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The Choice of Telework and the Patterns it Follows using Multiple Correspondence Analysis.

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1. Introduction

Over the years firms are trying to decrease or preserve to as low as possible the expenses across all possible levels and departments. A particular point of expense reduction is the option provided to the employees of working remotely, which by extent is an option for firms to reduce the rented area for the physical appearance of its employees. The last two years gave birth to this specific expense with roots stronger than before while indicating that because of COVID-19 many firms either adjusted to the new way of working temporarily from home and at the end due to high economic background they survived, while many smaller firms could not bear the weight of such expense and forced to bankruptcy (Balemi et al. 2021). After two challenging years many firms realized that numerous of its departments were able to work remotely partially or fully which would lead to reduction of working space resulting to lower rent price. Of course, in the case a firm has multiple offices the benefit is substantially higher.

Teleworking is a widely familiar term (introduced in the early 1970) especially between employees that work in firms with expertise in the field of technology and online platforms later on. Progressively over the years more companies started adopting that new model of providing the employees the option to work from home. During the pandemic of the last two years many countries applied the remote working obligation to prevent the spread of the virus where for instance in the EU around 37% of the employees started teleworking due to COVID (Ahrendt et al. 2020). According to Tomei 2021, the amount of money and time not spent on commute gives the opportunity to the employees to dedicate more to their family and household while due to remote work carbon emissions are reduced. Based on the findings of the Moens et al 2021, telework improved efficiency in performance of the individuals by 56.3% and concertation by 50.7% which is an indication of benefits for the employees and by extent an interesting approach worth considering for the companies that are able to apply such model.

1.1 Research question and goal

Full-time teleworking was not considered a feasible alternative solution for many firms and professions until the late 1990s, mostly regarding office-based work due to the absence of low-cost and sufficient computing power (Benschop et al., 2005). However, technology has become widely accessible and affordable, providing a decent alternative for employees to perform their work tasks fully remotely with ease. Previous research has revealed informative insights regarding telework under different circumstances, such as the examination of the behavior of train travelers during the pandemic (Ton et al., 2022), the benefits and challenges of teleworking (Morgan, 2004), and the work-life balance (Tomei, 2021). The specific analysis will focus on a more holistic view of the impact of COVID-19 on the individuals'' ability to transition to telework based on specific industries and professions, and a deeper understanding of the employees'' point of view on teleworking preference. Numerous aspects will be examined through access to survey data, where well-being, benefits, parental obligations, disabilities, and racial characteristics can provide valuable insights into understanding more of their combination and how it could affect the preference for teleworking. Additionally, the research will examine remote work policies in order to provide companies with insights on the employees' opinion on remote work and whether it is a viable long-term option. Through the application of the Multiple Correspondence Analysis model and K-modes clustering algorithm, employees will be classified into clusters based on certain characteristics, providing valuable insights for firms looking to implement teleworking. Thus, to provide companies with a competitive advantage by reducing expenses and gaining a deeper understanding of the benefits of teleworking for both employees and firms. All the notions mentioned above lead to the following research question:

''Based on individuals' characteristics what are the patterns that lean towards the preference for teleworking?''

1.2 Contributions to theory

The scope of interest for the examination of the specific research question is mainly the interest around teleworking, especially the wide adoption by firms and individuals as freelancers, as it was progressively applied over the years by many and acknowledged the most during the COVID-19 pandemic. In addition to everything mentioned above, the combination of the attributes influencing the teleworking preference is threefold:

First, there are relatively few researches to date based on empirical investigation regarding a) teleworking as we know it in its present state with the combination of the recent events of the COVID-19 pandemic, and preference of teleworking as a binomial attribute to be the main scope of research (Moens et al., 2021), b) the well-being of the employees is a subject that has been investigated in the past but not thoroughly under the scope of COVID-19 and its side-effects in a marital and parental point of view (Ahrendt, 2020), c) the productivity of the individuals (Loredana et al., 2021), d) individuals with disabilities should be examined for their preference on teleworking (Schur et al., 2020).

Second, the work-life balance and productivity are aspects that both firms and individuals aim to establish in numerous different industries (Martinez-Sanchez et al., 2008; Loredana et al., 2021; Tomei, 2021). Having such insights on how these two attributes could affect the classification task of telework preference will be truly revealing for the firms to assess how beneficial such an approach could be and to facilitate the formation of telework programs. Additionally, insights from the classification of the telework preference will provide firms the ability to assess different attributes that are either out of or within control and, thus, to be able to provide the best possible plan of telework to its employees based on their needs and characteristics.

Third, the specific analysis is based on the survey data provided by Buffer, a company widely known for its big customer portfolio in social media enhancement and promoting. The conduction of the survey developed with the collaboration of Nomad List and Remote OK, two of the major “players” in the field of teleworking network between individuals and employees that work remotely. The key feature of each survey was the preference of teleworking, defining it in two levels (1 equals a positive preference and 0 a negative one), with some extra additions of features after the COVID-19 pandemic.

2. Literature review

In this chapter it will be discussed further in detail the literature that was used for building the fundamentals of this research and additional to discuss the gap spotted from previous research and ambitious attempt to be covered by the existed. A more detailed description of the terminology that was used will be provided in order to be able to comprehend and familiarize with the content and context of the research. In addition, the hypothesis will be presented as well as the conceptual model.

2.1 Telework

2.1.1 The roots of Telework

It might seem that the term "telework" is a recent introduction, but it is quite the opposite. We credit this to a scientist named Nilles, who first introduced the term "telework" to the public in 1973. Nilles came up with the idea of this term after trying to combine the need to alleviate traffic congestion and pollution in overpopulated areas (Mears, 2007). More specifically, it is mentioned that telecommuting is a way of reducing transportation expenses and it is distinguished that such a technique could be applied to industries that can store, collect, and handle information rather than industries that require physical appearance and manufacturing of goods (Nilles, 1976). Additionally, Nilles (1976) highlights the reduction of expenses in transportation on behalf of industry when employees are working remotely, and thus not using commute means, resulting in industries capable of applying such a model to train its employees to use computers and widen the application of remote work to many more progressively. As it can be seen, it is almost five decades since the conception of telework, and its wide adoption took place more vividly over the last two years (2020-2022 as COVID-19 arose) setting the baseline for the years to follow. At this point, a terminology clarification for future reference would be necessary for the term "telework" and "telecommuting." Telework refers to virtual work, which involves an employee or an individual working away from the office with the help of a computer for communication and the accomplishment of tasks. It is important to mention that telework is not strictly connected to work done from

home as it can be done at any location as long as it is remotely and away from office such as café, hotel, airport, clients' office or home which seems though to be the vast majority of the teleworkers.

2.1.2 Definition of Telework

It is important to distinguish the differences between telecommuting and telework. Existing literature defines telework as we have described it previously, but it seems that there is not a single or clear established definition, and it is sometimes subject to change according to the content and context of the research. Based on the existing literature and progressively through time, the term is shifting and "evolving" based on the feedback it gets over the last five decades. This could be the result of the evolutionary nature of humankind and the addition of new attributes or the transformation of the existing ones, forcing the original term to shift and adapt to the new standards. Since the creation of telework, a variety of tasks can now be completed either fully or partially remotely with the help of technology, for example, which faced vast improvement over the last five decades (Golden 2009), thus the tasks are completed faster, and employees face them with ease at least from a technical aspect. The ability to use better technology also gave birth to new concepts and tasks that describe telework. A strong example of such technological progress could be the tool Microsoft launched with the name HoloLens, which allows employees to work remotely through Augmented Reality (AR). Such advanced technology was not either conceptualized in the past, and after its birth, the manufacturing procedure was rather challenging due to computing power (Evans et al.2017). AR is a neoteric tool which is capable of completing great industrial applications and assembly tasks, leading the way for a new cutting-edge approach of employees who have physical appearance tasks combined with remote completion (Evans et al.2017). Therefore, as it can be seen, AR is a new aspect of how technology can evolve and provide a powerful tool, especially for those employees who need to attend in physical appearance to their workplace. Such examples indicate that the elimination of previous restrictions is possible progressively through time. Based on the previous literature, some of the authors tried to provide their definition of what telework is according to their point of view, content, and field of study. They indicatively describe telework as a "means of modernizing work organization by introducing flexible work arrangements and greater autonomy and of achieving better reconciliation of work, private and family time" (EUR-Lex 2008). Additionally, telework is described as "the concept of telework encompasses

individuals who work from outside their usual workplace and as a result do not need to physically make a work-related trip" (Lopez-Soler et al.2021) or "as the organization of work by using ICTs that enable employees and managers to get access to their labor activities from remote locations" (Nilles 1998; Sullivan 2003; Martinez-Sanchez et al 2008). These are some of the examples that show that the definition of telework is subject to change according to the year of research and the author since, as we have discussed above, telework is shifting and evolving, mostly influenced by the technology progress as an attribute, which seems to be its major pulling force progressively through the years. A vivid example of the efforts to establish telework as an alternative way of working in the European Union (EU) and of course to set guidelines, regulations, and implementation procedure widely between Member States was most recently refined in 2008 (EUR-Lex 2008). Therefore, this is an indication of the importance of telework and the effort EU is putting on building even stronger fundamentals.

2.1.3 Telework literature

Many authors have conducted their research regarding telework and its applications in multiple fields of study and topics. However, this specific research will focus mainly on the classification of the employees based on their profession, into those who prefer teleworking and would recommend it to others and those who are against it, thus not recommending it. Some of the attributes that show great influence on such decision are among other the profession of each employee, the biggest struggle they encountered during teleworking, the equipment coverage in order the employee to be fully equipped for the task completion and the biggest benefit they enjoyed while teleworking. Therefore, the analysis will concentrate mainly on these attributes and how they influence the employees' preference on telework.

2.1.4 Telework and Benefits

As Bill Gates said (*These Are Bill Gates' Predictions for the Future of Work*, 2020) by 2050 half of the working population will be working from their home workspace. Many teleworkers support the option of teleworking due to numerous benefits they seem to enjoy. Teleworking seems to be a great option for an employee that aims in a balanced schedule between work and other everyday activities and aspects such as family responsibilities or

mental wellbeing (Morgan, 2004). The most frequently used keyword by the teleworkers is flexible, and the rationale behind this is of course as the word implies the flexibility they have over options to choose on how they want to work choosing the place and the pace, where employees support that technology “freed” them from the limitations of the location and time (Morgan, 2004; Hill, et al, 1998; Martínez-Sánchez, 2007; Benschop and Menting, 2005). Over the years, ICTs (Information and Communication Technology) has improved and is characterized by efficiency and effectiveness thereby giving birth to new opportunities to both employees, to manage better the working time and place and to complete many tasks at ease.

Teleworking has several advantages for employees, as noted by Morgan R.E. First, it can increase employee satisfaction and motivation, which can lead to increased loyalty and retention. Furthermore, teleworking can improve the quality and quantity of work, resulting in increased productivity and effectiveness. Additionally, teleworking allows employees to work from anywhere, eliminating geographic restrictions and expanding opportunities for employees all over the globe. This allows for better time management and organization, and can also improve work-life balance, reduce transportation costs and commuting time, and provide more opportunities for disabled employees. In addition to the advantages for employees, teleworking also offers several benefits for organizations. For example, it can lead to cost savings by reducing the need for office space and rental areas. Additionally, teleworking allows for increased flexibility and accessibility for customers, resulting in better customer support and more direct solutions for business-to-business tasks. Furthermore, teleworking improves internal communication and responsiveness, allowing for faster dissemination of information across departments.

2.1.5 Teleworkers’ Struggle

So far it may seem that telework is strongly connected with benefits but of course it is also linked with numerous drawbacks and challenges which can significantly affect the employees’ preference (Morgan, 2004).

- One significant barrier that could prevent the application of telework is that it could be no use for jobs that require a physical appearance of the employee to the workplace, which of course could possibly be surpassed with the help of advanced

technology such as HoloLens from Microsoft as we have mentioned above (Morgan, 2004; Evans et al.2017; Baruch, 2000).

- Sometimes it is up to manager's hand to decide if they would apply teleworking, who for different reasons (like trusting its teleworkers), do not feal comfortable applying such models yet, results in peddling the organizations' progress (Morgan, R. E. 2004; Baruch, 2000).
- Additionally, it is supported that skills atrophy is observed to teleworkers in social and time management aspects (Baruch, 2000).
- Many teleworkers are linked with the effect of distraction, and difficulty of space and time use (Baruch, 2000).
- Stress, performance anxiety and fear of bonus lack are also major threats teleworkers face (Baruch, 2000).
- Affiliation prospects are limited, social relations are diminishing, uncertain career development, weak influence over other employees at workplace and organizational events (Baruch, 2000).
- The ICT maintenance is quite a challenge when teleworkers face difficulties in terms of hardware and internet connection failure resulting in difficulty to complete the tasks (Ambikapathy et al, 2020).
- Distraction is an additional drawback for employees who telework, impacting the effectiveness of the task performance (Ambikapathy et al, 2020).
- According to EESC (2021) employees are working longer at night and weekends as well as the intensity of work has increased among teleworkers.

As it is presented extensively above, the challenges are numerous and of course some of them are applied to most of the employees but also many of them are subjective and apply to individuals with specific characteristics (EESC, 2021). Nevertheless, all these barriers teleworkers face should be addressed to a wider spectrum such as the EU Commission and narrow it down to organizations which should apply the corresponding laws accordingly.

2.1.6 Teleworkers' Equipment and Technology

As it is mentioned above, a crucial attribute to telework is of course the technology and the equipment employees make use of. Some authors (Kanellopoulos, 2011; Verhoef et al. 2016) support the importance of the technology and how it influences the task completion and performance of the employees in combination of how affordable it is progressively over the years. The more affordable the equipment is the bigger the proportion of organizations that apply telework within its employees, thus investing in proper equipment is a necessity for companies in order to apply successfully remote work models (Kanellopoulos, 2011). Simultaneously it is important to understand the vitality an organization to transform from a more analogue nature to a digital one, resulting eventually to a digital transformation where information has been transformed and stored digitally (Verhoef et al., 2021). Therefore, it is well understood that technology as we know it today could not be possibly applied to an organization that had not even accomplished the phase of digital transformation due to inability of applying such methods, thus these two dimensions should have been moving alongside progressively over the decades. More specifically according to Verhoef et al., 2021 in order a company to transform into a digital one it needs to go through the phase of digitalization where IT and digital technologies should be used in order to achieve that. In addition to everything mentioned above the term intermediate spaces introduces the ability an employee to gain access to through ICTs to content related to its work at any place different from its workplace and even his home, thus an individual can work from anywhere one can imagine such as elevators, parking lots, metro, subway etc. (Messenger, J. C. et al. 2016). Therefore, we can infer that with the help of technological equipment which nowadays is powerful enough to accomplish complicated tasks (Messenger, J. C. et al. 2016) and the affordability to be at its zenith the teleworkers can gain access to their data anytime anywhere mostly effortless.

3. Research Methodology & Data Analysis

3.1 Scope of data definition & description

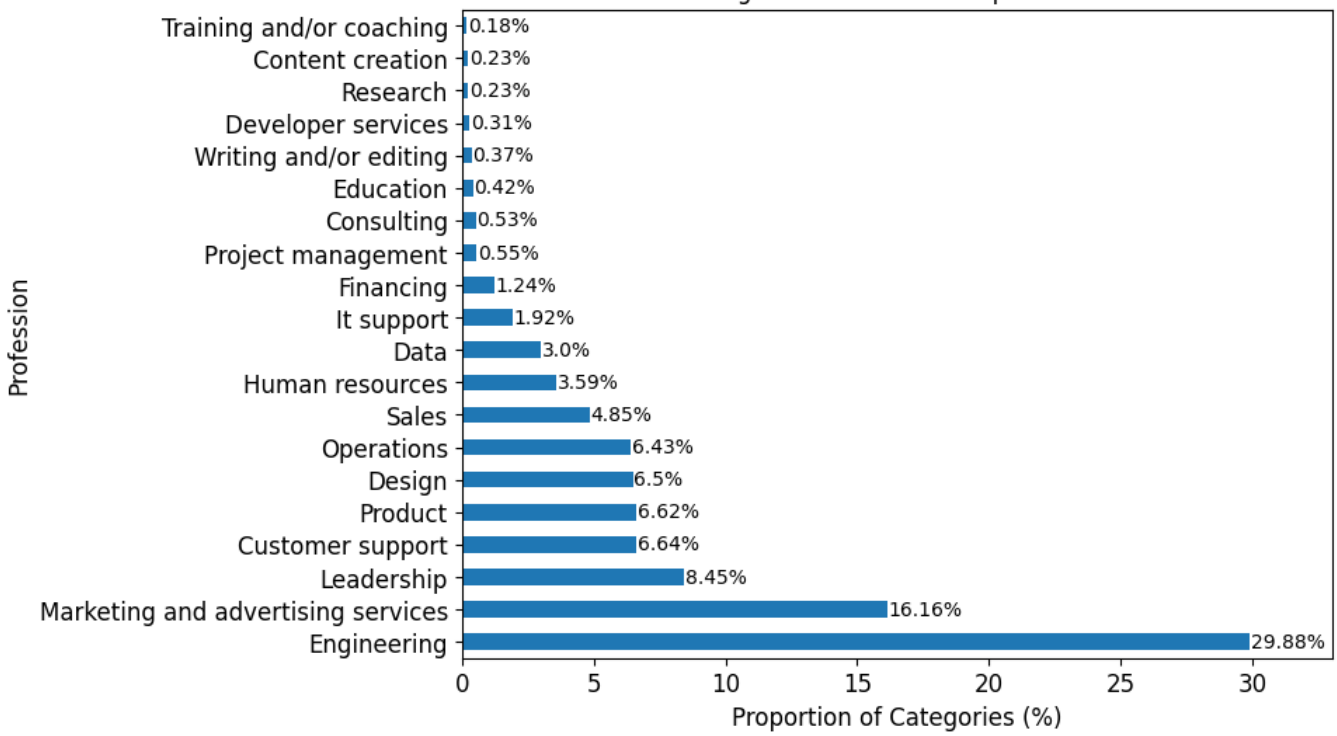
Due to the nature of this research and its research question the data that would seem most suitable would be collected from a survey. Diversity in terms of participants was a necessity and that led to the collaboration with the RemoteOK (https://remoteok.com), Buffer (https://buffer.com) and NomadList (https://nomadlist.com), who conducted surveys from 2018 – 2021. More specifically, for the data of year 2018 the size of the data set is 2363 observations, for the year 2019 the size is 3522 observations, for the year 2020 the size is 2217 and for the year 2021 the size is 2101 observations. These datasets were eventually merged into one data set with 9656 rows and 5 columns. The data collected were slightly differently through the years in terms of the questions asked but the core variables used in this research were the same for all the years and this helped to narrow them down to the final five variables among many that were used in the survey. More specifically the variables used were:

- "What country do you live in currently?", which describes the country the participants live in while they are remotely working. The specific variable has seventy-seven (77) unique levels or sub-categories which includes countries from all over the world (e.g., United States, Brazil, Canada, France, Germany, India).
- "Profession", which describes the profession of the participants or a more generic descriptions of their field. The specific variable has fifty-one (51) unique levels or sub-categories (e.g., Customer support, Consulting, Accounting, Engineering).
- "Would you recommend remote work?" which is a binary variable and describes the preference and recommendations regarding remote work or not, 1 stands for "yes" and 0 stands for "no".
- "Biggest struggle working remotely" which describes what is/was the biggest struggle they faced while teleworking. The specific variable has fifteen (15) unique values or sub-categories (e.g., Different time-zone, Career growth, Difficulty focusing or No struggle).
- "Biggest benefit working remotely" which describes what is/was the biggest benefit while teleworking. The specific variable has thirteen (13) unique values or sub-categories (e.g., Schedule flexibility, Work from home option, Choosing different location to work, More time to spend with family and/or pets).

3.2 Exploratory analysis

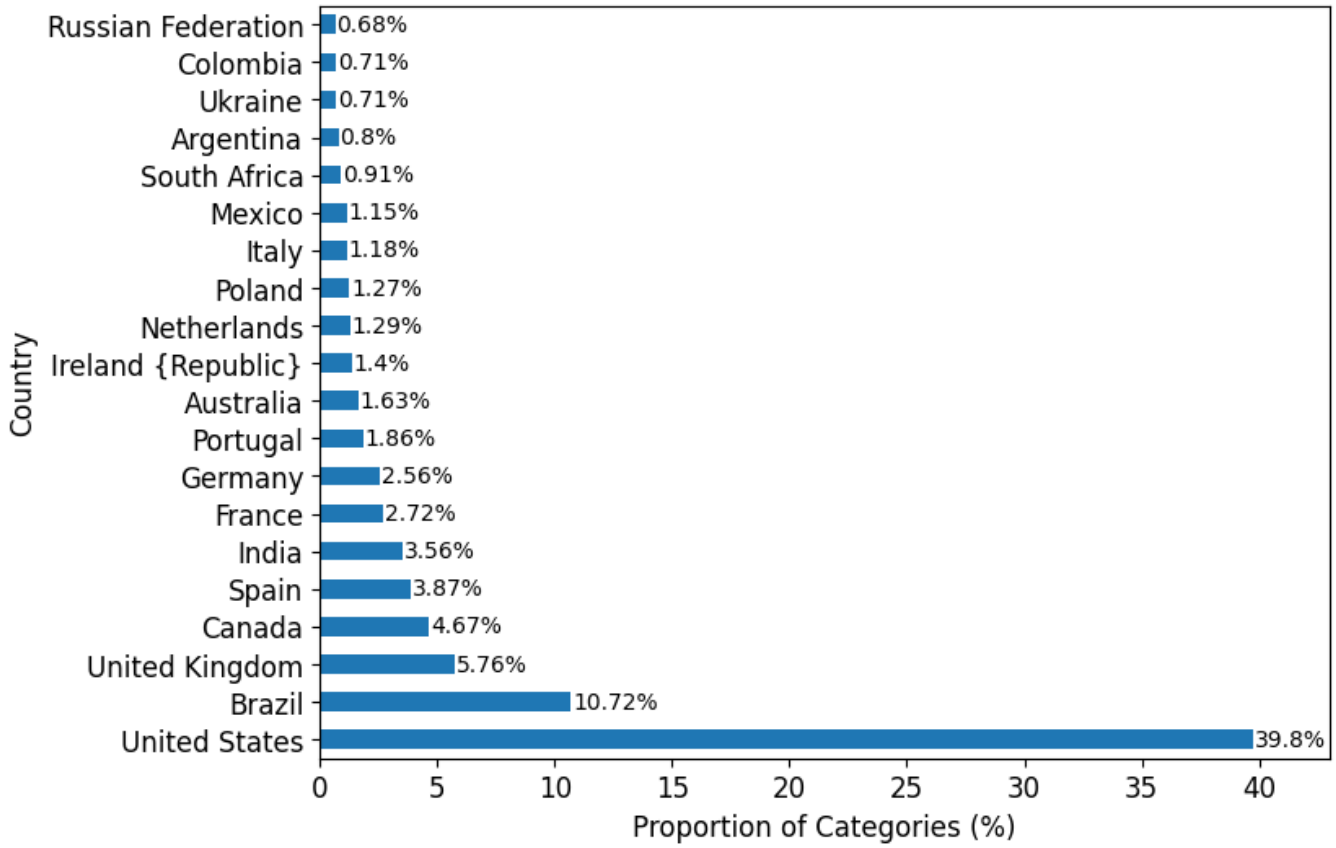
Since the data were collected from a survey, the type of the variables was on the vast majority categorical with various levels apart from the variable “Would you recommend remote work” which is numerical, and by extent there were no limitations in terms of measurement units. The data set in general is an aggregation of four different data sets each one representing a year that the survey was conducted. After the aggregation, the size of the final data set was 9656 rows and 5 columns. Each of the data sets ware checked for NA values and after thorough inspection, all the NA values were indeed a false entry and by extent the row itself was empty in all of the variables’ fields, which saved time on imputing the missing values and instead dropping the whole row was the optimal solution. Additionally, it was necessary to examine the frequency of each variable in the data set. As it can be seen in Figure 1, the profession that has the highest frequency is “Engineering” with 29.88% of all individuals to claim that this is their profession while the second highest to be “Marketing and advertising services” with 16.16% of all individuals. For space efficiency the list of professions in Figure 1 contains the twenty highest in frequency professions.

Figure 1: Profession Proportion



Accordingly, we proceed with Figure 2 where as it can be seen the twenty highest in frequency countries show that the country with the highest frequency is the United States with 39.8% of all individuals and the second highest to be Brazil with 10.72% of all individuals which is around four times less than the United States. Additionally, based on Figure 2 it can be seen that half out of the twenty countries are European countries.

Figure 2: Country Proportion



It is worth mentioning that the variable "Would you recommend remote work?" seems to be imbalanced and therefore having a minority class that of the participants that answered that they would not recommend remote work ("0"). Due to the nature of the research, it seems though reasonable the vast majority to recommend remote work. To be more precise 9343 participants have answered "yes" while only 313 have answered "no".

Based on the above we have additionally the frequencies for the "Struggles" and "Benefits" of working remotely;

As we can see in Table 1 these are the biggest struggles individuals professional face when they telework and their frequencies. More specifically, the biggest struggle is the lack of option to unplug (19.94%) as well as loneliness (17.37%) but also some more technical problems such as difficulties with communication (16.12%). It is worth mentioning that there are 8.48% individuals that do not face any struggle (see Appendix Figure 4).

Table 1 Biggest struggles individuals face when they telework.

Biggest struggle working remotely	**Proportion & Number of individuals**
Not being able to unplug	19.94% (1925)
Loneliness	17.37% (1677)
Difficulties with collaboration and communication	16.12% (1557)
Distractions at home	10.02% (968)
Staying motivated	8.55% (826)
No struggle	8.48% (819)
Being in a different time zone than teammates	6.94% (670)
Taking vacation time	3.21% (310)
Difficulty focusing	1.98% (191)
Finding reliable Wi-Fi	1.97% (190)
Working across time zones	1.83% (177)
Career advancement or growth	1.5% (145)
Working more	1.41% (136)
Networking and socializing	0.38% (37)
Finding job opportunities	0.29% (28)

Additionally, we can see the biggest benefits individuals enjoy and their frequency in Table 2. The benefit with the highest frequency is the ability of a flexible schedule (27.61%), also the time they do not spend in commuting (15.24%) as well as the more free time to spend with pets and family (9.64%). It is also important to mention that individuals state the increased productivity, the lack of distraction as well as increased focus (see Appendix Figure 3).

Table 2 Biggest benefit individuals enjoy when they telework.

Biggest benefit working remotely	**Proportion & Number of individuals**
Ability to have a flexible schedule	27.61% (2666)
Flexibility to work from any location	24.66% (2381)
I have more time because I don't commute	15.24% (1472)
I get to spend more time with my pets and/ or family	9.64% (931)
Ability to work from home	7.16% (691)
Flexibility in how I spend my time	5.29% (511)
Flexibility to live where I choose	3.45% (333)
It's better for me financially	2.37% (229)
The ability to better focus on my work	1.77% (171)
I feel safer	1.27% (123)
Flexibility in my career options	0.89% (86)
No distractions	0.45% (43)
Productivity increased	0.2% (19)

3.3 Multiple Correspondence Analysis (MCA)

Multiple Correspondence Analysis (MCA) is a statistical technique that is particularly useful for exploring relationships and patterns between categorical variables (Hoffman & De Leeuw, 1992; Le Roux & Rouanet, 2009). Categorical variables are variables that can be divided into distinct categories, such as "Profession", "What country you live I currently" or "Biggest benefit working remotely". These variables can be difficult to analyze using traditional statistical methods, as they do not have a continuous scale and cannot be easily quantified. MCA is a multivariate method that aims to minimize the distance between lines connecting objects with all the categories they are in, rather than as a method to represent chi-square distances, making it easier to understand and interpret the data (Hoffman & De Leeuw, 1992; Le Roux & Rouanet, 2009). The core concept of MCA is that a category is the

center of the objects that chose it. It is also useful for identifying groups of variables that are related to each other, and for identifying relationships between variables that may not be immediately apparent. It can be applied to data sets of any size, and it is generally easy to implement using statistical software such as Python, SPSS, SAS, or R.
The matrix *X* represents the data matrix of object scores, where each row corresponds to an observation (e.g., individuals in this case) and each column corresponds to a variable (e.g., Profession) (Hoffman & De Leeuw, 1992). The matrix *X'X* is the product of the transpose of *X(X')*, which results in a square matrix with the same number of columns as *X*. When *X'X = nI*, where n is the number of observations and *I* is the identity matrix, this indicates that the object scores (i.e., the values in *X*) are standardized, are uncorrelated, have a mean zero and therefore *z*-scores are zero to (Hoffman & De Leeuw, 1992). The diagonal elements of *nI* are all equal to *n*, which means that the variances of the object scores are equal, thus, the normalization of *X'X = nI* ensures that we avoid a trivial solution where all object scores and categories coordinates are equal to zero, resulting in a zero loss function.

The objects (rows) and categories are shown in a biplot in a low number of dimensions *p*. The categories of a variable are represented by a $k_j \times p$ matrix of coordinates Y_j which is computed as the centroids of the observations that choose the category of the variables *j*, while the objects are represented by an $n \times p$ matrix of object scores *X* (with uncorrelated columns) (Hoffman & De Leeuw, 1992). The concept of homogeneity analysis is applied in MCA through the use of indicator matrices G_j, where if object *i* has category *k*, row *i* of G_jY_j has the category coordinates for category *k*. MCA minimizes the sum of squared distances between rows of *X* and $G_j\ Y_j$ over all variables *j* simultaneously, this is the same as minimizing sum of squares of all lines connecting objects *i* to their category in variable *j* (Hoffman & De Leeuw, 1992). The optimization is done using the loss function σ over *X* and $Y_1, Y_2, \ldots, Y_m$:

$$\sigma(X; Y_1,\ Y_2, \ldots, Y_m) = \sum_j\ SSQ\left(X - G_jY_j\right)$$

where *SSQ* represents the sum of squares of all elements of the matrix (Hoffman & De Leeuw, 1992).

Table 3 The discrimination measures per variable per dimension

Variable	Dimension 1	Dimension 2
“What country do you live in currently?”	0.674	0.329
“Profession”	0.275	0.402
“Would you recommend remote work?”	0.0001	0.005
“Biggest struggle working remotely”	0.692	0.221
“Biggest benefit working remotely”	0.661	0.378
λ	0,460	0,267

The discrimination measures can be defined as the average squared distance of the category quantifications to the origin of the p-dimensional space (Hoffman & De Leeuw, 1992; Michailidis & De Leeuw, 1998). The larger the discrimination measure for a variable, the better the categories of that variable discriminate among individuals. Hence those categories have their category points further apart (Hoffman & De Leeuw, 1992; Michailidis & De Leeuw, 1998). A category point is defined as the centroid of the objects that belong to that category. According to table 3, “What country do you live in currently?”, “Biggest struggle working remotely” and “Biggest benefit working remotely” discriminate well on the first dimension while “Profession” and “Would you recommend remote work?” discriminates better on the second dimension. The average of the variables’ discrimination measure is described by the diagonals of λ (Hoffman & De Leeuw, 1992; Michailidis & De Leeuw, 1998).

Overall, MCA is a powerful tool for exploring and understanding relationships between categorical variables, and it can provide valuable insights into patterns and trends in the data. It is an important tool in the statistical toolkit for anyone working with categorical data, as well as in fields such as marketing, social sciences, and education.

3.3.1 Measurements

Before we start with the interpretation of the results it is necessary to import the proper packages for applying MCA. First the “prince” package (Prince, 2020) is imported along with other libraries that were needed for conducting the research. Next, we will create an MCA object and specify the number of dimensions (five) that we want to use for the analysis. We will then fit the MCA model to the data using the **fit()** method.

3.4 Total and Explained Inertia

In Multiple Correspondence Analysis (MCA), Total Inertia is a measurement that reflects the diversity and complexity of the relationships between the variables in the dataset. It is calculated as the sum of the variances of all of the variables in the dataset and can provide insights into the complexity and diversity of the data (Greenacre, 1988; Le Roux & Rouanet, 2009). A higher total inertia indicates that there is a greater amount of variance in the data, suggesting that the variables in the dataset are diverse and may be related to each other in complex ways. By analyzing the total inertia of the dataset, we can gain insights into the relationships between the variables and identify groups of variables that are strongly related to each other (Greenacre, 1988; Le Roux & Rouanet, 2009).

In addition to Total Inertia, another measurement in MCA is Explained Inertia. This measurement is used to understand the amount of variance in the data that is explained by a particular dimension or component (Greenacre, 1988; Le Roux & Rouanet, 2009). In MCA, explained inertia is expressed as a percentage and represents the proportion of total inertia in the data explained by the dimensions of the correspondence matrix. By analyzing the explained inertia of the different dimensions, we can gain insight into the importance or relevance of a particular dimension in the analysis. Those dimensions with the highest explained inertia are generally considered the most important or relevant for understanding the structure of the data (Greenacre, 1988; Le Roux & Rouanet, 2009). Overall, both Total Inertia and Explained Inertia are measurements in MCA that can inform our understanding of the complexity and diversity of the data and help us identify meaningful patterns and trends in the data.

3.5 K-modes clustering

K-modes clustering is a clustering algorithm that is used to group a set of data points into clusters based on their categorical attributes (Chaturvedi et al., 2001). This method is similar to K-means clustering, but it is specifically designed for categorical data. In K-modes clustering, the data is partitioned into a specified number of clusters (K = 5 in this research) based on the mode (most common value) of the categorical attributes. Each cluster is represented by a centroid, which is the mode of the categorical attributes in that cluster (Chaturvedi et al., 2001). Data points are assigned to the cluster with the nearest centroid, based on the distance between the data point and the centroid. This distance is calculated using a distance metric such as the Hamming distance, which measures the number of attributes that differ between the two points (Chaturvedi et al., 2001). K-modes clustering can be useful for identifying patterns and trends in categorical data, and for grouping similar data points together. It is often used in applications such as market segmentation, customer segmentation, and text classification.

The algorithm modifies the traditional K-means approach by replacing the means of the clusters with modes. This is done by using the dissimilarity measure:

$$d(T, H) = \sum_{i=1}^{n} \delta(T_i, H_i) \qquad (3.5),$$

where $d(T, H)$ gives equal significance to every kind of attribute (Sharma & Gaud, 2015). Additionally, where n is the number of categorical variables, T_i and H_i are the categories of the i_{th} variable for the data points of T and H, respectively, and $\delta(T_i, H_i)$ is a function that returns 0 if $T_i \; and \; H_i$ are the same category, and 1 if otherwise (Sharma & Gaud, 2015). In other words, the dissimilarity measure is used to compare categorical variables and to determine the closest cluster for each data object. The most commonly used dissimilarity measure in the K-modes algorithm is the Hamming distance (Sharma & Gaud, 2015), which measures the number of mismatches between two categorical variables. The K-modes algorithm aims to partition the data into K clusters such that the dissimilarity between the data objects within each cluster is minimized, while the dissimilarity between objects in different clusters is maximized. The cost function for the K-modes algorithm is defined as:

$$C(Q) = \sum_{i=1}^{n} d\,(Z_i, Q_i) \qquad (3.6),$$

where Z_i is the $_i$th element and Q_i is the nearest cluster center for Z_i. The algorithm minimizes this cost function by assuming that the number of probable groups of data (i.e. K) is known. The process of K-modes clustering consists of four main steps: generating K clusters by arbitrarily selecting data objects, assigning data objects to the closest cluster center according to equation 3.6, updating the K clusters based on the allocation of data objects, and calculating the K latest modes of each cluster (Sharma & Gaud, 2015). The process is repeated until no data objects have changed cluster membership or some additional predefined criterion is met.

4. Results

4.1 Eigenvalues results

One of the measurements of the MCA are the Eigenvalues. The eigenvalues of the dimensions (Roux & Rouanet, 2009) in an MCA analysis represent the importance of each dimension in explaining the relationships between the variables in the data set. Higher eigenvalues indicate that a dimension is more important, while lower eigenvalues indicate that a dimension is less important. In this case, the eigenvalues of the dimensions are as follows:

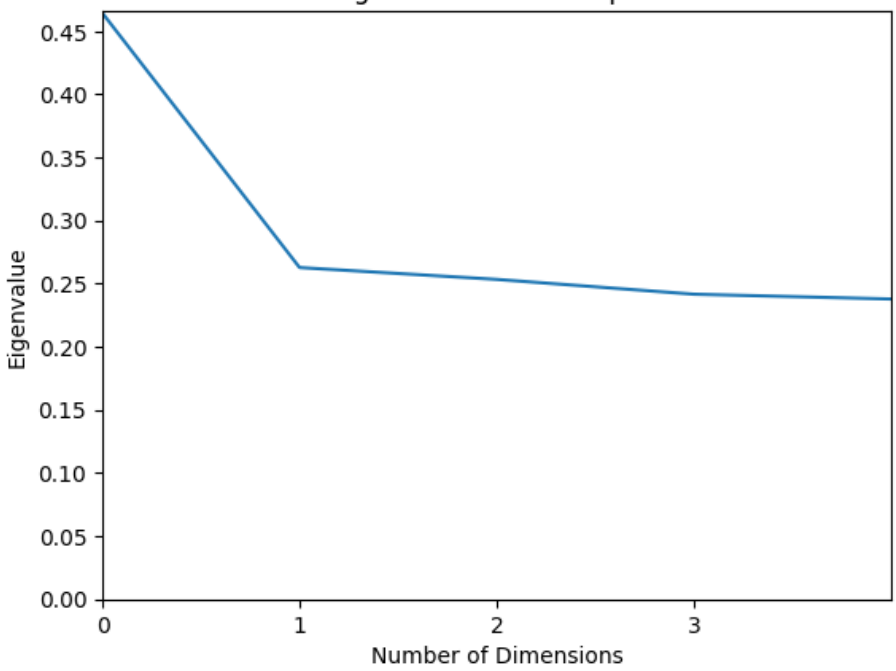
Table 4 Dimensions and their Eigenvalues

Dimensions	Eigenvalue
Dimension 1	0.464
Dimension 2	0.266
Dimension 3	0.255
Dimension 4	0.244
Dimension 5	0.239

This suggests that the first dimension may be the most useful for understanding the overall structure of the data and for making general inferences about the data, followed by dimension

2 and dimension 3. Dimension 4 and 5 are less important and it is noticeable the degrading rate of contribution to the explanation of the relationships between the variables. Thus, a measure called Elbow rule (Figure 7) will be applied in order to identify the optimal number of dimensions. The elbow point, which is the point at which the explained variance starts to level off, represents the optimal number of dimensions to retain and in this case it seems to level off at the first dimension, resulting on continuing our analysis with two dimensions to help with the interpretation of the plot. The remaining dimensions may be useful for understanding more specific aspects of the data, but they may not be as relevant for overall interpretation of the results. Overall, the eigenvalues of the dimensions provide valuable insights into the relationships between the variables in the data set, and can be used to inform the choice of the number of dimensions to include in the MCA analysis.

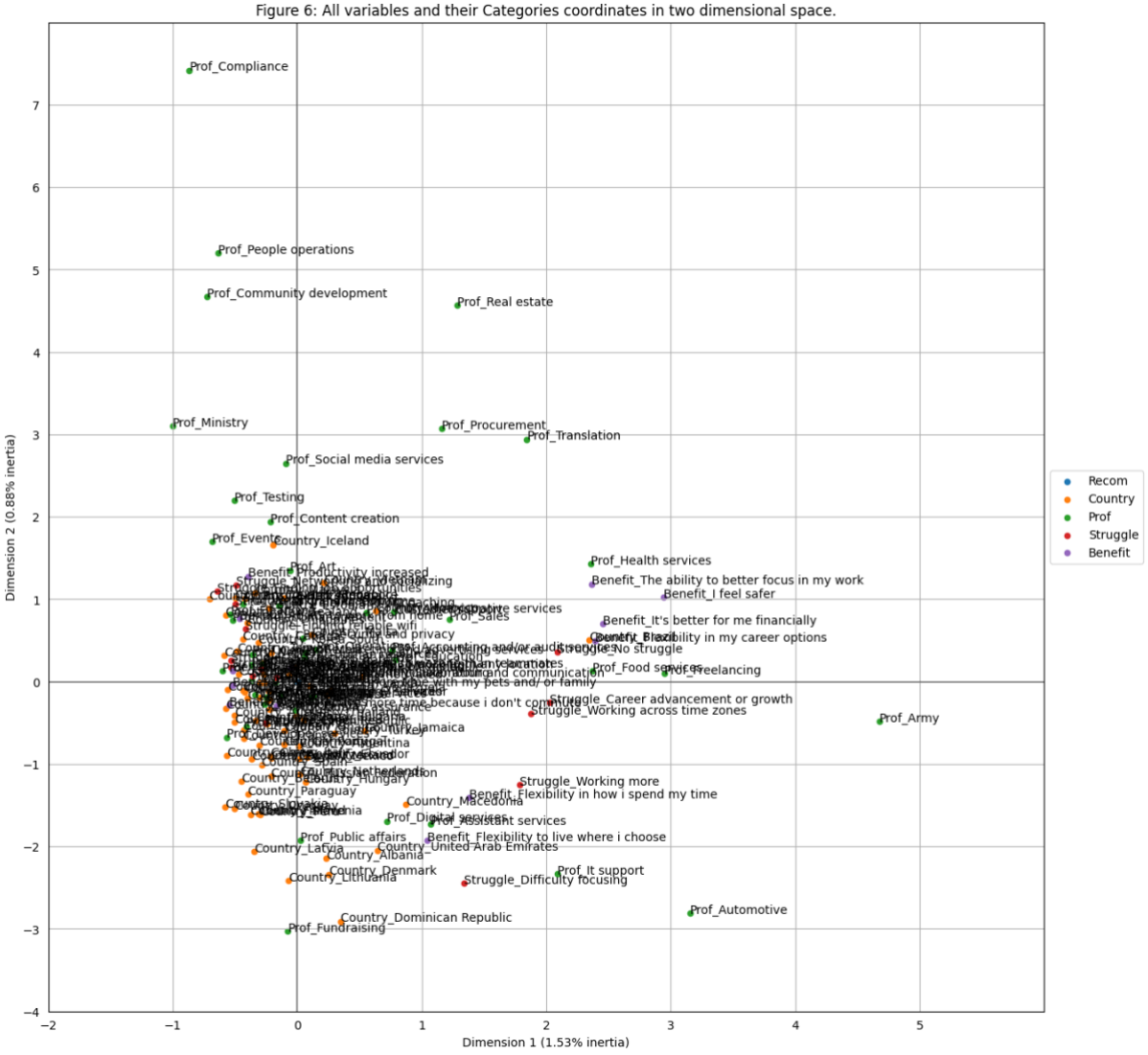
Figure 5: Elbow Rule plot



4.3 Dimensions relationship visualization

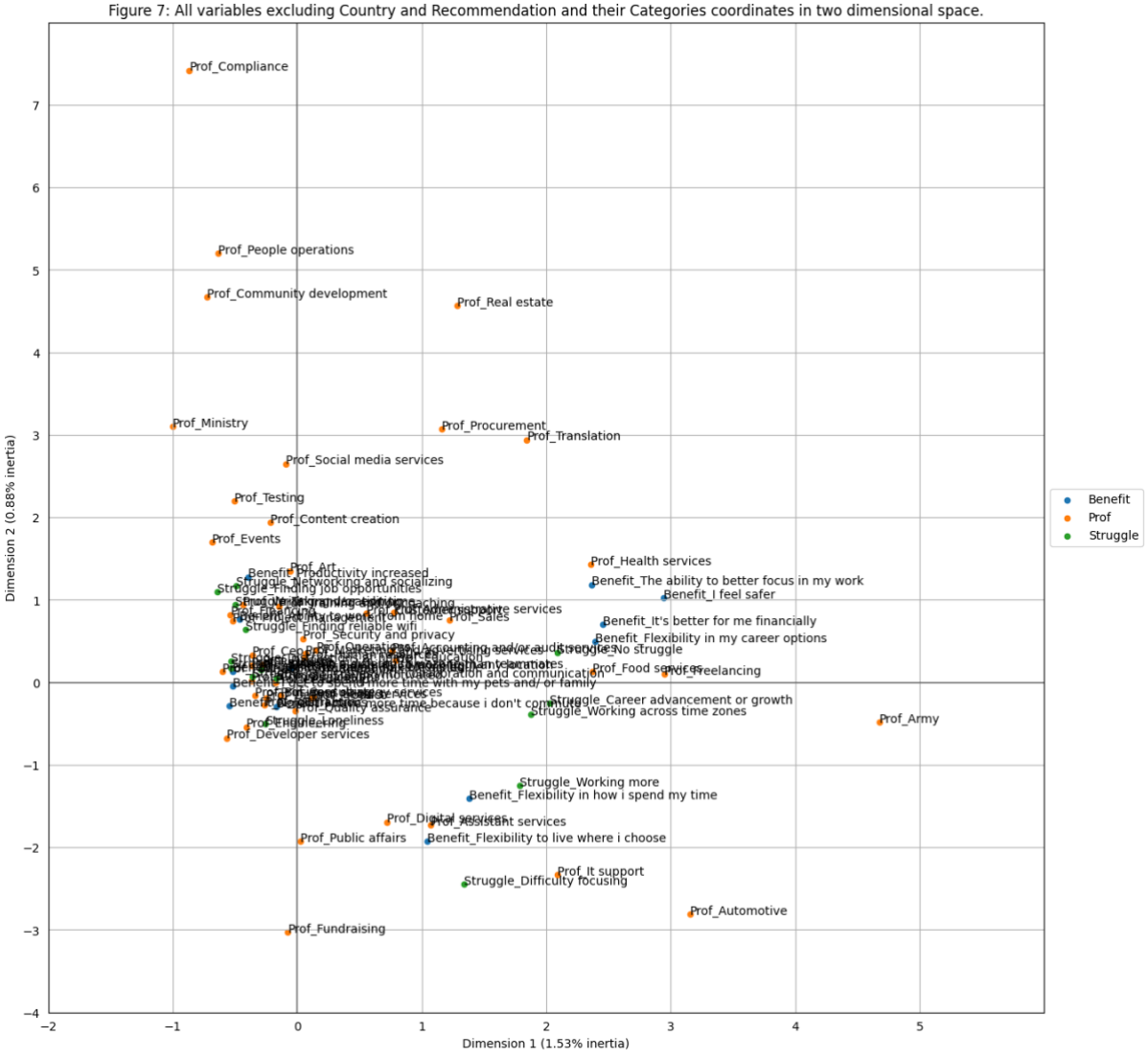
In the context of Multiple Correspondence Analysis (MCA), “mca.plot_coordinates” is a method that can be used to visualize the relationships between the variables in the data set. It generates a scatter plot of the MCA dimensions, with each data point representing a variable and a unique level in the data set. This can be particularly useful for identifying patterns and trends in the data, and for understanding the underlying structure of the data set and interpret the dimensions of the plot. For the purpose of space saving in the plot and to ease the interpretability, prefixes were used for the variables’ names:
{"What country do you live in curently?": "Country", "Profession": "Prof", "Biggest struggle working remotely": "Struggle", "Biggest benefit working remotely": "Benefit", "Would you recommend remote work?": ”Recom"}

Figure 6: All variables and their Categories coordinates in two dimensional space.



In Figure 6 we are using the dimension 1 on x axis which has the higher eigenvalue and dimension 2 on y axis. Each dimension includes its inertia percentage where dimension 1 and dimension 2 explains 1.53% of inertia and 0.88% respectively. In the specific plot all five variables are used with the vast majority of the variables' categories to be concentrated close to the origin, describing the average ones. Meanwhile the categories that are far from the origin and closer to the edge of the plot are the ones that describe homogeneous group of objects. Some of the categories that seem to be closer are individuals who telework, and their profession is related to food services, health services, freelancing while their struggle is career growth, working across time zones or perhaps no struggle and as a benefit the flexibility in a career option, feeling safer and better focus which categories are really close to the country Brazil. These individuals can be spotted around the point (3,1). Additionally, around the point (0, -2) we can see that many countries such as Latvia, UAE, Albania, Lithuania and Denmark are close to the profession public affairs.

Figure 7: All variables excluding Country and Recommendation and their Categories coordinates in two dimensional space.



Based on the interpretation above we will continue with the next plot (Figure 7), only now we have excluded the variables Country and Recommendation.

Figure 7 provides valuable insights into the relationship between individual professions and the benefits and struggles they face. The plot helps to identify professions such as freelancing, automotive, health services, food services, IT support, assistant services or translation, which are associated with a higher prevalence of benefits they seem to enjoy such as more safety, better financially, flexibility in career options, better focus. Additionally, some of the struggles individuals face are career growth, working across different time zones, difficulty focusing, working more and some of them do not face any struggle. These individuals can be spotted around the point (3,1) and (2, -2). This information can help decision-makers understand the needs and priorities of individuals in different professions and tailor support or resources accordingly. Additionally, interpreting such plots may help identify which professions seem to be connected more with a list of struggles, providing an important insight.

4.4 Clustering the data

After creating the K-modes algorithm (*Kmodes*, 2022), it was applied to the data where five clusters were obtained:

Table 5 Clusters and their number of observations

Cluster 1	3939 data points
Cluster 2	1988 data points
Cluster 3	1561 data points
Cluster 4	1006 data points
Cluster 5	1162 data points

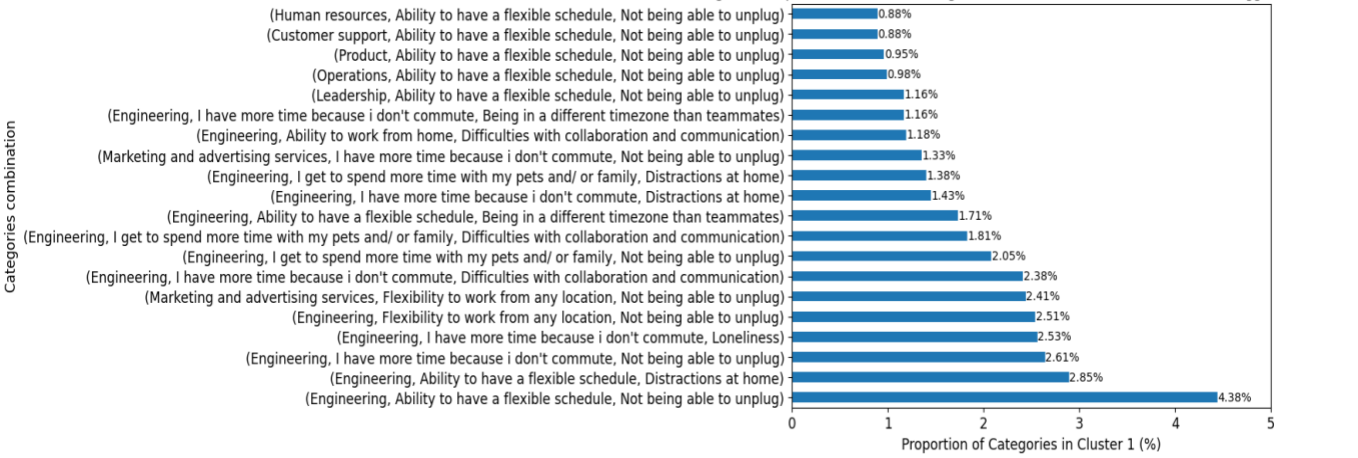
Table 6 Brief description of the clusters is provided based on the centroids of each cluster.

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
What country do you live in currently?	United States	United States	Brazil	United States	United States
Profession	Engineering	Marketing and advertising services	Engineering	Design	Engineering
Biggest struggle working remotely	Not being able to unplug	Staying motivated	No struggle	Difficulties with collaboration and communication	Loneliness
Biggest benefit working remotely	I have more time because i don't commute	Ability to have a flexible schedule	Flexibility to work from any location	Ability to have a flexible schedule	Flexibility to work from any location

Additionally, a new column was created on the data set named “cluster” where all observations from the data set are now assigned to a cluster.

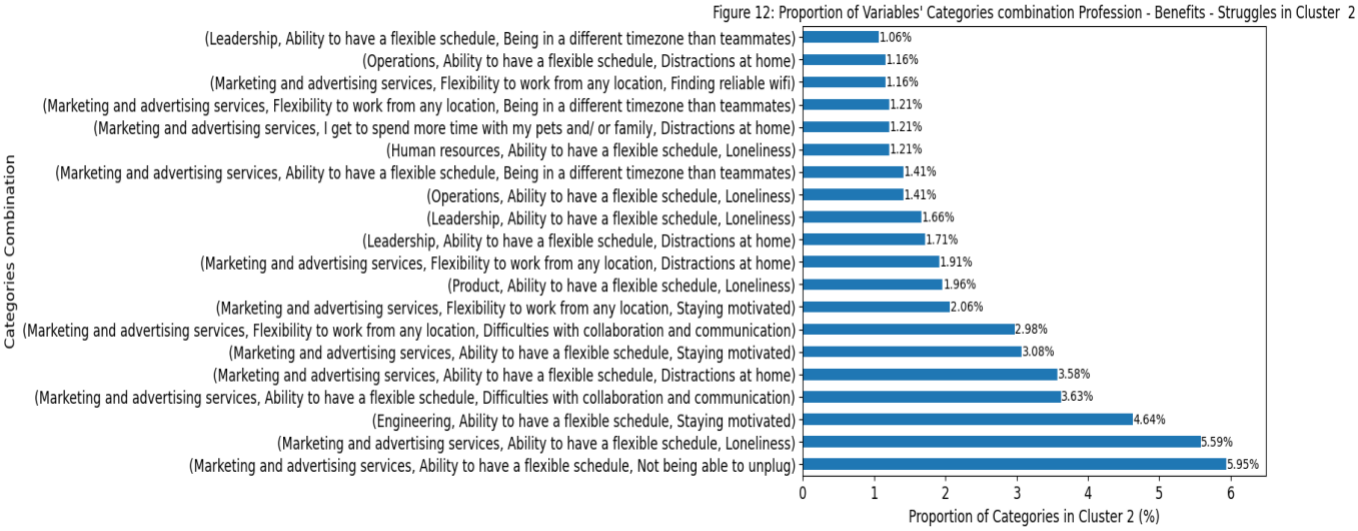
As it can be seen from Figure 8 the bar plot shows which combinations have the higher frequency between the variables “Profession”, “Biggest benefit working remotely” and “Biggest struggle working remotely”. On the x – axis we have the number of observations from the cluster 1 and accordingly how many observations are assigned to each combination of the variables’ features, additionally on the y – axis we have the twenty most frequent combinations of the variables’ features. Based on everything mentioned above, the plot informs us that profession engineering is connected mostly with the benefit of flexible schedule, more time due to not commuting and the ability to work from anywhere as well as with the struggle of not being able to unplug, distractions at home, loneliness and difficulties with collaboration and communication. Furthermore, it is noticeable that the vast majority on this combination of categories has as a profession the engineering while individuals face in their majority the struggle of not being able to unplug and finally the benefit with the highest frequency is (Appendix Figure 9, Figure 10 and Figure 11).

Figure 8: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 1



Based on the interpretation of Figure 8 we continue with Figure 12. In cluster 2, we have the same variables and their categories combination as plotted in cluster 1. As it can be seen the majority of profession is referred to Marketing and advertising services while it is mostly connected to the benefit ability to have a flexible schedule and the flexibility to work from any location as well as it is connected to struggles such as not being able to unplug, loneliness, staying motivated and distractions at home. Marketing and advertising services has the highest frequency among the other professions while the staying motivated has the biggest proportion of the struggles individuals face and finally the ability to have a flexible schedule is also the category with the highest frequency among other benefits individuals seem to enjoy (Appendix Figure 13, Figure 14 and Figure 15).

Figure 12: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 2



Based on the plot interpretation provided for clusters 1 & 2, the same notion applies for clusters 3, 4 and 5. Therefore, Figure 16, Figure 20 and Figure 24 provides the Frequency of variables Profession, Benefits and Struggles for cluster 3, 4 and 5 respectively.

Figure 16: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 3

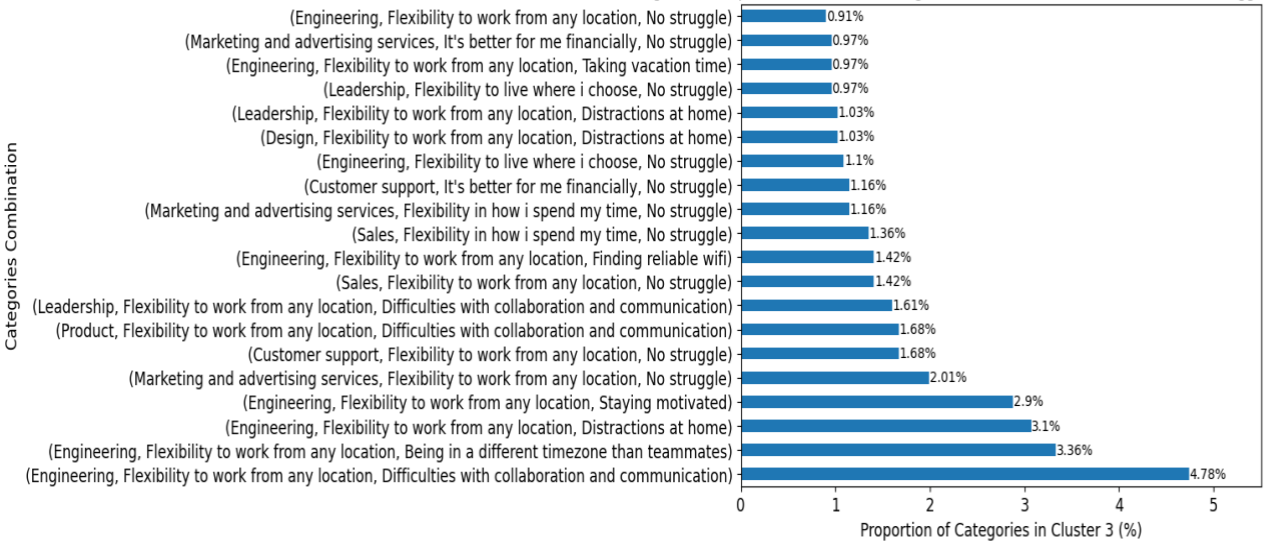


Figure 20: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 4

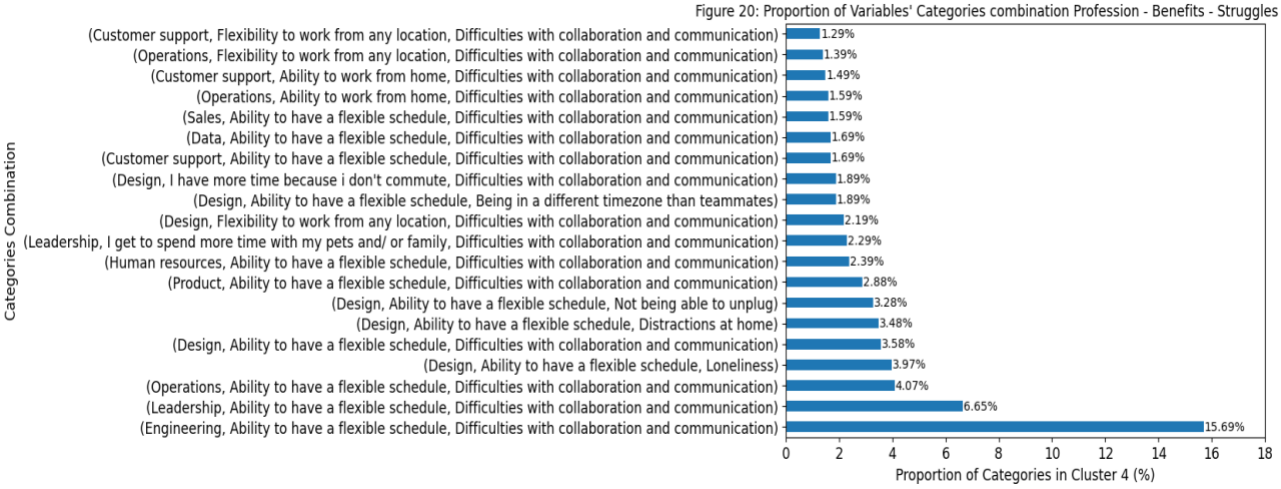
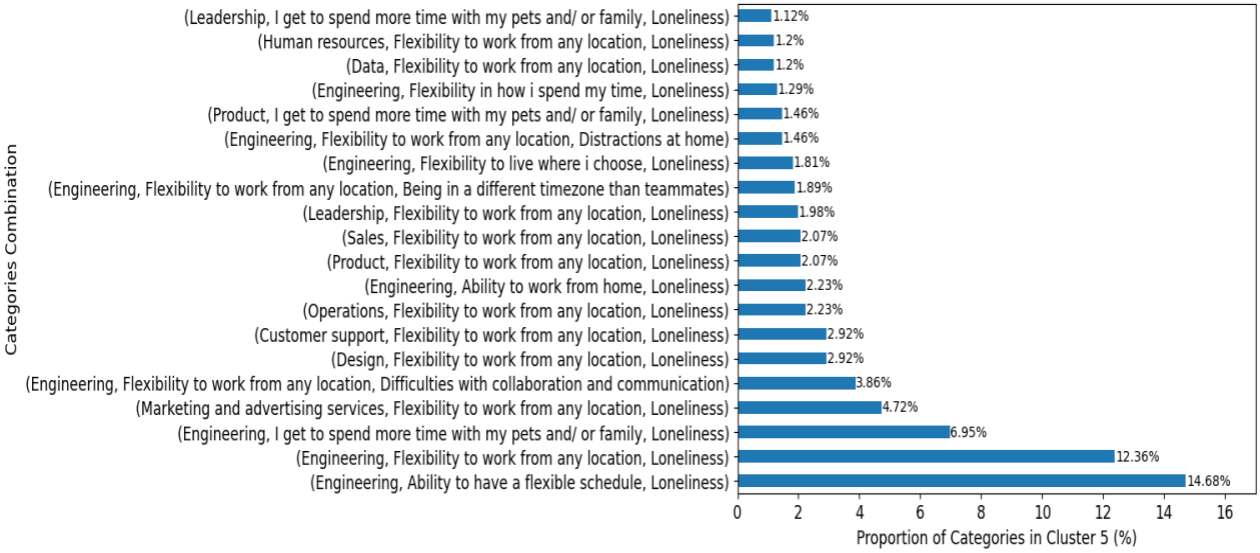


Figure 24: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 5



In summary, the above frequency plots of the clusters can provide valuable insights regarding individuals and the struggles the face as well as the benefits they enjoy in combination with their profession. Therefore, we can obtain which professions are assigned mostly to which benefits and struggles and thus how easily we could eliminate such struggles and retain those benefits in the future.

5. Conclusion

5.1 Summary of main findings

This chapter presents the final conclusions and recommendations based on the discussion of the results in chapter four. In this study, Multiple Correspondence Analysis (MCA) was used to analyze data from a survey on consumer behavior as well as K-modes for clustering the data as a method.

- The MCA model identified five dimensions in the data, and their eigenvalues indicated that the first dimension was the most important, followed by dimension 2 through 5. The analysis is based on dimension 1 and 2 based on the Elbow rule plot where the eigenvalues are 0.464 and 0.266 respectively.
- From Figure 6 includes all of the variables and we interpreted that some of the categories seem to be closer and refers to individuals who telework, and their profession is related to food services, health services, freelancing while their struggle is career growth, working across time zones or perhaps no struggle and as a benefit the flexibility in a career option, feeling safer and better focus which categories are really close to the country Brazil. Additionally, Figure 7 includes only the variables Profession, Benefit, Struggle and describes professions such as automotive, IT support, assistant services or translation, which are assigned to benefits such as being better financially, flexibility in career options, better focus. Additionally, some of the struggles individuals face is working across different time zones, difficulty focusing, working more and some of them do not face any struggle.
- Interpreting the frequency plots for the obtained clusters we can see that the highest frequency for profession in cluster 1 belongs to engineering while the most frequent benefits refer to the ability to have a flexible schedule, more time due to not commuting, flexibility to work from any location and accordingly regarding the struggle we have distractions at home, not being able to unplug and loneliness.

For cluster 2, the profession with the highest frequency is marketing and advertising services, while the most frequent benefit is the flexible schedule as well as the struggle with the highest frequency to be loneliness, not being able to unplug and staying motivated. For cluster 3, the profession with the highest frequency is engineering combined with the benefit of flexibility to work from any location while facing struggles such as collaboration and communication, distractions at home and staying motivated. For cluster 4, the profession with the highest frequency to be engineering, leadership, operations combined with the benefit of having a flexible schedule and the struggle of collaboration and communication. Finally for cluster 5, we find profession engineering again to have the highest frequency combined with the benefit of having a flexible schedule, work from any location, more time with family and pets and finally the highest frequency for straggle is assigned to loneliness.

Overall, these results suggest that the dimension 1 and 2 of the MCA represent the main underlying structure of the data, while the main pattern obtained are the ones described above from Figure 6 & Figure 7. Additionally, we get a lot of information regarding the individuals for each cluster and the frequency of their profession in combination with the benefit they enjoy as well as the struggle they face while teleworking.

5.2 Contribution to theory

The results of this study contribute to the existing body of knowledge on the topic of telework and remote work in several ways. First, the study provides insights with a number of factors that seems to leverage telework and remote work adoption among individuals. This includes the role of profession, struggles, benefits, and country in shaping individuals preference for telework and thus recommending it. The identified patterns through MCA suggest that some professions are connected more often to specific benefits and struggles and therefore more emphasis must be given to these combinations. Furthermore, through the identified clusters we have a bigger picture of additional combinations between the variables' categories through their frequency. Second, the study adds to our understanding of the impacts of telework and remote work on employee well-being, job satisfaction, and performance. The findings suggest that telework and remote work can be linked to both advantageous and

disadvantageous effects on these outcomes, depending on the specific context and the individual characteristics of the employees. Finally, the study offers practical implications for organizations considering implementing telework and remote work policies. The results highlight the importance of addressing the struggles individuals face during telework and remote work while organizations should try and neutralize them based on the culture, providing adequate support to their employees. It is also important organizations to retain the benefits their employees enjoy and try to implement as many as possible to the existing ones. Additionally, the results of this study suggest that various patterns highlight the factors that influence the most the option of telework. Overall, this study contributes to the existing literature on telework and remote work by providing a more nuanced and context-specific understanding of the factors that influence adoption, the impacts on employee outcomes, and the practical considerations for organizations.

5.3 Limitations

There are several limitations to this study that should be considered when interpreting the results. First, the sample of this study was drawn from a single organization, which may limit the generalizability of the findings to other organizations or sectors. It is possible that the attitudes and perceptions of employees and managers towards telework and remote work may vary across different organizational contexts, and further research is needed to confirm the generalizability of these findings.

Second, this study relied on self-report measures by individuals to assess attitudes and perceptions towards telework and remote work, which may be subject to biases or errors. It is possible that participants may have over- or underestimated their attitudes or perceptions, or that their responses may have been influenced by social desirability.

Third, this study shows great imbalance in the variable “Would you recommend remote work?”, which makes it difficult to disentangle the effects of telework and remote work from other factors that may influence employee well-being and performance. It is possible that the results of this study may be confounded by other factors that are not accounted for in the analysis.

Fourth, this study did not have information on additional individual characteristics such as gender, age, education level, socio-economic status, or marital status, which may have contributed with more robust findings in terms of insights. For example, it is possible that

these demographic factors may be related to attitudes towards telework and remote work, and further research is needed to examine these relationships.
Finally, this study collected data from a global sample, which means that the results are more generalized and may not be applicable to a specific country or continent. It is possible that the attitudes and perceptions of employees and managers towards telework and remote work may vary across different cultural and regional contexts, and further research is needed to examine these differences.

5.4 Recommendations for future research

Based on the findings and limitations of this study, there are several recommendations for future research on the topic of telework and remote work. First, it would be useful to replicate this study in a larger sample of organizations in order to confirm the generalizability of the results and to explore any potential differences across different sectors and contexts.
Second, it would be valuable to include a test sample in future studies in order to disentangle the effects of telework and remote work from other factors that may influence employee well-being and performance. This could be accomplished through the use of a randomized controlled trial or a quasi-experimental design.
Third, it would be important to include more detailed information on individual characteristics such as gender, age, education level, socio-economic status, and marital status in order to examine the potential moderating effects of these factors on the relationships between telework and remote work and employee well-being and performance.
Fourth, it would be useful to assess the long-term impacts of telework and remote work on employee well-being and performance, as well as the potential trade-offs between these policies and other factors such as work-life balance and career advancement.
Finally, it would be valuable to examine the role of organizational support in promoting the successful adoption and implementation of telework and remote work policies, and to explore strategies for effectively managing telework and remote work teams. Additionally, an avenue for future research could be the measurement of expenses' variation for organizations that adopted the model of telework and if that proved that model useful or not in terms reducing the fixed costs.

5.5 Conclusion

In conclusion, this study examined the attitudes and perceptions of employees and managers towards telework and remote work on a global scale by finding the factors that influence the most such decision using Multiple Correspondence Analysis. The results of the study showed that telework and remote work can have both positive and negative impacts on employees' well-being and performance, depending on the specific context and the support provided by the organization. These findings contribute to the existing body of knowledge on the topic of telework and remote work by providing new insights into the factors that influence the adoption and implementation of these policies, and the impacts of these policies on employee well-being and performance depending on the specific context and the support provided by the organization. However, the study also had several limitations, including a reliance on self-report measures, a lack of a control group, and a lack of information on individual characteristics such as gender, age, education level, socio-economic status, and marital status. These limitations should be taken into account when interpreting the results of the study. Overall, the findings of this study suggest that telework and remote work may play a more central role in the future of work, but that it is important to consider the needs and preferences of individual employees and the broader organizational context when designing and implementing these policies. Future research should aim to replicate and extend these findings in order to further our understanding of the potential benefits and challenges of telework and remote work.

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Appendix

Figure 1: Profession Proportion

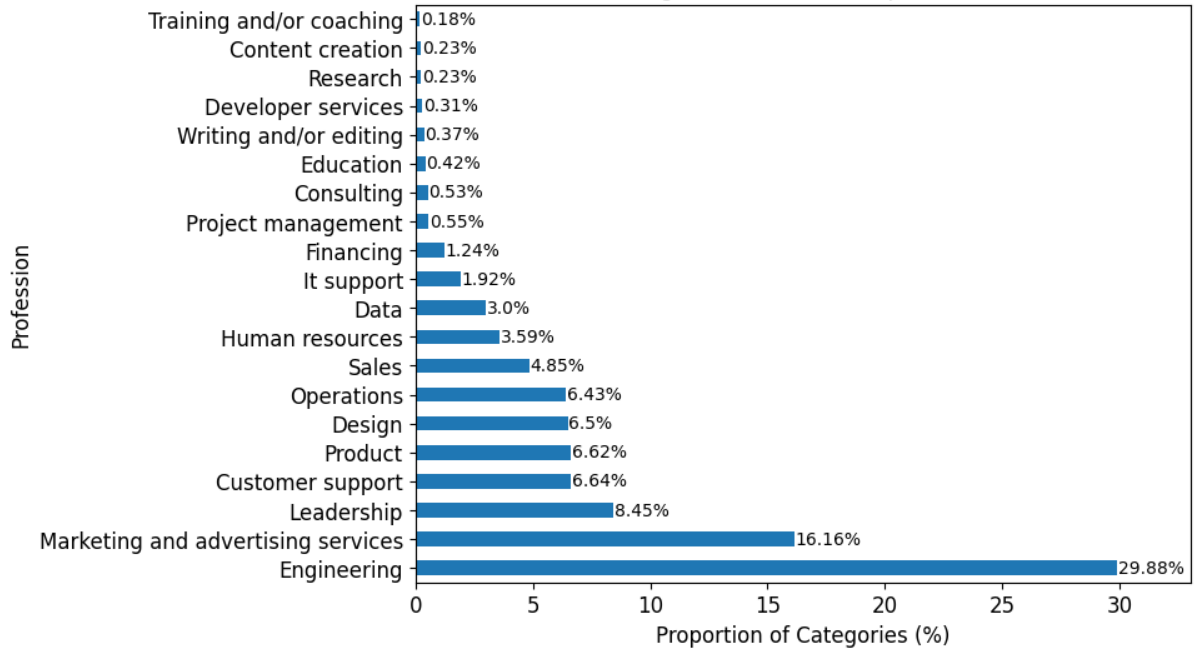


Figure 2: Country Proportion

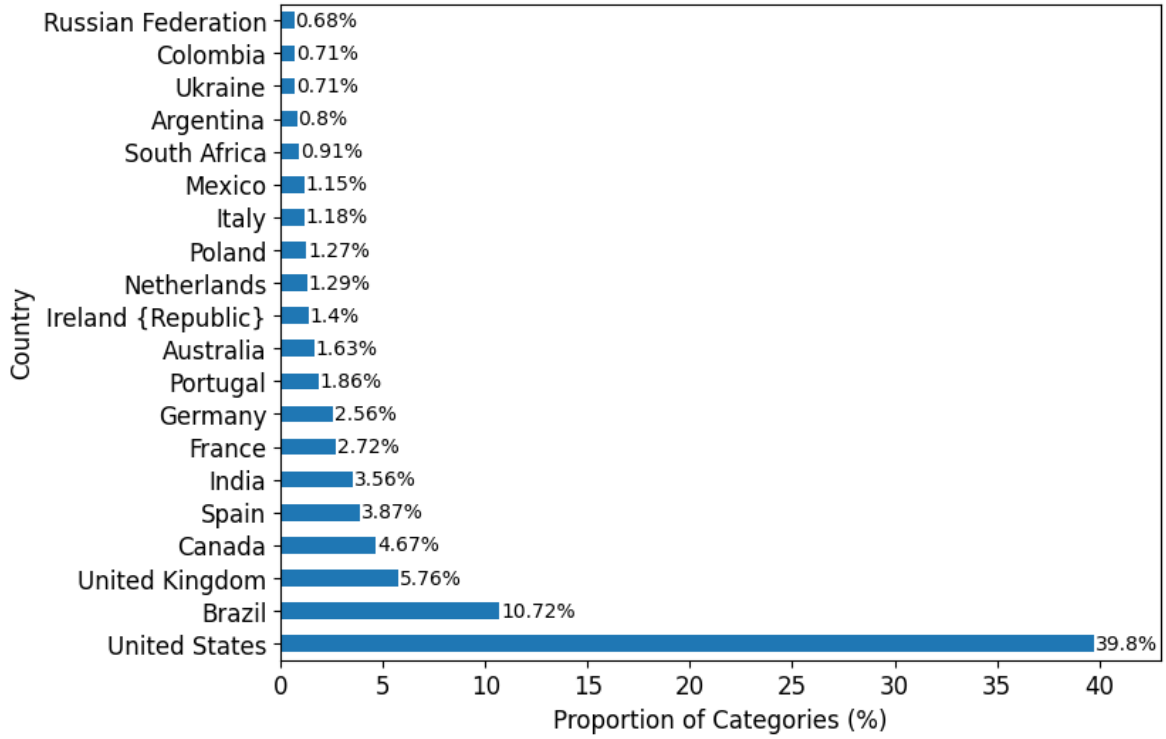
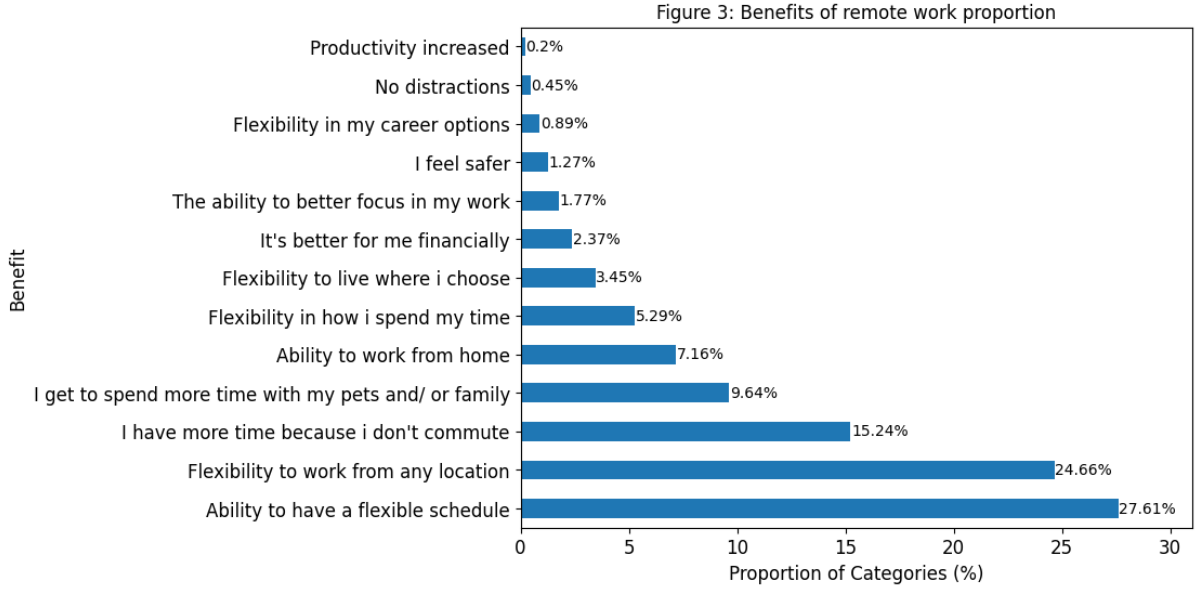


Figure 3: Benefits of remote work proportion



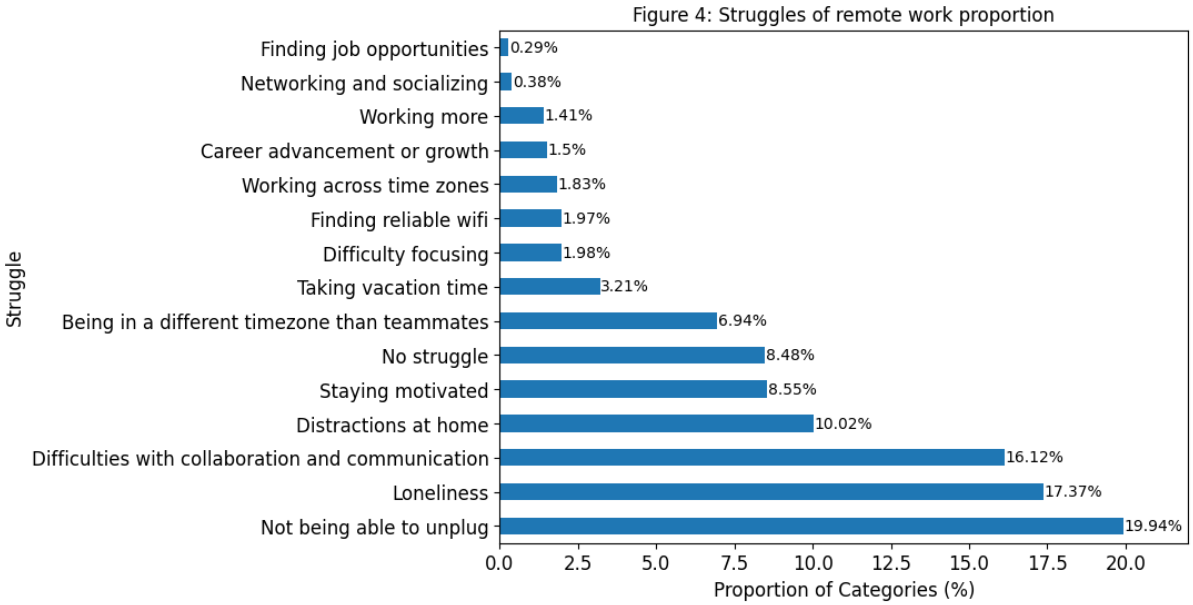


Figure 4: Struggles of remote work proportion
Struggle
Finding job opportunities
Networking and socializing
Working more
Career advancement or growth
Working across time zones
Finding reliable wifi
Difficulty focusing
Taking vacation time
Being in a different timezone than teammates
No struggle
Staying motivated
Distractions at home
Difficulties with collaboration and communication
Loneliness
Not being able to unplug
0.29%
0.38%
1.41%
1.5%
1.83%
1.97%
1.98%
3.21%
6.94%
8.48%
8.55%
10.02%
16.12%
17.37%
19.94%
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
Proportion of Categories (%)

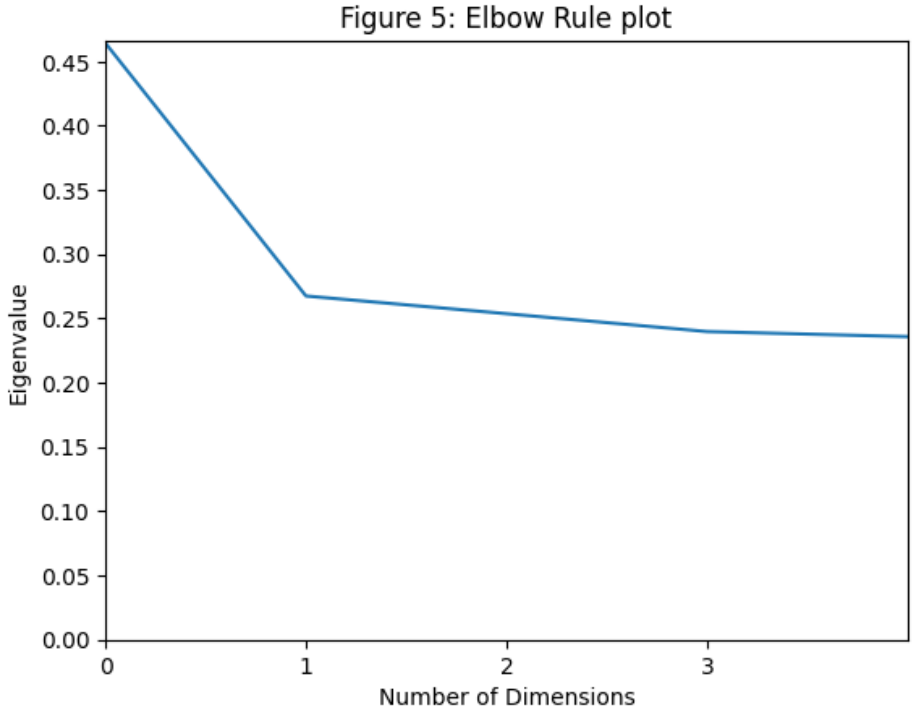


Figure 5: Elbow Rule plot
Eigenvalue
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
1
2
3
Number of Dimensions

Figure 6: All variables and their Categories coordinates in two dimensional space.

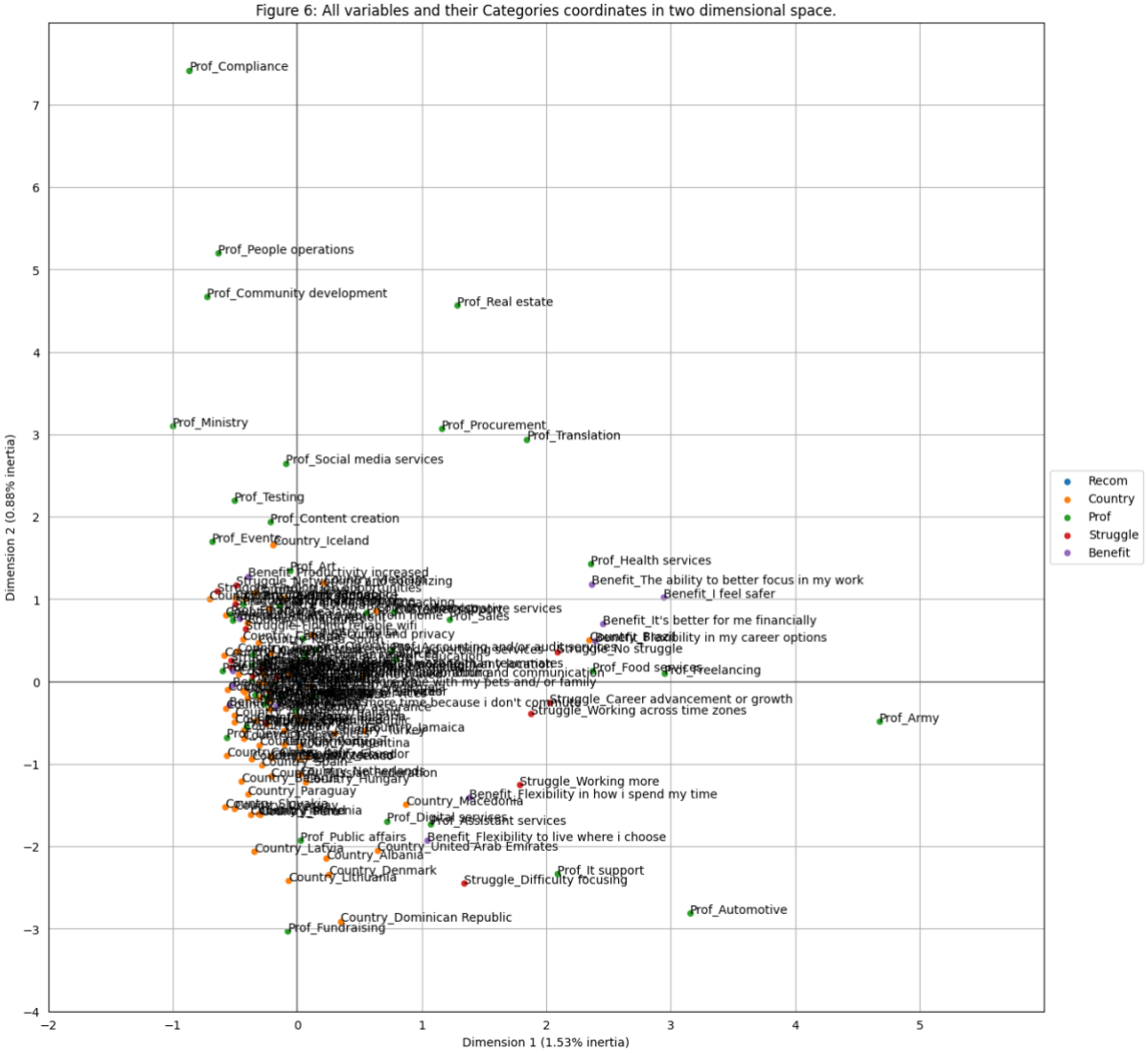


Figure 7: All variables excluding Country and Recommendation and their Categories coordinates in two dimensional space.

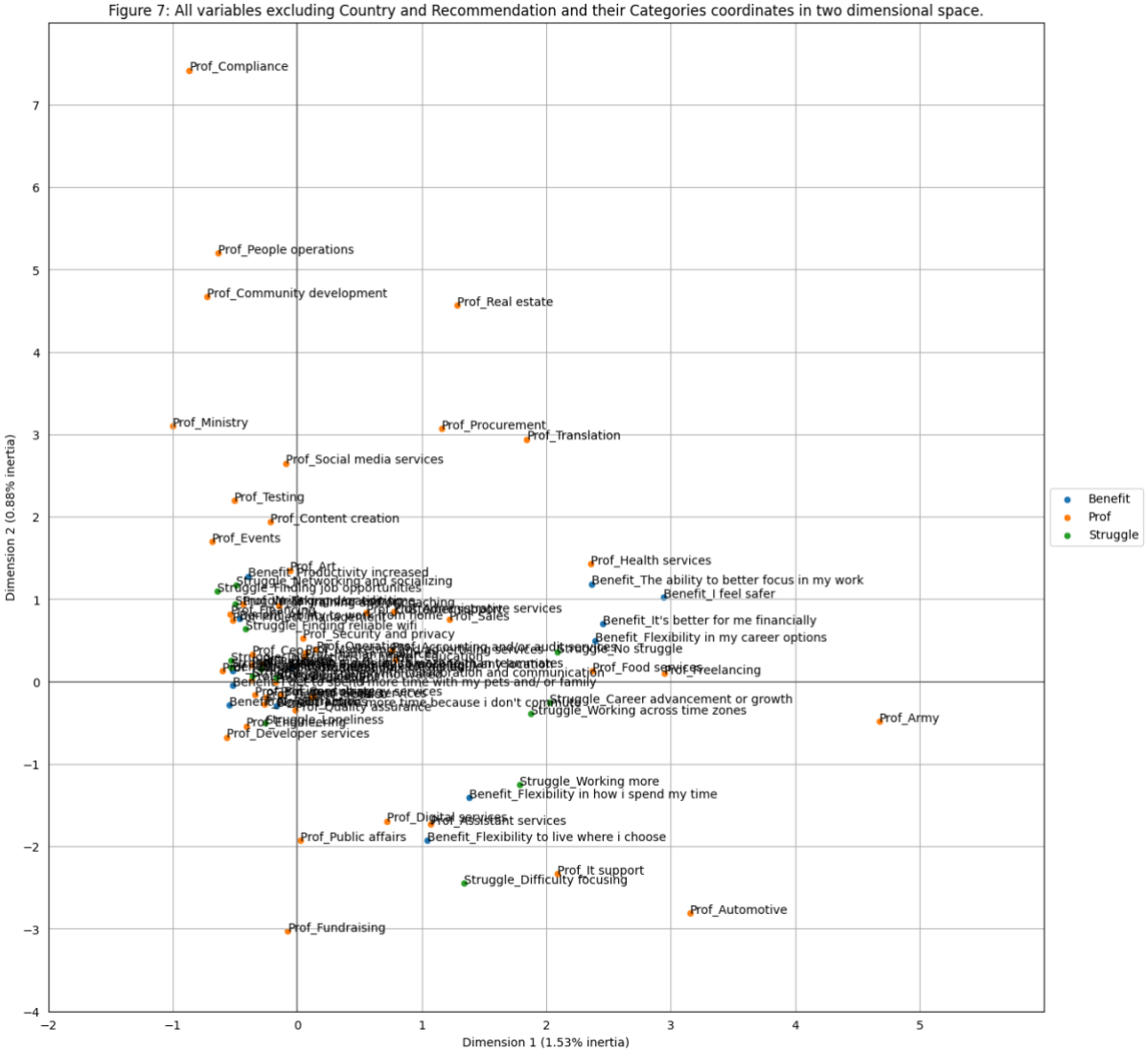


Figure 8: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 1

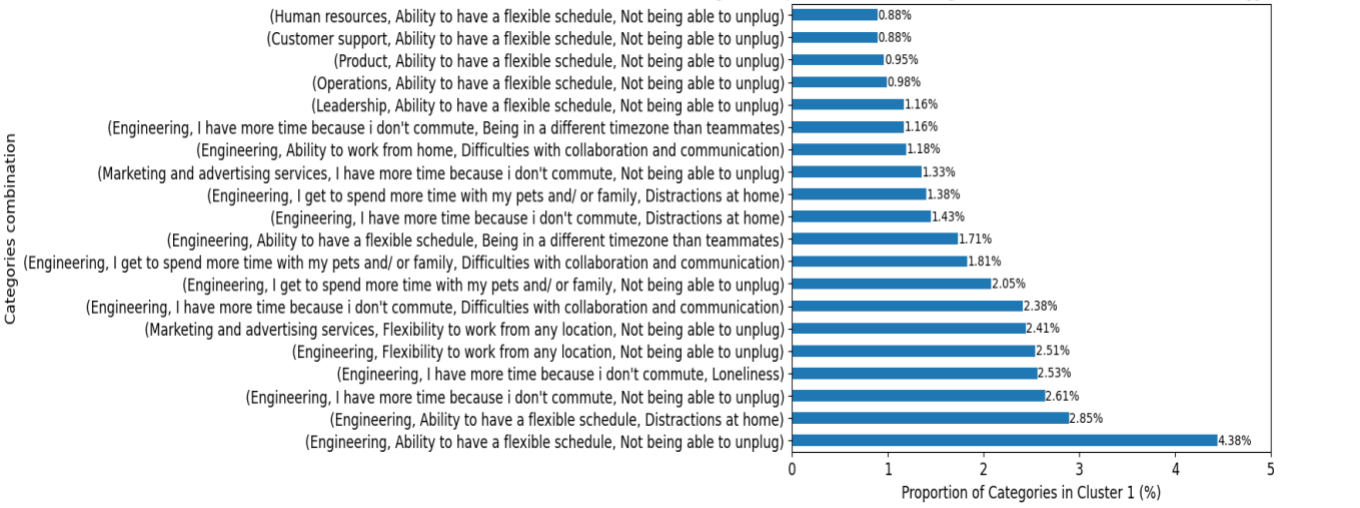


Figure 9: Profession Categories proportion in Cluster 1

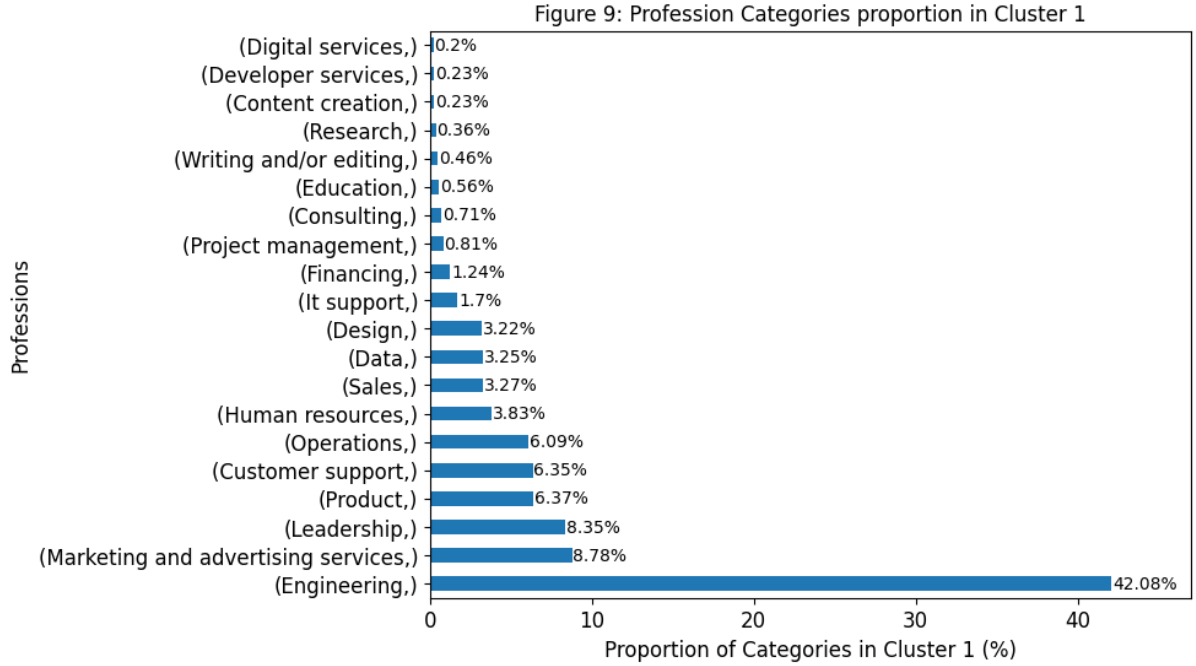


Figure 10: Struggle Categories proportion in Cluster 1

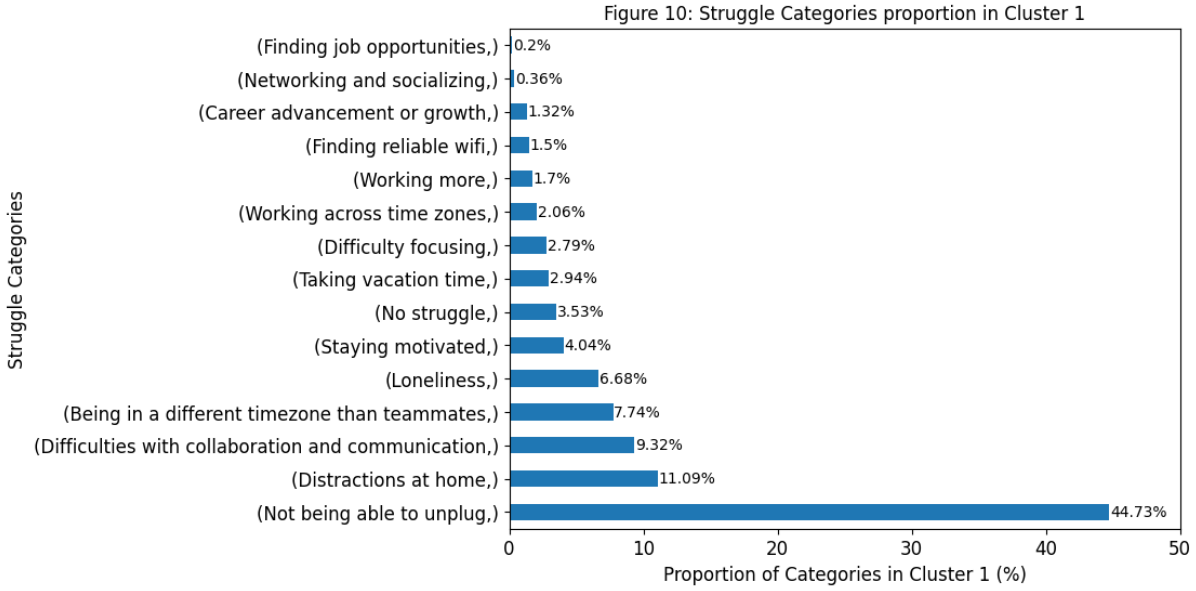


Figure 11: Benefit Categories proportion in Cluster 1

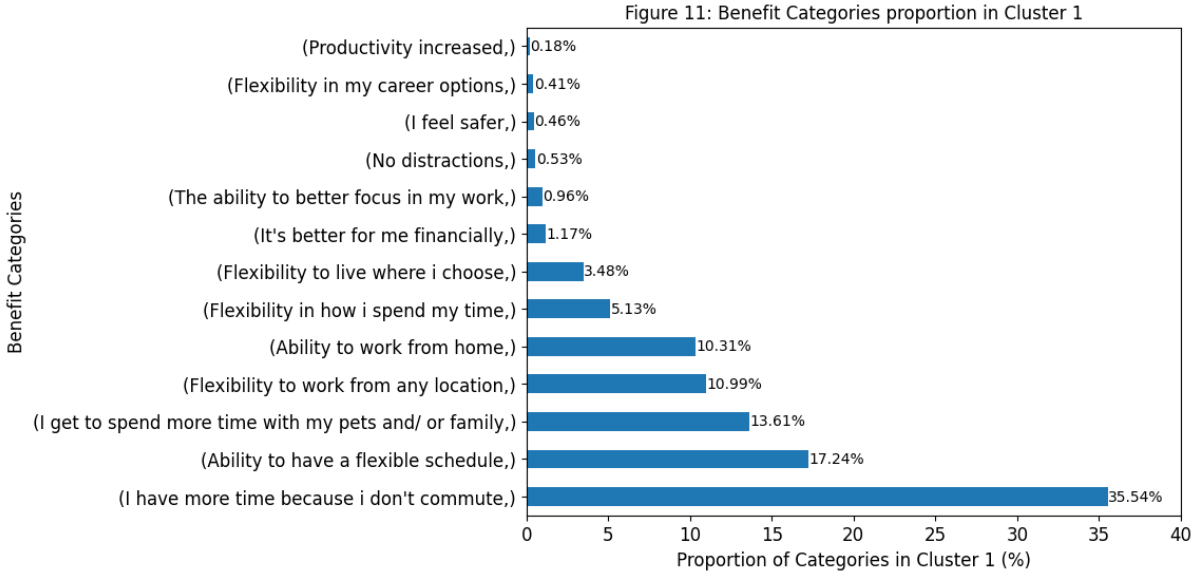


Figure 12: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 2

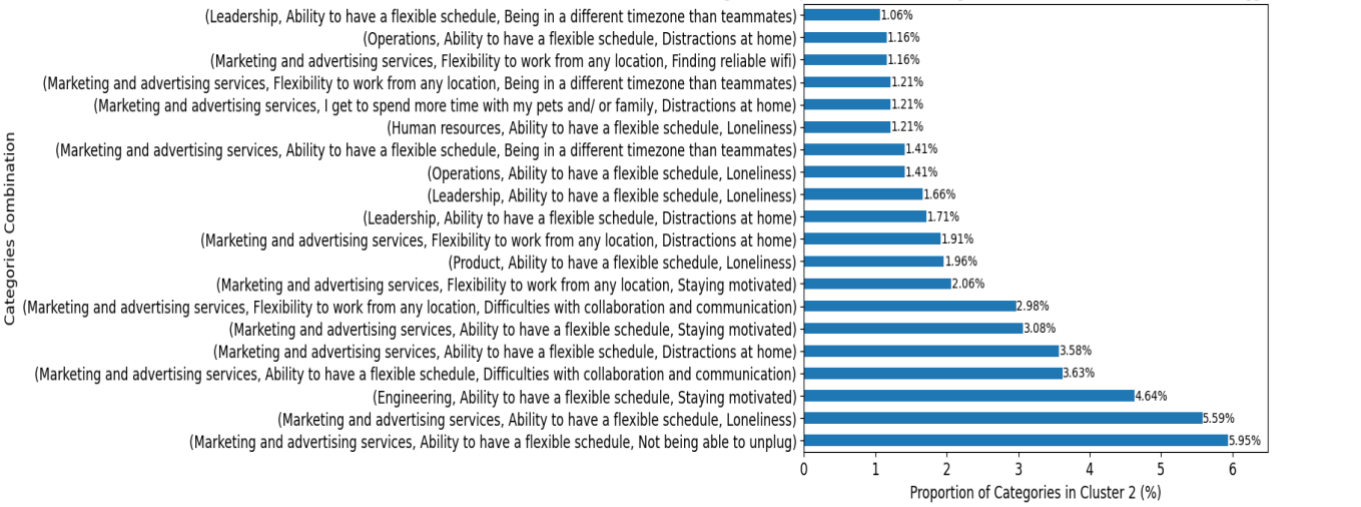


Figure 13: Profession Categories proportion in Cluster 2

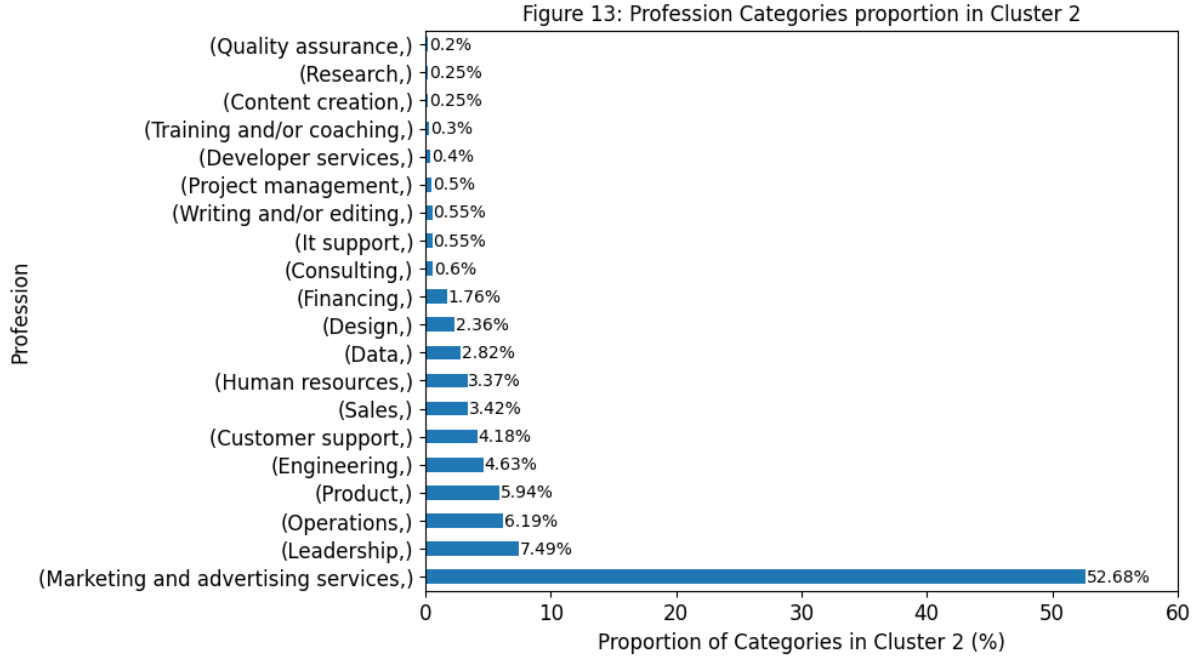


Figure 14: Struggle Categories proportion in Cluster 2

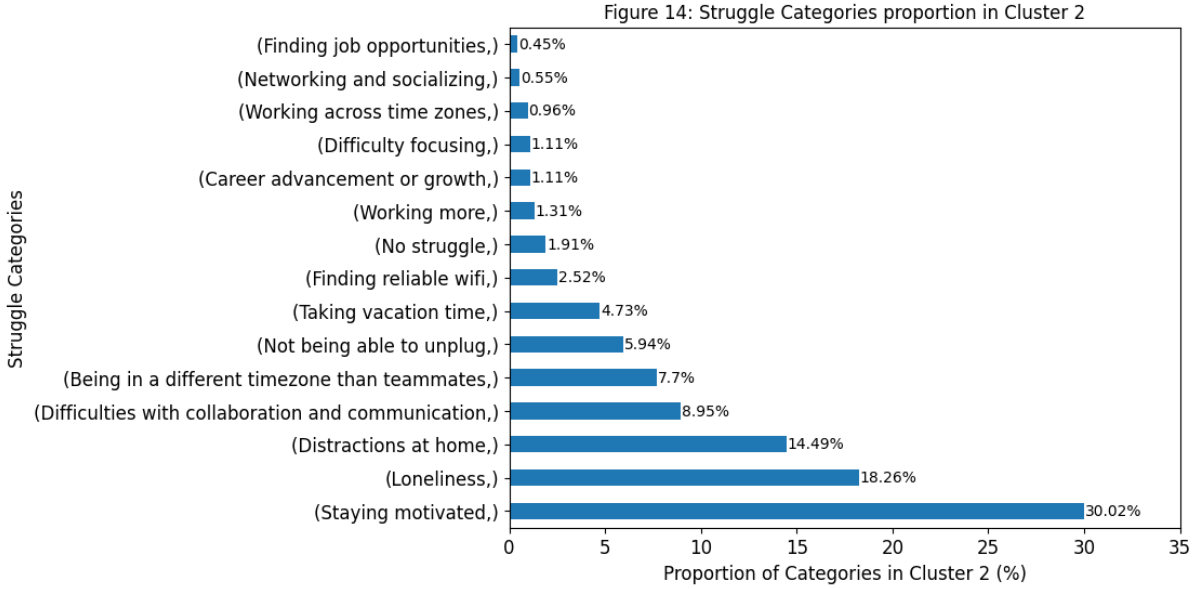


Figure 15: Benefit Categories proportion in Cluster 2

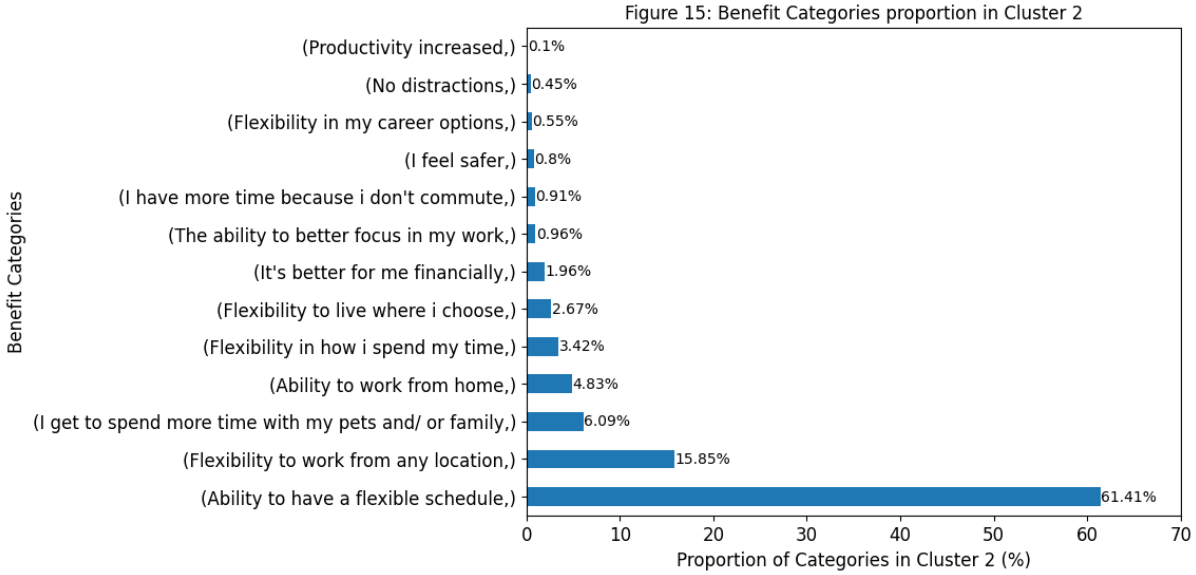


Figure 16: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 3

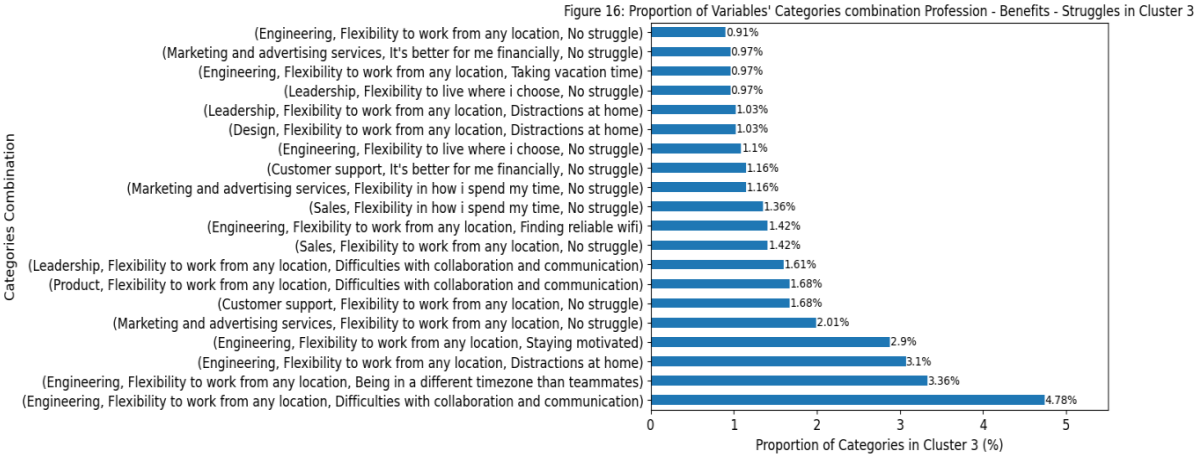


Figure 17: Profession Categories proportion in Cluster 3

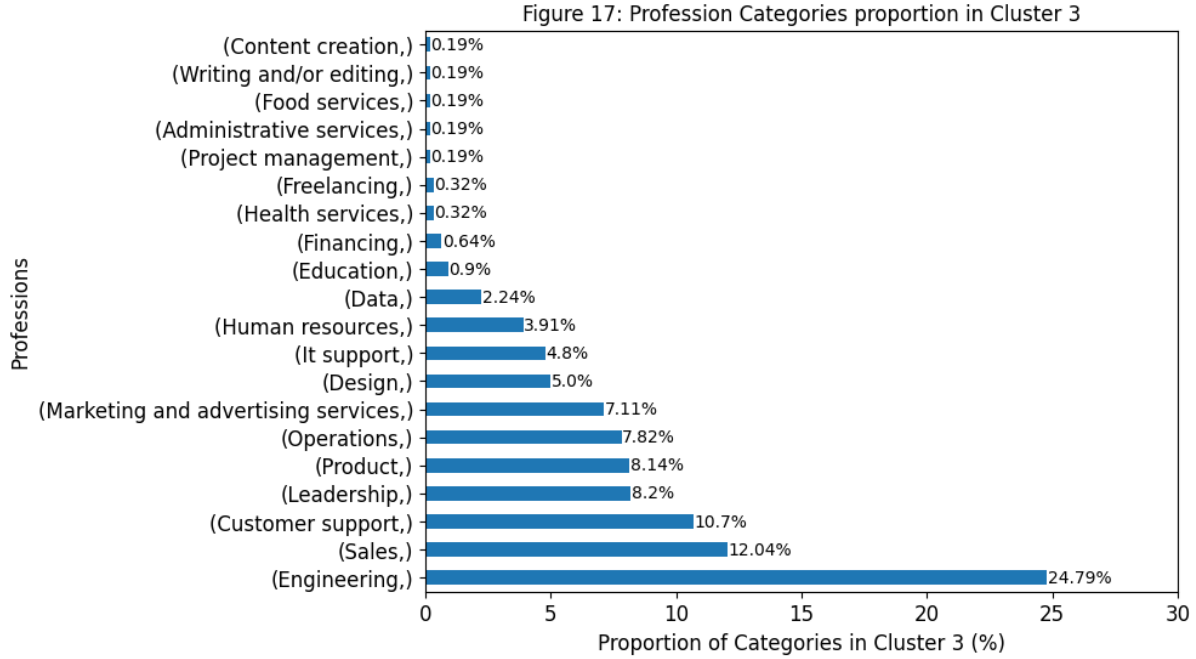


Figure 18: Struggle Categories proportion in Cluster 3

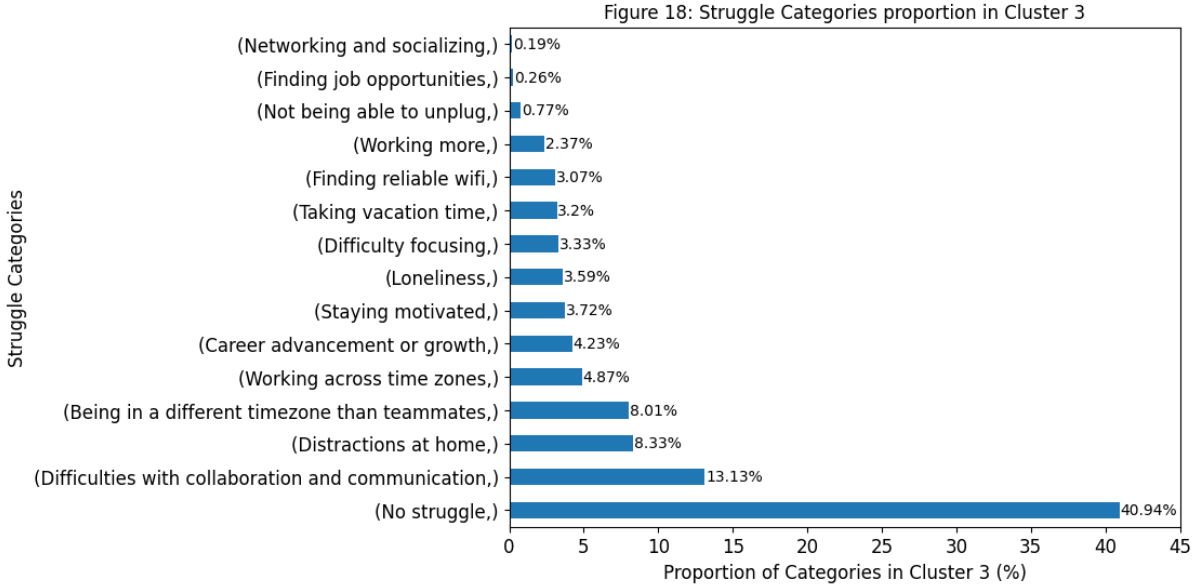


Figure 19: Benefit Categories proportion in Cluster 3

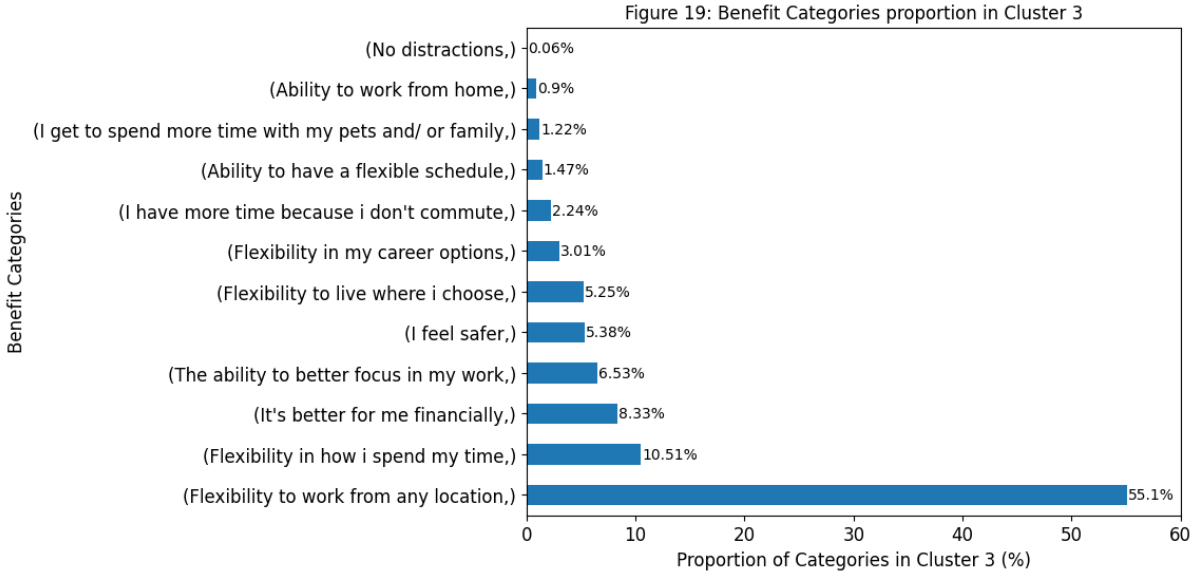


Figure 20: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 4

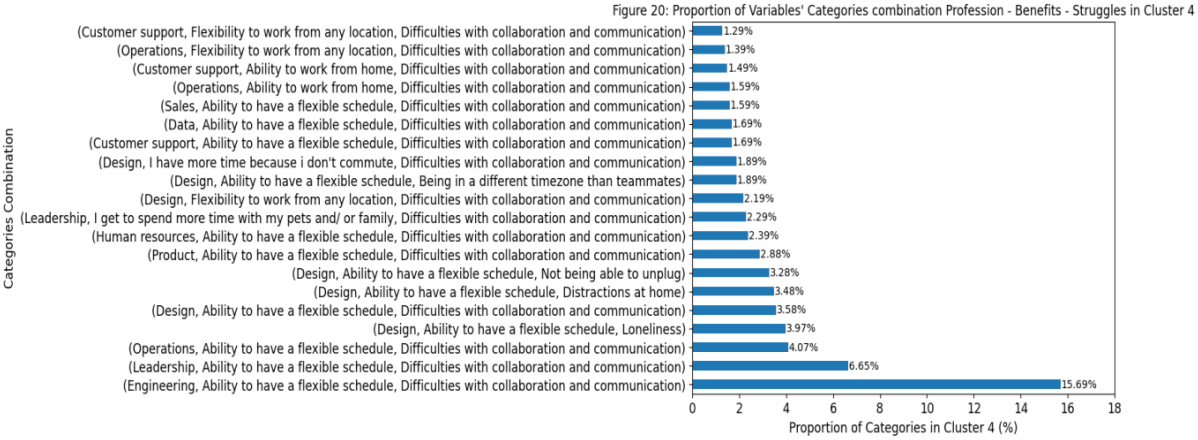


Figure 21: Profession Categories proportion in Cluster 4

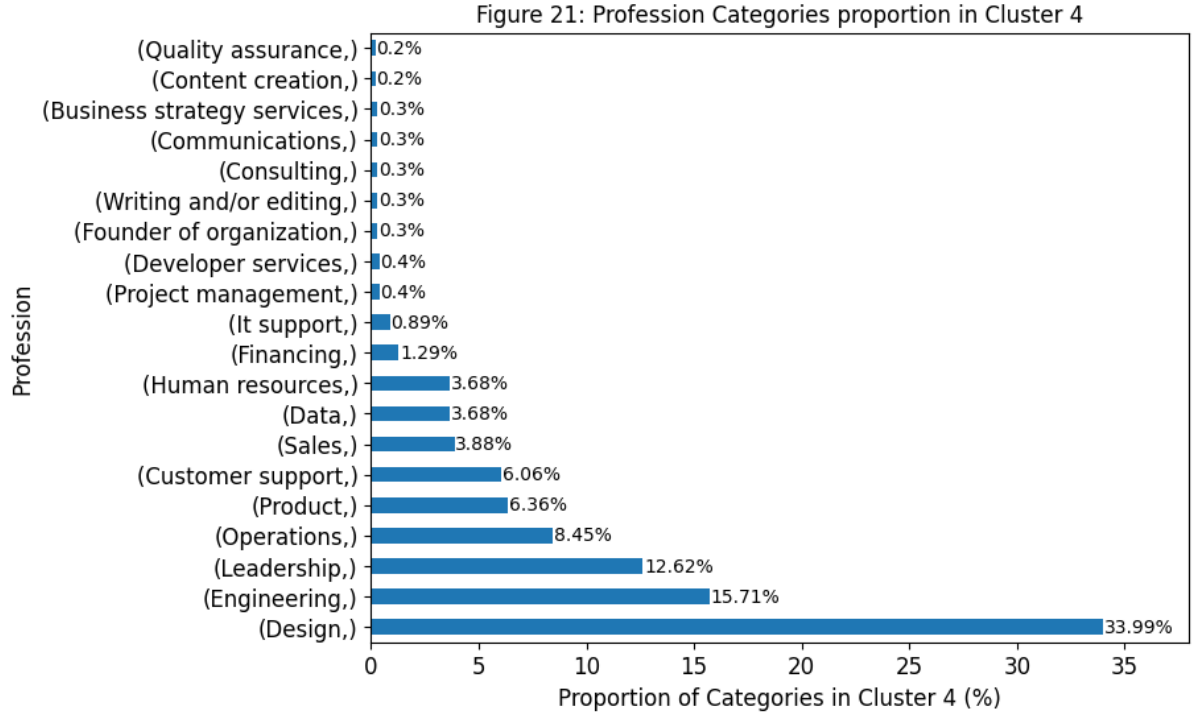


Figure 22: Struggle Categories proportion in Cluster 4

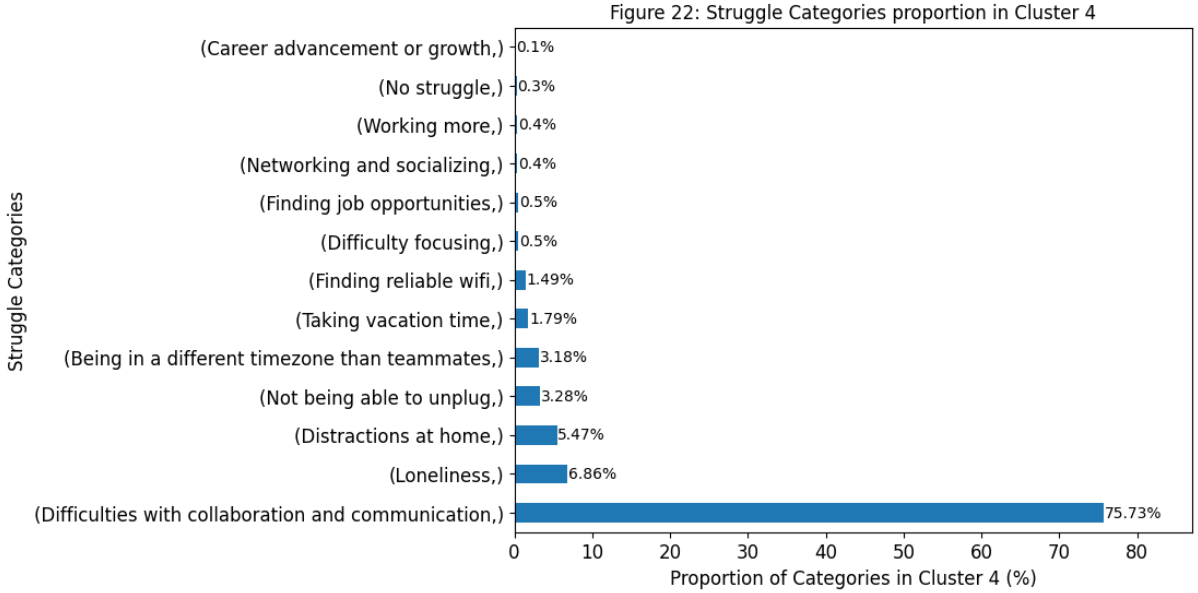


Figure 23: Benefit Categories proportion in Cluster 4

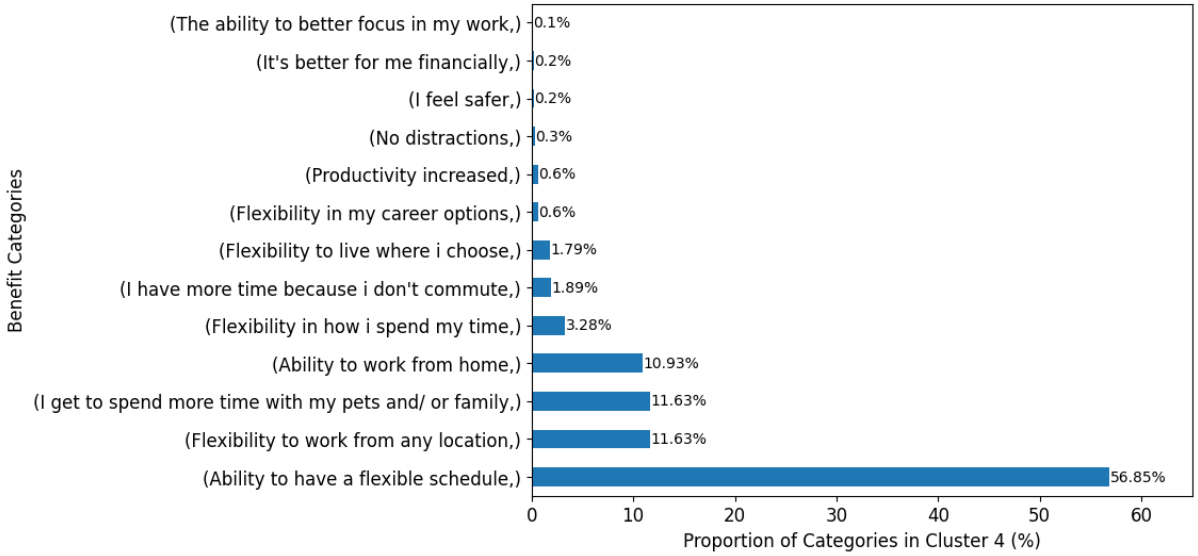


Figure 24: Proportion of Variables' Categories combination Profession - Benefits - Struggles in Cluster 5

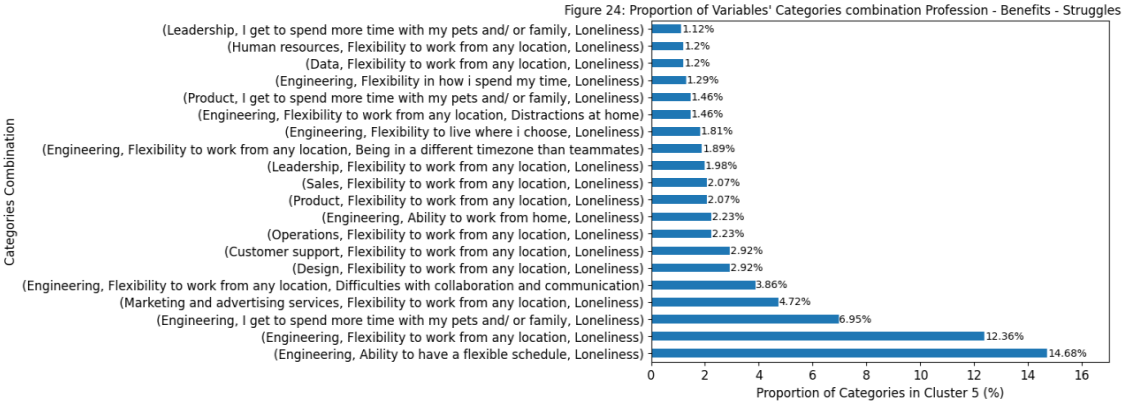


Figure 25: Profession Categories proportion in Cluster 5

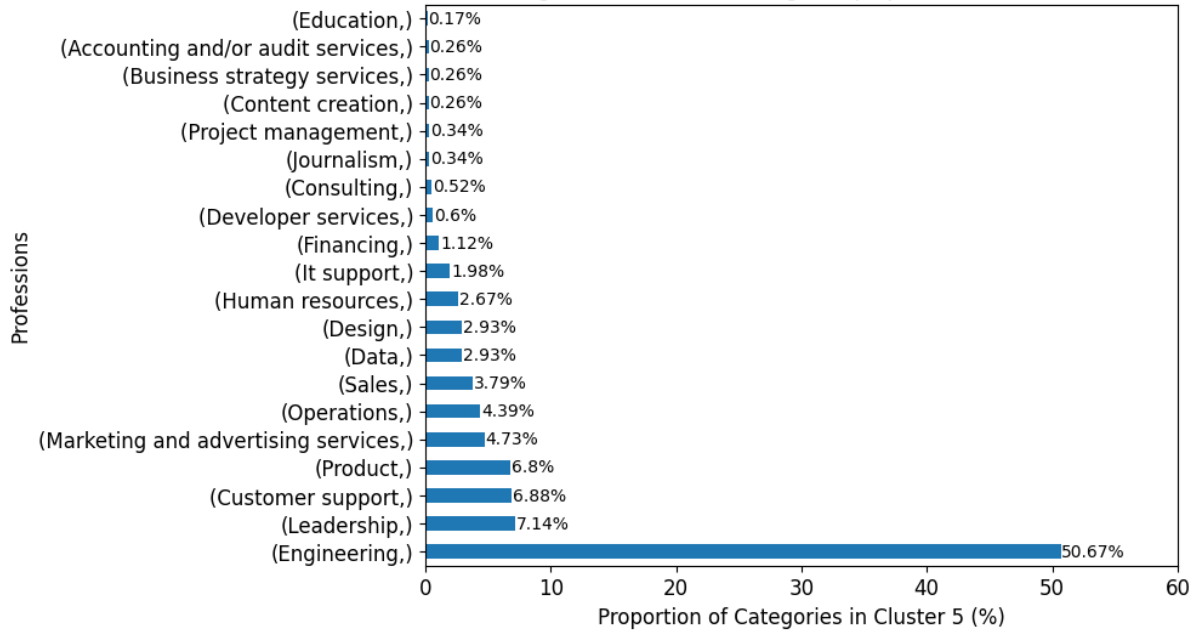


Figure 26: Struggle Categories proportion in Cluster 5

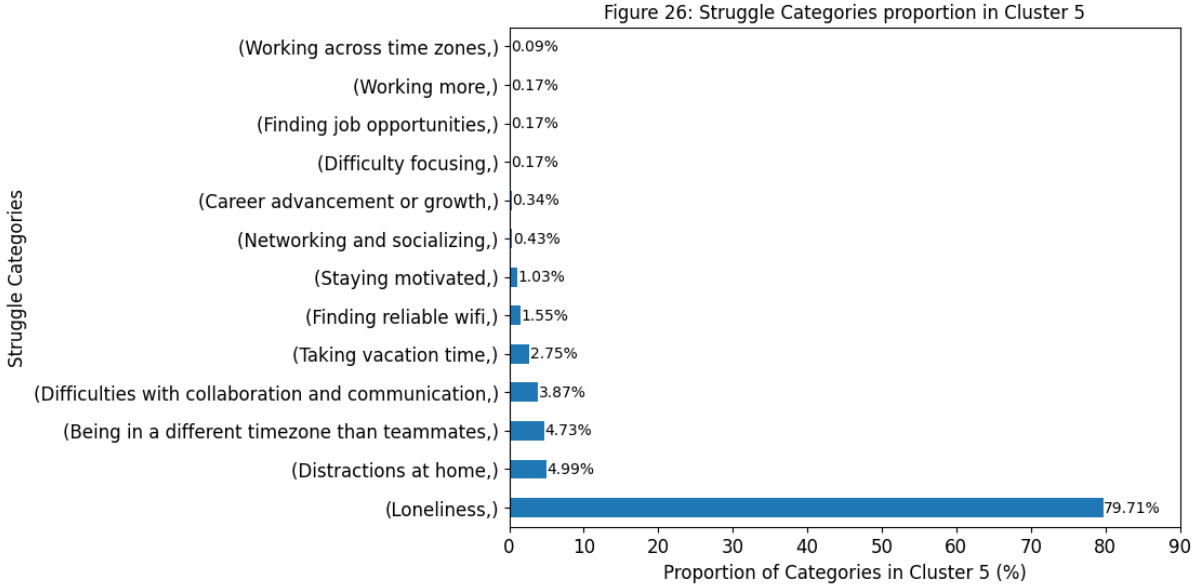


Figure 27: Benefit Categories proportion in Cluster 5