in the form of percentages.

The first results of interest for the study are obtained from descriptive statistics. Being a large database, those indicators of high importance will be deepened for the results of the study. Analysing the answers of the workers at European level, it is observed that on average 40% of them are tired after work, avoiding fulfilling their duties at home. At the same time, 39% of workers said that working hours did not change due to teleworking at home. Another interesting result is that 50% of workers say "I never feel like family responsibilities keep me from working time", and another 36% declare "I never find it difficult to focus on work because of the family", showing that among the workers there are many



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individuals who carry out their activity as before, without any impediments. Contrary to the above results, an average 36% of workers are emotionally overwhelmed by workload and 23% often feel isolated when working. From these statistical results, based on the descriptive statistics, the conclusion is that there were two categories of people in Europe: some workers successfully coped with the trials of teleworking, and the other part felt emotionally overwhelmed, failing to find a balance between personal and professional life.

Telework has many advantages (Mann and Varey, 2000) such as saving resources, freeing up traffic, flexibility (Fonner and Roloff, 2010), lower costs for employers (Wellman and Haythornthwaite, 2008) and increased productivity (Azarbouyeh and Naini, 2014), but following the COVID-19 pandemic, a pertinent observation is that the impact of telework can also be negative. Lack of contact with co-workers leads to isolation, which influences other issues such as dissatisfaction with work and loss of interest in work.

### 3.2. Common characteristics of European workers

In the next part of the study the focus will be on the analysis of correlations. The strongest correlation exists between the indicators *Never (Found it difficult to concentrate on your job because of your family responsibilities)* and *Never (Found that your family responsibilities prevented you from giving the time you should to your job)* with a correlation coefficient of 0.836 at a significance level of 5%. This result is expected, as many workers among the workers have adapted perfectly to the telework at home. Reasonable, direct and significant correlations were found between the indicators *Increased a little (Change in working hours)* and *Daily (How often do you prefer to work from home)* with a value of the correlation coefficient of 0.592 and the indicators *I agree (I am satisfied with the amount of work I managed to do)* and *I agree (Overall, I am satisfied with my experience of working from home)* with a correlation value of 0.667. These correlations illustrate details about those European workers who managed to increase their determination and concentration, becoming more productive than when they worked in the office. Another significant correlation coefficient 0.631 helps to notice that there is a direct and significant correlation between the indicators *Rarely (You feel emotionally drained by work)* and *Rarely (You feel physically exhausted at the end of the working day)*.

Due to very weak correlations between certain variables, a decision to continue the analysis with only some of these indicators was made, so the most significant results for each component to be obtained.

Based on the table of eigenvalues, it was observed that the first main factor has an eigenvalue of 774,419 and retains about 24% of the initial

variable variation. In order to develop relevant conclusions, the cumulative percentage of information retained by the components must exceed the 70% threshold. Analysing the table of eigenvalues, it has been noted that the first 6 components retain about 73% of the variation of the variables.

### Principal components

*Table no. 1*

Component 1	<ul style="list-style-type: none"> <li>➤ (-)Never(Found that your job prevented you from giving the time you wanted to your family)</li> <li>➤ (-)Never(Found it difficult to concentrate on your job because of your family responsibilities)</li> <li>➤ Sometimes(Found that your family responsibilities prevented you from giving the time you should to your job)</li> <li>➤ Rarely(You feel emotionally drained by work)</li> <li>➤ (-)Never(You feel isolated when working)</li> </ul>
Component 2	<ul style="list-style-type: none"> <li>➤ Increased a little (Change in working hours)</li> <li>➤ Rarely(Your colleagues or peers help and support you)</li> <li>➤ (-)Agree(I am satisfied with the amount of work I managed to do)</li> <li>➤ (-)Agree(I am satisfied with the quality of my work)</li> <li>➤ (-)Agree(With the equipment I have at home I could do my work properly)</li> <li>➤ Rarely(Physical contact)</li> <li>➤ Decreased a lot(Performance)</li> <li>➤ Strongly disagree(Overall, I am satisfied with my experience of working from home)</li> </ul>
Component 3	<ul style="list-style-type: none"> <li>➤ Decreased a lot(Performance)</li> <li>➤ Rarely(Felt too tired after work to do some of the household jobs which need to be done)</li> <li>➤ Never(Found it difficult to concentrate on your job because of your family responsibilities)</li> <li>➤ Rarely(Found that your family responsibilities prevented you from giving the time you should to your job)</li> <li>➤ Rather unlikely (Do you think you might lose your job in the next 3 months?)</li> <li>➤ Always(You have the feeling you are doing useful work)</li> <li>➤ Strongly agree(Overall, I am satisfied with my experience of working from home)</li> </ul>
Component 4	<ul style="list-style-type: none"> <li>➤ Several times a month(Work from home preference)</li> <li>➤ Most of the time(Physical contact)</li> <li>➤ Not very well informed(Informed about COVID-19 prevention)</li> <li>➤ Neither agree nor disagree(I am satisfied with the quality of my work)</li> </ul>

Component 5	<ul style="list-style-type: none"> <li>➤ Rarely(Found that your job prevented you from giving the time you wanted to your family)</li> <li>➤ Once or twice a week(Over the last 2 weeks, how often have you worked in your free time to meet work demands?)</li> <li>➤ Rather unlikely(Do you think you might lose your job in the next 3 months?)</li> <li>➤ Sometimes(You feel physically exhausted at the end of the working day)</li> <li>➤ Increased a lot (Performance)</li> </ul>
Component 6	<ul style="list-style-type: none"> <li>➤ Less often(Frequency of working from home before the outbreak)</li> <li>➤ Agree(Overall, I am satisfied with my experience of working from home)</li> </ul>

The first main component is determined in a negative way by the indicators *Never (Found that your job prevented you from giving the time you wanted to your family)*, *Never (Found it difficult to concentrate on your job because of your family responsibilities)* and *Never (You feel isolated when working)*. This component includes those European workers who have been affected from a personal point of view in terms of telework at home during the COVID-19 pandemic. They did not manage to provide enough time for the family, they often focused very hard on the work they had to do, feeling all this time that they are isolated from colleagues and the work environment. These workers were emotionally affected by telework. There is no evidence of their performance, but in terms of family and work balance, they felt overwhelmed. On the positive side, the first component is determined by the indicators *Sometimes (Found that your family responsibilities prevented you from giving the time you should to your job)* and *Rarely (You feel emotionally drained by work)* that support the idea described above, as a conclusion of the results obtained. The first component is generically called the **Emotional impact of telework**.

The second component is positively determined by the indicators *Increased a little (Change in working hours)*, *Rarely (Your colleagues or peers help and support you)*, *Rarely (Physical contact)*, *Decreased a lot (Performance)* and *Strongly disagree(Overall, I am satisfied with my experience of working from home)*. This time the results are that European workers are dissatisfied with the experience of telework, but the main reasons are different from the first component. They underwent changes in the work schedule, low interest from colleagues and isolation from others. Overall, this experience negatively influenced their job performance, causing them to be dissatisfied with the experience of working from home during the COVID-19 pandemic. In a negative sense, this component is determined by indicators that

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reveal details about the fact that teleworking does not provide them with the equipment they want, which is why the quality of work decreases. This second component will be named **Labour productivity in telework**.

The third component is determined in a positive way by all indicators. European citizens who are part of the component can be analysed from two points of view. First, by the indicators *Rather unlikely (Do you think you might lose your job in the next 3 months?)*, *Always (You have the feeling you are doing useful work)*, *Strongly agree (Overall, I am satisfied with my experience of working from home)* and *Decreased a lot (Performance)* it is noticed that European workers feel safe in terms of service, working hours have decreased and the work they do considers significant. Overall, they are satisfied with their professional life during telework. Secondly, the observation is that personal life is also in a good balance with the indicators *Rarely (Felt too tired after work to do some of the household jobs which need to be done)*, *Never (Found it difficult to concentrate on your job because of your family responsibilities)* and *Rarely (Found that your family responsibilities prevented you from giving the time you should to your job)* highlighting this idea. The conclusion is that this component contains those European workers who adapted to telework during the COVID-19 pandemic and can generically be called **High degree of adaptability to telework**.

The fourth main component is determined in a positive way by the following indicators: *Several times a month (Work from home preference)*, *Most often (Physical contact)*, *Not very well informed (Informed about COVID-19 prevention)* and *Neither agree nor disagree (I am satisfied with the quality of my work)*. These European citizens are not very well informed about the pandemic and prefer to work from home several times a month. This component is determined by indifferent workers regarding telework during the COVID-19 pandemic and can generically be called **Indifferent workers**.

The fifth component reveals a new category of workers. This is determined in a positive way by the indicators *Rarely (Found that your job prevented you from giving the time you wanted to your family)*, *Once or twice a week (Over the last 2 weeks, how often have you worked in your free time to meet work demands)*, *Rather unlikely (Do you think you might lose your job in the next 3 months?)*, *Sometimes (You feel physically exhausted at the end of the working day)* and *Increased a lot (Performance)*. This information lead to the conclusion that these workers used the pandemic period to improve professionally, so this component can generically be called **Winners of telework**.

The sixth component is determined in a positive way by only two components *Less often (Frequency of working from home before the outbreak)*

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and *Agree (Overall, I am satisfied with my experience of working from home)*. This component contains those European workers who discovered telework in the pandemic and easily adjusted, so it can generically be called **Workers who easily accepted the transition to telework**.

### 3.2 Typology of European countries

The clustering method within each component was chosen in order to illustrate the finding of typologies of groups of European countries in which workers similarly perceive the forced adoption of telework imposed by the COVID-19 pandemic and to place Romanian workers in a pattern common with other European workers.

An analysis of the similarities and differences between European citizens will be conducted and those countries where the effects of telework during the COVID-19 pandemic had an impact like that recorded on Romanian workers will be identified.

Based on the first component, the emotional impact of telework, two main clusters were identified. Citizens who have been affected to a lesser extent on a personal and family level are found in countries such as Finland, Belgium, Portugal and Spain. Romania forms a secondary cluster with the Czech Republic, Bulgaria and Slovakia, an expected result due to the fact that all these countries belonged to the former communist bloc, the citizens being trained and educated in the same direction. A surprising result is that the countries of northern Germany, the Netherlands, Austria and Sweden were severely affected emotionally, although these countries are highly administratively evolved and have implemented telework in many organizations before the COVID-19 pandemic. The citizens of Romania differ from the citizens of northern Europe, having more similarities with those in the southern and central areas (Italy, Slovakia).

For the second component, Labour productivity in telework, which highlights those citizens affected in terms of performance, two main clusters were identified. Romania is in the second cluster, among the most severely affected countries, along with countries such as Poland, the Czech Republic and France. The countries that have not been so severely affected are Germany, Finland, Austria and Estonia. Romanian citizens are in a state of decline in terms of productivity along with countries such as Slovenia, Hungary, Ireland and Portugal. The second main cluster consists of citizens of Denmark, the Netherlands, Belgium and Estonia, who manage to maintain their best performance compared to all other European countries.

Depending on the component High degree of adaptability to telework, other two main clusters were identified which are divided as follows: one

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cluster contains the countries Italy, Portugal, Spain, Belgium, Poland and France, and the second cluster contains all the other remaining countries. The citizens of the countries belonging to the first cluster have easily adapted to telework during the pandemic and are totally satisfied with this experience. Romanian citizens belong to the cluster with those who have not adapted so easily to teleworking, being very similar to Irish citizens. One explanation for this result may be the large number of Romanians currently working in Ireland. The countries of the former communist bloc Romania, Lithuania, Bulgaria differ from the northern countries Sweden, the Netherlands, Austria, and Germany in terms of adaptability to teleworking.

The component named after the study Indifferent Workers is divided into two main clusters, one consisting of 6 countries and the other 19. The countries of Central Europe have formed a main cluster (Slovakia, Czech Republic, Croatia, Poland, Slovenia) being the countries that following the telework at home during the COVID-19 pandemic, they did not feel much change in terms of either personal or professional life. Northern European countries such as Germany, Austria, Sweden, and Ireland have formed a secondary cluster proving that there are similarities between their citizens. It should be noted that Romanian workers are like those in central Europe.

Depending on the Winners of Telework component, three main clusters resulted. Citizens who have had a very professional career from the Czech Republic, Slovenia, Estonia, Croatia, Slovakia, and Luxembourg, have used the telework period in order to evolve, dedicating their personal time to develop in the service they owned. In terms of Winners, Romanian workers are very similar to those in France and Italy.

For the sixth component Workers who easily accepted the transition to telework, findings are that the countries of Latvia, the Netherlands and Sweden have formed a main cluster. These countries are similar in terms of teleworking, easily adapting to the whole process caused by the COVID-19 pandemic. With small differences, but still similar, noticed that the citizens of Finland, the Czech Republic, Denmark, Slovenia, and Luxembourg form the second main cluster. The citizens of Ireland, Italy and Poland are very similar to those in Romania forming a secondary cluster.

Regarding the placement of Romanian citizens in a common pattern with other citizens, Romania is often similar to Poland and Bulgaria on the emotional impact of telework and labour productivity in telework and Ireland on the high degree of adaptability to telework and workers who easily accepted the transition.

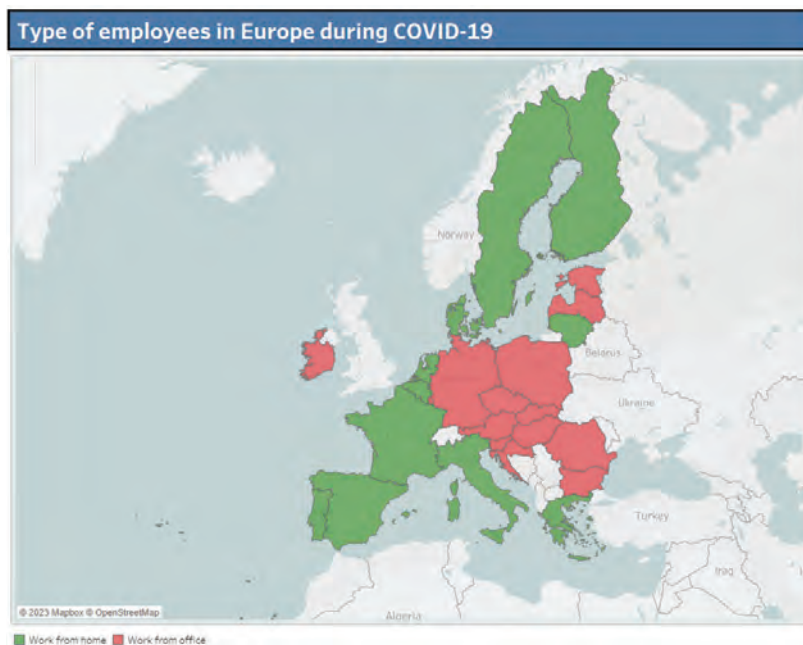
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### 3.2 Logistic regression - prediction of workers' behaviour

After analysing the 6 components and using the clustering dendrogram together with descriptive statistics, for each component, the selected European countries will be divided into countries affected by the components and countries not affected by the component. For example, for the component – Emotional impact of Telework, Austria is classified as an affected country, because the employees of this country have a negative emotional impact regarding remote work during the pandemic.

#### Type of employees in Europe during Covid-19

Fig. 1



Most developed countries encourage working from home, countries such as France, Spain or Norway, but there are also very developed countries such as Germany that do not encourage working from home, they favour the type of office employee. Most of the eastern countries of the former communist bloc are classified as countries where employees prefer to go to the office.

Based on the new database obtained from the main components and on the new column with the type of worker, we will apply Logistic Regression. The algorithm will be applied in python with the help of the sklearn library, which is one of the most used machine learning libraries.

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As the waves of Covid-19 started in 2020 and there is currently no deadline for them to stop, one must consider that working from home is a necessary thing and what people could do in the coming years, and how it would be in 2021, 2022, 2023, etc. to have the comfort of working from home. Thus, we will apply the logistic regression on 2 European countries, respectively on Germany, a country with a developed economy and on Romania, a European country from the former communist bloc with a developing economy, to find out which components must be unaffected.

For Germany, if at least the Emotional Impact of Telework or Labour Productivity in Telework were no longer negative, then Germany would also become a country in the future where working from home would be desirable. On the other hand, according to the logistic regression, even if they were Winners of Telework, they would not leave the office.

For Romanian employees to become employees from home, Labour Productivity in Telework should be improved, Romanians considering that working from home affects work productivity. At the same time, the High degree of adaptability to telework component needs to be improved, the employees in this country not being able to adapt very well to remote work.

## CONCLUSIONS

The research developed a better understanding of what teleworking meant for European workers during the COVID-19 pandemic, highlighting both positive and negative aspects. Analysing the perceptions of European workers, it is discovered that teleworking had multiple and contradictory implications on teleworkers. Some of them declared themselves negatively influenced both personally and professionally, while at the opposite pole, the others said they were very satisfied.

Following the study, six main components were identified that illustrate different patterns of teleworkers. For the first component, the emotional impact of telework, it was discovered that the analysis is supported by the literature (Duxbury et al., 1998). The second component, labour productivity in telework, highlighted that group of European workers who were affected in this regard. Contrary to this component, Fonner and Roloff (2010) state that teleworking should increase productivity, but research has shown that there are also European workers who have been negatively influenced in terms of performance during the COVID-19 pandemic. The third component, high adaptability to telework, contains those European workers who are generally satisfied with the changes produced by telework, they do not professional excel, but are not affected in terms of family life. For the fourth component,



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indifferent workers, it is found that this group of workers are uninformed about the pandemic and do not have conclusive opinions regarding telework. The fifth component reveals a new category of European workers, the winners of telework. Studies on them are numerous, most support telework and provide it as a solution for a better balance in terms of family and personal life (Azarbouyeh and Naini, 2014). The sixth component is generically called the workers who easily accepted the transition to telework and highlights those workers who discovered telework during the pandemic and adapted very easily.

Regarding the placement of Romanian workers in the context of other European workers, the cluster analysis was performed. As a result, it was found that in terms of the emotional impact of telework, Romanian workers resemble Bulgarians, Czechs and Slovaks, while in terms of labour productivity these are very similar to the Poles, Czechs and French. Highlighting the cluster analysis, Romanian workers are very similar to the Irish in terms of high adaptability and very different from workers in northern countries such as Sweden, the Netherlands, Austria and Germany. At the same time, Romanian workers are very different from Nordic workers in terms of indifferent workers, but similar to those in the countries of central Slovakia, the Czech Republic, Croatia, Poland and Slovenia. Analysing the winners of telework component, Romanian workers form the same cluster with French workers and Italian workers. Regarding the component of workers who easily accepted teleworking, Romanian workers form a secondary cluster with Irish, Italian and polish workers.

The limitations of the research are generated by the data on the perception of European workers whose reference time is the period July 2020. A useful comparison would be the analysis of the perceptions of teleworkers after a year of activity in relation to the results currently achieved. Obtaining new main factors may highlight other influences and effects (felt after a longer period of telework) or may support the conclusions gathered by strengthening the results assimilated from the study created.

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