EXPLORING GENDER PAY GAP IN THE IT SECTOR

Chief Assist. Prof. Radka Nacheva, PhD

University of Economics – Varna, Bulgaria

Chief Assist. Prof. Velina Koleva, PhD

University of Economics – Varna, Bulgaria

Abstract: *The issue of gender equality is still on the agenda, including in terms of workplace payment gap. The literature review shows that the issue has been enshrined in a number of normative documents since 1951. However, the research done so far strongly suggests that in both European Union countries (including Bulgaria) and the United States, there is a gender pay gap despite the legal basis. This paper identifies the most significant reasons that give rise to this inequality. The aim of the paper is to investigate the pay gap between men and women in the Information technologies (IT) sector by proposing an integrated research process. To fulfil the purpose, we will process with the means of data mining and statistical analysis: opinions of users of the social network Twitter, extracted by keywords for gender equality in the IT sector; opinions of employees in IT companies obtained through a survey. Our proposed integrated research process consists of the following phases: Data Collection; Retrieving Dataset; Data Pre-processing; Data Analysis and Data Visualization. We combined social media and survey data. Data mining and statistical software are used for its implementation.*

Keywords*: IT sector, payment gap, gender equality, social media mining, sentiment analysis*

JEL code: *J16, C83, C88*

Introduction

The world is experiencing significant technological progress in a number of sectors. Modern technologies enable the implementation of innovations (Peicheva, 2022) in the economy. The trends and challenges imposed by globalization, technological progress, automation and digitization give new meaning to the nature of work and lead to significant changes in the structure of employment (Antonova and Ivanova, 2021). Artificial intelligence is entering the workplace, even on the verge of eliminating some positions held by humans. Acquiring digital skills is now mandatory when starting work in many industries (Vasilev, 2021; Marinova and Sulova, 2021; Armyanova, 2019; Narleva, 2011). In addition, the "leadership requires flexibility and adaptability because of the constant changes in the business environment" (Veleva, 2020).

Despite the serious technological progress that marks humanity, people still face serious violations of fundamental human rights, such as gender equality for example. We are witnessing acts of discrimination against women and girls not only at the workplace and in schools, but also in their family environment and close surroundings.

In order to promote gender equality and protect women and girls around the world, the United Nations (UN) has also designated this as a Sustainable Development Goal. Goal 5 aims to "achieve gender equality and empower all women and girls" (United Nations, 2022a). According to UN data, it is reported that "39.4 per cent of total employment before the pandemic in 2019 but made up nearly 45 per cent of global employment losses in 2020" (United Nations, 2022a). In 2022, the UN also reports that

115 countries have implemented about 76 percent of the laws and regulations needed to guarantee women's rights (United Nations, 2022a).

Within the framework of the European Union (EU) since 2013, the Gender Equality Index has been maintained, which reports gender equality according to 31 indicators, organized in 6 core domains (work, money, knowledge, time, power and health) and 2 additional domains - violence against women and intersecting inequalities (European Institute for Gender Equality, 2022a). According to data from 2022 of (European Institute for Gender Equality, 2022b), the average index for the EU is 68.6 out of 100 points, an increase of 0.6 points compared to 2021. The lowest rating is given to Greece with 53.4 points, followed by Hungary with 54.2 points and Romania with 53.7 points. Sweden has the highest points - 83.9, followed by Denmark with 77.8 points and the Netherlands with 77.3 points. Bulgaria ranks below the EU average for the general index of gender equality - 60.7 points. According to the Work indicator, the average for the EU is 71.7 points out of 100 (European Institute for Gender Equality, 2022c). Here again Sweden has the highest percentage of gender equality in the workplace - 83 out of 100. It is followed again by Denmark with 79.5 points and the Netherlands with 78.7 points. At the bottom of the ranking remains Italy with 63.2 points, followed by Greece with 65.6 and Slovakia with 66.5 points. Gender equality in the workplace in Bulgaria is rated with 69.3 points, which is again below the EU average.

On the other hand, Eurostat data from 2022 show that within the EU there are also differences in payment between men and women. They introduce an indicator that measures "difference between average gross hourly earnings of male paid employees and of female paid employees as a percentage of average gross hourly earnings of male paid employees" (Eurostat, 2022). The most serious pay gaps are reported in Latvia (22.3 %), and the lowest in Luxembourg (0.7 %). The average difference for the EU is 13%, while for Bulgaria it is 12%.

The gender pay gap exists not only within the EU, as evidenced by UN statistics. For example, a Pew Research Center publication states that "women ages 25 to 34 earned 93 cents for every dollar a man in the same age group earned on average" (Barroso and Brown, 2021). The authors compare the payment level with that of 1980, reporting that in 40 years in the United States, this difference has decreased by 26%.

From the mentioned statistics, it can be concluded that discriminatory practices against women, including the pay gap, still exist even in developed countries. In this regard, **the aim of our paper** is to investigate the pay gap between men and women in the IT sector by proposing an integrated research process. To fulfil the purpose, we will process with the means of data mining and statistical analysis:

- opinions of users of the social network Twitter, extracted by keywords for gender equality in the IT sector;
- opinions of employees in IT companies obtained through a survey.

1. Literature review

The remuneration of professionals in the IT sector is a highly topical issue that is subject to annual research and analysis. The dynamics, flexibility and constant growth of salaries in the industry, provoke interest both in practical and research aspects. A

number of international consultancy organizations and online platforms such as: Noblehire, Forrester, Glassdoor, CareerBuilder, HeadHunter, ManpowerGroup Solutions, CIO, etc., as well as the Bulgarian Computerworld, Zaplatomer.bg, Basscom, Alpha Research, Mediapool, publish their representative annual surveys, tracking trends in this sector.

Much more interesting and under-researched, especially in Bulgaria, is the issue of the gender pay gap. It measures the difference between the average earnings of women and men - professionals in the IT sector. Expressed as a percentage, it is used to show how we value the relative contribution of men and women to the workforce (Commonwealth Government of Australia, 2022).

The issue of gender equality has been prioritized in many documents: Sustainable Development Goals (SDGs) (United Nations, 2022b), Directive of the European Parliament and of the Council on the implementation of the principle of equal opportunities and equal treatment of men and women in matters of employment and occupation (EUR-Lex, 2022), Labour Code (2022), ILO Equal Pay Convention No. 100 (ZBUT Normi i praktika, 2022), etc. (see infra. Giteva, n.d.). The basic principle is that women and men are entitled to equal pay for equal or equivalent work (Labour Code, 2022).

However, research shows that the gender pay gap in the EU in 2020 is 13% and has changed minimally over the last decade, i.e., women earn on average 13% less per hour than men (EUROSTAT, 2022). Approximately the same percentage is observed in the USA (Barroso and Brown, 2021). One of the interesting trends is that the wage gap is much lower for new entrants (i.e., young employees) and tends to increase with age. These differences across age groups have different patterns across EU countries and the US.

In the information and communications technologies (ICT) sector (according to ILOSTAT data), women are not only under-represented in terms of employment, but they face a median gender pay gap of 21%, which is significantly larger than the 16% median gender pay gap for the overall economy. According to the ILO Global Wage Report 2018/19, when women enter the ICT workplace, they tend to be concentrated in less well-paid occupations such as ICT project managers, rather than the better paid ICT software development positions (ILO Department of Statistics, 2019).

Here are some of the reasons why women earn less (European Commission, 2022):

- Sectoral segregation – around 24% of the gender pay gap is due to women's increased involvement in low-paid sectors such as social care, health and education. High feminism jobs are systematically undervalued;
- Differences between paid and unpaid work - women may work more hours per week than men but spend more hours in unpaid work, a fact that also influences their career choices. That is why the EU promotes equal distribution of parental leave, adequate public provision of childcare services and adequate company policies on flexible working;
- Glass ceiling - position in the hierarchy affects pay: less than 8% of CEOs of leading companies are women;

- Pay discrimination - in many cases women earn less than men for doing the same job or work of equal value, even though the principle of equal pay has been enshrined in the European Treaties (article 157 TFEU) since 1957.

Data for Republics of Bulgaria show that men have a significant numerical advantage in the IT sector. They represent almost 64% of all employees in the industry. Their average annual salary is over 46 thousand BGN, while for women it is only 31 thousand BGN. The pay gap is just over 15 thousand BGN (Questona, 2022). However, compared to previous years, there has been an increase in the percentage of women for various software-focused technology positions. We are witnessing changes in the industry, which "has long been an all-male territory". Traditionally, the most interest from ladies has been in Quality Assurance related positions, but more and more women will be moving into writing code as they have highly competitive expertise in technologies such as .Net, Java, PHP, Python, etc. The presence of ladies in the team is also valuable in that they contribute pragmatism, good ideas and a different perspective (Dimitrova, 2018).

The topicality of this problem provoked our research interest. In the study below we will present a survey on the pay of men and women in the IT sector, with the main part of respondents in Bulgarian organizations.

2. Method

2.1. Material

4185 worldwide publications in English were retrieved from the social media Twitter in the period 20 - 22 September 2022. The key phrases “IT pay gap”, “IT gender equality” and “IT companies pay gap” were used. The connection to Twitter and the data retrieval were done via Orange data mining tool.

On the other hand, we conducted research among employees in IT companies who expressed their opinion about gender equality in this sector.

2.2. Design

The observed independent variables are Location and Description of Twitter posts, as well as Gender in the survey. The dependent ones are recognized emotions and sentiment polarities.

The experiment’s results are detailed in the next sections of the paper.

2.3. Procedure

The content that is extracted from social media is unstructured. Due to the diverse type of data - text and multimedia, it is difficult to process them. On the other hand, we conducted a survey among employees in the IT sector. The received survey data are semi-structured. That is why we need to combine social media mining approaches and user opinion research in one integrated approach.

There are various approaches to social media mining in the scientific literature, which are based on established data mining techniques. In previous research we followed the social media mining stages: Retrieving data; Pre-processing; Normalizing Dataset; Sentiment Analysis and Emotions Mining; Reporting (Nacheva, 2021). Considering our previously suggested social media mining process, the social media

analytics workflow of (Packt, 2022) and the workflow of leveraging social media of (Huang, 2018), as well as the survey research process in (Forza, 2002; Tomljenović and Marušić, 2010; Jurisch et. al., 2013), we can suggest the following integrated research process shown on Fig. 1.

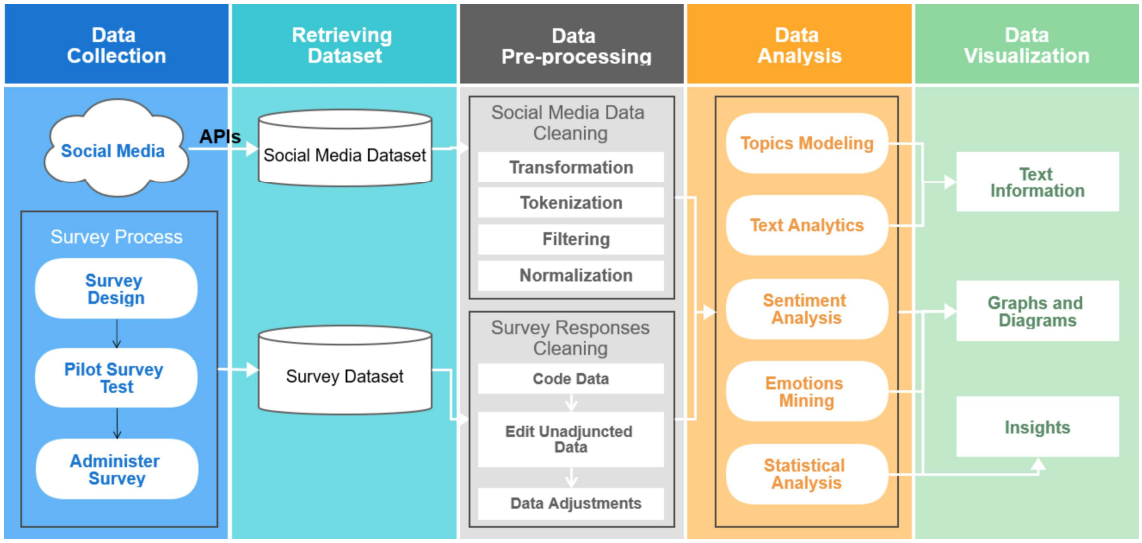


Fig. 1. Proposed Integrated Research Process

Source: Own Elaboration

We conducted our research on the stages: Data Collection; Retrieving Dataset; Data Pre-processing; Data Analysis and Data Visualization.

In the first stage of our research - **Data Collection**, we combined social media and survey data. We choose social media for extracting posts to form the basis of our research. In parallel, we conducted a survey among the target audience. We developed a questionnaire that consists of two parts. The first part contains questions that form the profile of the audience: gender, age and country of residence. The second part consists of 9 questions that refer to the pay gap between men and women in the IT sector. Q1 through Q8 have possible answers *Yes/No/I don't know*. The last one is an open question, through which the participants express their opinion on the studied problem.

Q1. According to your opinion, is there a gender pay gap in the organization you work for?
Q2. Has the organization published gender segregated pay information in all pay bands?
Q3. Has the organization published gender segregated pay information or an overall gender pay gap (mean/ average)?
Q4. Does the organization have a strategy, or has it acted, to close any gender pay gap identified?
Q5. Has the organization published figures showing a mean overall gender pay gap in the company?
Q6. Has the organization published figures showing the company provides equal pay for equal work in all pay bands?
Q7. Does the organization have a fair remuneration policy or equivalent?

Q8. Does the company have an Equal Opportunity Policy or equivalent, to ensure non-discrimination against any type of demographic group?

Q9. Please share your thoughts on gender equality in the IT sector, including fair pay for women vs. men.

The survey was pilot tested and the questions adjusted to be as clear as possible for the participants.

In the second stage of our research - **Retrieving Dataset**, we are preparing two separate repositories - one with the extracted data from the social media and one with the received survey responses. The first repository contains unstructured data, while the second one - semi-structured.

Data Pre-processing is the next third stage of our proposed research process. Due to the differences in the type and structure of the received data, different methods are applied for their cleaning and preparation for analysis. Social media posts go through the standard: Transformation; Tokenization; Filtering; Normalization. Survey responses need to be: coded, edited from unadjuncted data and adjusted for data analysis, to prepare for processing on the next stage.

The processed data became the basis for performing: topic modelling, text analytics, sentiment analysis, emotion mining, statistical analysis. These are the techniques we applied to the next phase of our research process - **Data Analysis**. Data mining and statistical software are used for its implementation.

The obtained results of the analysis are visualized through graphs, diagrams, tables or in text form in the last phase of the process proposed by us - **Data Visualization**.

The following sections describe the experiment we conducted to test the process.

3. Results and Discussion

To test the practical applicability of the process described above (Fig. 1), we used data mining software Orange and statistical software. Both tools are used at different stages of the process. Orange covered all the steps involved in collection, pre-processing, analysing and visualizing the posts from the chosen social media. We applied the statistical software in stages: Data Pre-processing, Data Analysis and Data Visualization, when working with survey data. In the data analysis phase, we applied the MeaningCloud add-in for Microsoft Excel. Fig. 2 shows the experiment setup with Orange tool.

The emotions mining was performed by using the Tweet Profiler module of Orange, which supports several methods of content classification. The classes based on the classifications of Plutchik and Ekman were applied. Each of them identifies a different number of basic emotions. Plutchik's classifier supports emotions: anticipation, acceptance, joy, surprise, anger, disgust, fear, sadness. Ekman's classifier supports emotions: joy, surprise, anger, disgust, fear, sadness. Ekman's classifier results are shown in Fig. 3.

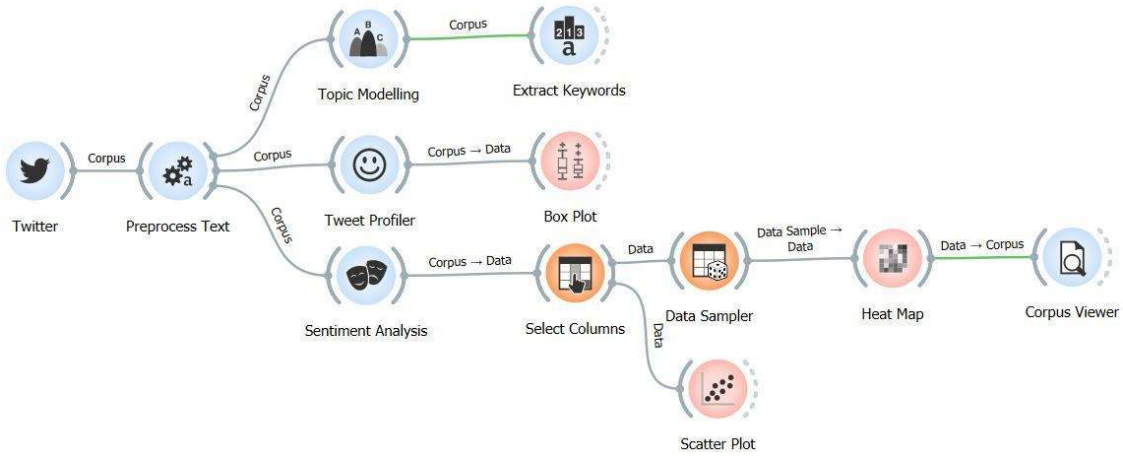


Fig. 2. Orange Tool Set-up for Social Media Mining

Source: Own Elaboration

Most of the tweets are identified with positive emotions: joy - 57,35% and 17,21% - surprise. The negative emotions of fear, sadness and disgust are forming 25,44% of recognized emotions in all tweets. None of the tweets were marked with the negative emotion anger.

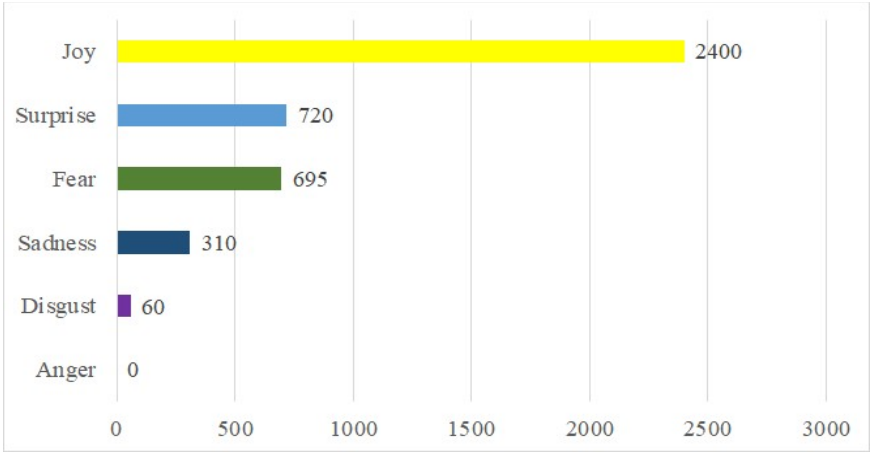


Fig. 3. Ekman Emotions Classifier's Results in Orange Based on Twitter Posts

Source: Own Elaboration

The situation with Plutchik's classifier is quite different (Fig. 4). 65,95% of tweets are recognized as positive with identified emotions of joy, surprise, trust and anticipation. 0,53% are only associated with anger.

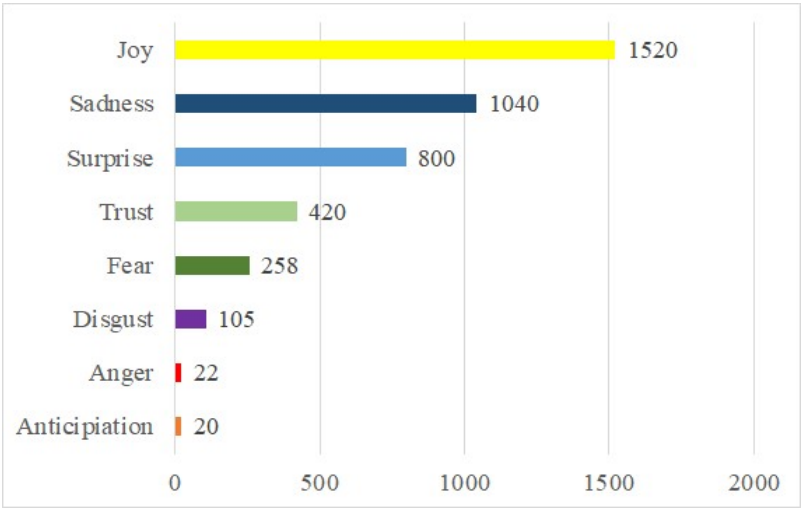


Fig. 4. Plutchik Emotions Classifier's Results in Orange Based on Twitter Posts

Source: Own Elaboration

Sentiment analysis of the tweets shows a different picture - an overwhelmingly negative polarity (Fig. 5). As a control point, we applied the MeaningCloud, through which we examined the tweets polarities. It confirms the results of the Orange Tool of predominantly negative polarities. Negative and extremely negative opinions form 51% of the sample. Positive and extremely positive opinions are 28%. Neutral polarities are only 6%. No polarity was detected in 15% of the retrieved opinions.

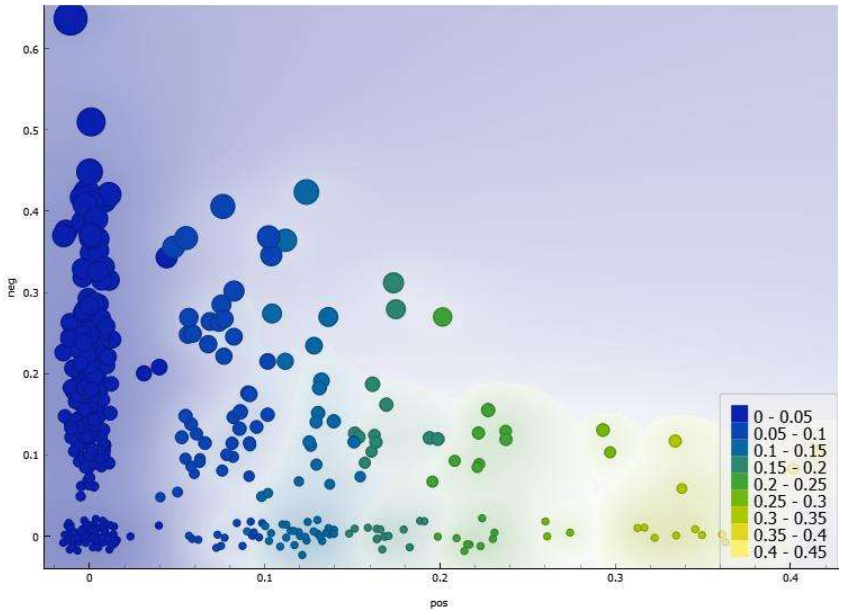


Fig. 5. Sentiment Analysis Results in Orange Tool Based on Twitter Posts

Source: Own Elaboration

On the other hand, we conducted a survey among 128 employees of IT companies. Two of them did not consent to their data being used for research purposes. Their responses were excluded from the data analysis.

52% of the respondents were men and 48% women. Their age is between 21 and 72, mean = 30,36, SD=9,558. 70% of the men and 80% of the women are participants from Bulgaria, and the rest of them are from Germany (24% of the men and 10% of the women), Sri Lanka and Russia (for both countries 3% of the men and 5% of the women). The data analysis by country of residence and age of the participants cannot be done, since a representative sample cannot be formed based on these characteristics. The only criterion by which the responses obtained in this study were compared was the gender of the participants.

Table 1 contains the answers to the given questions from 1 to 8. Question 9 contains the opinions of the participants, which we processed by applying data mining techniques.

Table 1.

Distribution of survey questions' responses by gender (in number and in percentage)

Questions		Gender		Gender	
		Man	**Woman**	**Man (%)**	**Woman (%)**
Q1.	I don't know	12	21	10%	17%
	No	54	21	43%	17%
	Yes	0	18	0%	14%
Q2.	I don't know	9	15	7%	12%
	No	54	45	43%	36%
	Yes	3	0	2%	0%
Q3.	I don't know	9	15	7%	12%
	No	54	45	43%	36%
	Yes	3	0	2%	0%
Q4.	I don't know	27	30	21%	24%
	No	24	21	19%	17%
	Yes	15	9	12%	7%
Q5.	I don't know	12	18	10%	14%
	No	51	39	40%	31%
	Yes	3	3	2%	2%
Q6.	I don't know	15	15	12%	12%
	No	42	36	33%	29%
	Yes	9	9	7%	7%
Q7.	I don't know	18	15	14%	12%
	No	3	15	2%	12%
	Yes	45	30	36%	24%
Q8.	I don't know	21	15	17%	12%
	No	9	18	7%	14%
	Yes	36	27	29%	21%

Source: Own Elaboration

According to the answers received to Q1, 60% of the participants categorically state that there is no gender pay gap in the organization they work for. On the other hand, according to 79% of the participants, the companies they work for do not publish gender segregated pay information or any gender pay gap. 60% of respondents claim that the IT companies they work for have a fair remuneration policy or equivalent. 50% are of the opinion that companies have an Equal Opportunity Policy or equivalent, to ensure non-discrimination against any type of demographic group. Based on the data from Table 1, we can draw a conclusion about the expressed confidence of those employed in the IT sector for equal pay for men and women, maintaining policies to avoid discrimination and transparency in pay.

From another point of view, 14% of the participants (women) expressed concern that there is a pay gap between men and women. Also, between 12% and 14% of participants (again women) express concerns that the companies they work for do not support fair remuneration and equal opportunities policies. On these questions (Q1, Q7 and Q8), between 2% and 7% of the participants, who are men, confirm women's concerns about inequality in the workplace.

We also analysed emotions in Q9 answers. Results of the Ekman classifier are shown in Fig. 6. Most of the tweets are identified with negative emotions: sadness - 52,38% and fear - 9,52%. The remaining 38,1% were recognized with joy and surprise.

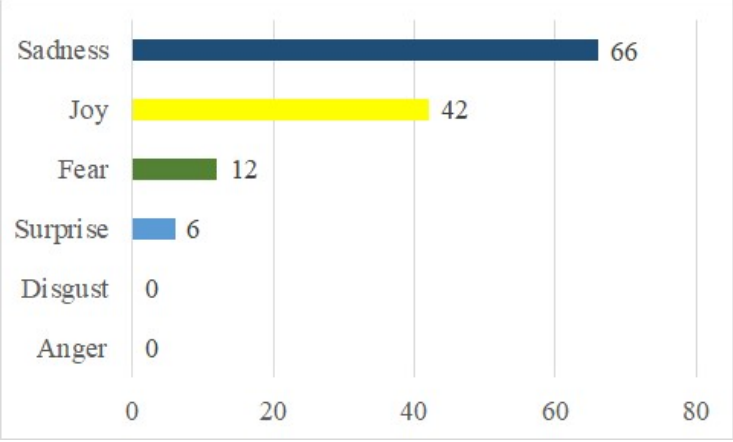


Fig. 6. Ekman Emotions Classifier's Results in Orange Based on Q9 Responses

Source: Own Elaboration

In contrast, we applied the Plutchik classifier too. Its results (Fig. 7) show inverse dependence - predominantly positive emotions of joy and trust (both are 80,95% of the sample). The negative emotions of sadness and fear form 19,05%.

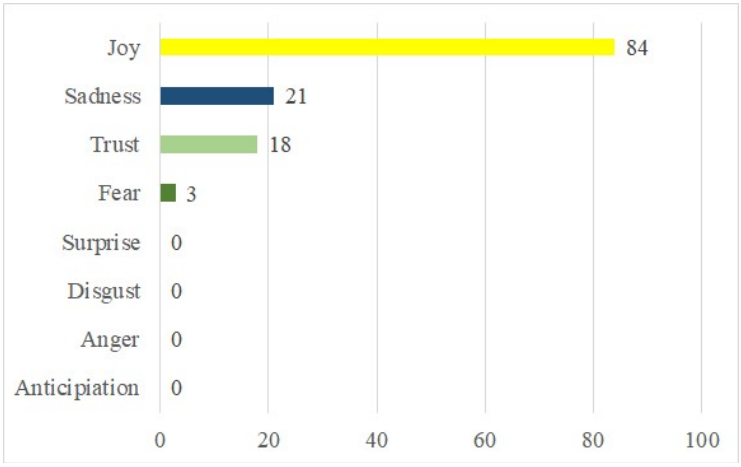


Fig. 7. Plutchik Emotions Classifier's Results in Orange Based on Q9 Responses

Source: Own Elaboration

Sentiment analysis in the Orange tool based on Q9 responses (Fig. 8) shows predominantly negative polarities. In comparison, we applied the MeaningCloud, through which we examined the Q9 answers' polarities. It showed opposite results - predominantly positive polarities. Positive and extremely positive opinions are 52% of the sample. Negative and extremely negative opinions form 19% of the sample. Neutral polarities are only 10%. No polarity was detected in 19% of the retrieved opinions.

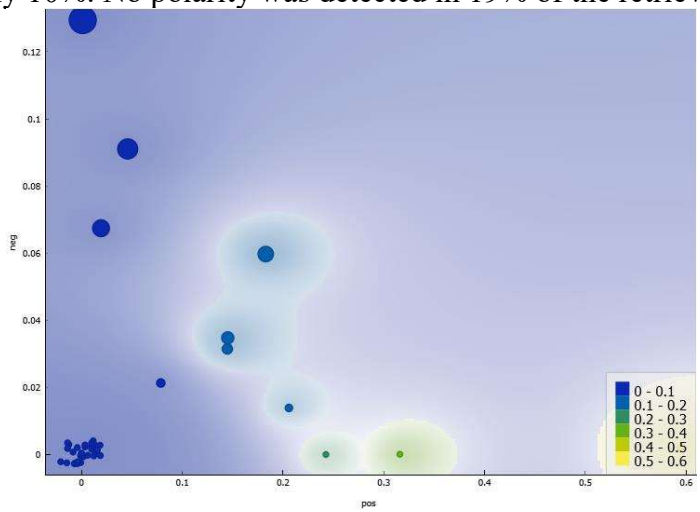


Fig. 8. Sentiment Analysis Results in Orange Tool Based on Q9 Responses

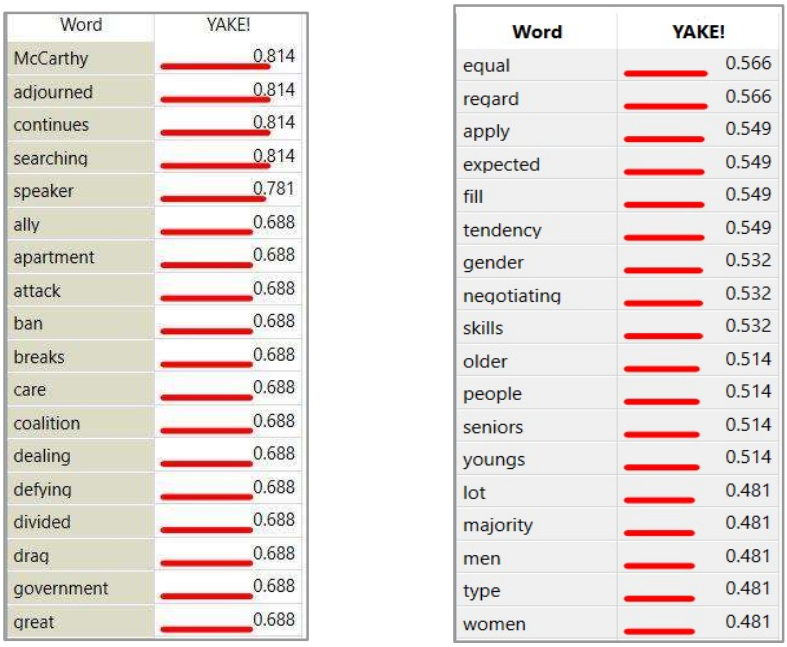
Source: Own Elaboration

The users of the social network Twitter express a variety of emotional attitudes through their posts. For the sentiment analysis in the Orange tool, we implemented Vader's model, which is based on the Natural Language Toolkit (NLTK). It is used for "lexicon- and rule-based sentiment analysis" (Orange, 2022a). MeaningCloud uses its own dictionary - Global Sentiment Analysis (MeaningCloud, 2022). Both tools showed similar results - predominant negative polarities.

In contrast, the MeaningCloud results showed that IT employees' opinions were predominantly positive. The emotion classifiers confirm these results by eliciting predominantly positive emotions of joy and trust, both when analyzing tweets and survey opinions. Only results of the Ekman classifier applied on Q9 are different - mainly negative emotions were recognized.

Topic modelling is also included as part of our proposed integrated research process. We extracted the most common keywords in the texts (Fig. 9). Scoring method YAKE! was applied, which is "an unsupervised state-of-the-art method that works with texts of different sizes" (Orange, 2022b). It is suitable for large datasets such as social media posts, for example.

Differences in topic modelling are also visible (Fig. 9). In the extracted sample of tweets there are those that do not correspond to the key phrases.



Word	YAKE!
McCarthy	0.814
adjourned	0.814
continues	0.814
searching	0.814
speaker	0.781
ally	0.688
apartment	0.688
attack	0.688
ban	0.688
breaks	0.688
care	0.688
coalition	0.688
dealing	0.688
defying	0.688
divided	0.688
drag	0.688
government	0.688
great	0.688

Word	YAKE!
equal	0.566
regard	0.566
apply	0.549
expected	0.549
fill	0.549
tendency	0.549
gender	0.532
negotiating	0.532
skills	0.532
older	0.514
people	0.514
seniors	0.514
youngs	0.514
lot	0.481
majority	0.481
men	0.481
type	0.481
women	0.481

Fig. 9. Topics Modeling Results in Orange Tool for Twitter Posts (left) and Survey Responses of Q9 (right)

Source: Own Elaboration

The differences in the results of sentiment analysis and emotions mining originate from the dictionaries used, the sample size and the number of blank fields. We can conclude that the main emotions and polarities are positive. This is also confirmed by the qualitative analysis we performed on a random sample of Q9 responses. Some of the key phrases used by the target audience of the study are: fairly equal rates between genders or social groups; payments are based on performance and skills; especially in the IT sector, there is a gender equality; there is no pay gap in the IT sector; IT is perfect, both genders are treated the same; etc.

Conclusion

In conclusion, we can summarize that both globally and within the EU, discriminatory practices targeting women and girls still exist. In the workplace, women still suffer from pay inequality. Despite the categorical nature of the legislation on the matter, the studies carried out confirm this conclusion. A positive trend is that the pay gap is much lower for younger employees and tends to increase with age.

Our research has shown that the IT sector differs from the general problems in this direction. Opinions extracted from social network Twitter and expressed by employees in IT companies show positive attitudes towards gender equality in the workplace. The majority of survey participants state categorically that the companies in which they work pay equally for the work of women and men, maintain policies for equality among their employees and that they do not treat them differently on the basis of gender.

Of course, this study has its limitations, for example, it does not indicate whether the opinion expressed is due to knowledge or assumption, how the pay gap can be overcome, whether the percentage of women in the workplace is comparable to that of men, etc. These issues will be discussed in a future study.

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