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- *The Scientific Bulletin of Politehnica University of Timisoara, Transaction on Management. Economics Engineering. Transportation Engineering (ranked according to CNCSIS classification in Romania: C class).*

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CONTENT

	Editorial	5
1	A Study on Factors Influencing the Level of Job Satisfaction of Public Servants. The Case of Lugoj City Hall – Romania Oana-Maria OPRIȘ-DAVID, Valentina TAUCEAN and Claudiu ALBULESCU	7
2	An Analysis of the Legal Implications of Data Security Risks of Teleworking in Romania, Mirabela METZLER, Caius Tudor LUMINOSU and Valentina TAUCEAN	14
3	Decoding Progress: Assessing R&D Institutes Performance in the Contemporary Landscape, Aurelia-Ioana BIHOLAR and Anca DRAGHICI	20
4	The Use of Artificial Intelligence in Entrepreneurial Management – Creating the Ideal Customer Profile Florin-Cristian FILIPOVICI and Matei TAMASILĂ	28
5	Enhancing Viscosity Quality Testing Accuracy in the Automotive Industry, Denisa-Roxana SIMA and Adrian PUGNA	34
6	Critical Evaluation of Individualized Progressive Lens Functions through Value Analysis, Maria-Roxana ENE, Adile-Elena NEMOIANU and Adrian PUGNA	40
7	Occupational Health and Safety Risk Assessment Using the MAXM Method, Horatiu-Marius NITESCU, Marilena GHEORGHE and Catalin Gheorghe AMZA	45
8	Significance of CAx Technologies in Industry 4.0: The Path from Education 4.0 to Industry 4.0 Through Lifelong Learning in Metal Processing Industry, Aleksandar ZIVKOVIC, Aco ANTIC, Mijodrag MILOSEVIC and Dejan LUKIC	52
9	Redefining Communication Standards in Academia and Society: The Role of Media Competences and Respectful Engagement, Anca DRAGHICI, Ilie-Mihai TAUCEAN, Valerij DERMOL, Alice BUZDUGAN, Nada TRUNK, Caius LUMINOSU and Maria Elena BOATCA	58

Scientific Bulletin of Politehnica University of Timisoara, Romania

Transactions on ENGINEERING AND MANAGEMENT

Vol. 9 Issue 1 & 2, 2023

Editorial

Anca DRAGHICI¹

Ready with new the 2023 volume, number 1&2 of the “*Scientific Bulletin of Politehnica University of Timisoara – Transaction on Engineering and Management*” (ISSN 2392-7364) having an increase visibility due to the journal index in CrossRef (<https://www.crossref.org/>), CEEOL (<https://www.ceeol.com/>) and index Copernicus (<https://journals.indexcopernicus.com/>) databases. The Editorial Board strategy was focused on the alignment of the journal content with the Open Science movement and this was supported by the excellent collaboration and constant support offer by the UPT Library and the Politehnica Publishing House.

The articles of the *Scientific Bulletin* 9th volume of 2023 (having 2 numbers) have been reviewed by the *Associated Editors*; their professional (volunteer) review work has a positive impact on the quality content of this volume. Furthermore, the *Scientific Bulletin* benefits from the constant support of the R&D staff of the *Research Center in Engineering and Management (RCEM)*² (of the Faculty of Management in Production and Transportation, Politehnica University of Timisoara, FMPT/UPT, Romania); RCEM provide a productive and positive network, and a scientific community through which we support knowledge sharing, buddy schema and trainings (formal or informal).

In 2023, the Faculty of Management in Production and Transportation, Politehnica University of Timisoara has organized *SIM 2023: 17th International Symposium in Management: Reinventing Management in Turbulent Times* (20-21 October 2023, Timisoara & Silagiu, Romania) and two articles were selected and published in the current volume.

Furthermore, the key strengths of the 2023 volume are:

- **Diverse Research Topics:** The volume covers a wide range of topics, including job satisfaction, data security in teleworking, AI in entrepreneurial management, and viscosity testing in the automotive industry.
- **Interdisciplinary Approach:** It integrates various fields such as engineering, management, and social sciences, providing a comprehensive perspective on contemporary issues.
- **International Collaboration:** Contributions from researchers across different countries enhance the quality and diversity of the research.
- **Practical Applications:** The studies offer practical insights and solutions, such as improving job satisfaction in public institutions and enhancing quality testing in the automotive industry.



The first paper, “*A Study on Factors Influencing the Level of Job Satisfaction of Public Servants. The Case of Lugoj City Hall – Romania*”, with Oana-Maria OPRIS-DAVID, Valentina TAUCEAN and Claudiu

ALBULESCU authors (from Politehnica University of Timisoara, Romania). The article’s valuable contribution is related to the research methodology that has been tested and validated on a case study.

The second paper “*An Analysis of the Legal Implications of Data Security Risks of Teleworking in Romania*”, by Mirabela METZLER (Lawyer, Timis Bar Association, Romania), Caius Tudor LUMINOSU and Valentina TAUCEAN (from Politehnica University of Timisoara, Romania) aim to identify the legal implications of specific data security risks in the case of teleworking, from both the perspective of the

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² Information available at: <http://www.mpt.upt.ro/eng/research/research-center.html>

organization and the individual, thereby facilitating managerial decision regarding privacy compliance and protection of intellectual property.

The third paper, “*Decoding Progress: Assessing R&D Institutes Performance in the Contemporary Landscape*” by Aurelia-Ioana BIHOLAR and Anca DRAGHICI (from Politehnica University of Timisoara, Romania), presents the current state of R&D institutes, delving into their methodologies, achievements, and adaptability within the contemporary research ecosystem.

The fourth article, entitled “*The Use of Artificial Intelligence in Entrepreneurial Management – Creating the Ideal Customer Profile*” by Florin-Cristian FILIPOVICI and Matei TAMASILIA, demonstrate the usefulness of AI technology in marketing and customer relationship management.

Next article, entitled: “*Enhancing Viscosity Quality Testing Accuracy in the Automotive Industry*” by Denisa-Roxana SIMA and Adrian PUGNA (from Politehnica University of Timisoara, Romania), examine an issue pertaining to the precision of viscosity measurements crucial to the rubber processing industry within the Western side of Romania, where viscosity is being tested using the PREMIER™ MDR MOVING DIE RHEOMETER by Alpha Technologies.

In the next article, entitled: “*Critical Evaluation of Individualized Progressive Lens Functions through Value Analysis*”, the authors: Maria-Roxana ENE, Adile-Elena NEMOIANU, Adrian PUGNA (Politehnica University of Timisoara, Romania) have analyzed the functions of the individualized progressive lens, to improve them.

The next two papers were selected from the SIM 2023 conference:

1. “*Occupational Health and Safety Risk Assessment Using the MAXM Method*” by Horatiu-Marius NITESCU, Marilena GHEORGHE, Catalin Gheorghe AMZA (from Faculty of Industrial Engineering and Robotics, National University of Science and Technology Politehnica Bucharest, Romania) have presented and demonstrated a new method for the evaluation of hazards for occupational safety and health, called Multiple AXes Matrices – MAXM;

2. “*Significance of CAx Technologies in Industry 4.0: The Path from Education 4.0 to Industry 4.0 Through Lifelong Learning in Metal Processing Industry*” by Aleksandar ZIVKOVIC, Aco ANTIC, Mijodrag MILOSEVIC and Dejan LUKIC (from the University in Novi Sad, Faculty of Technical Sciences, Serbia) have presented an overview of the interconnection and reciprocal influence of CAx, Lifelong Learning, Industry 4.0, Education 4.0.

The last paper, developed by an international group of researchers, is focusing on “*Redefining Communication Standards in Academia and Society: The Role of Media Competences and Respectful Engagement*”. This article presents the set of open educational resources created on topics such as democracy and inclusive democratic participation, media literacy and the fight against disinformation and the prevention of aggression in the context of the implementation of the RespectNET project "Respectful communication through the media education network" (Erasmus + project, 2021-1-IT02-KA220-HED-000027578, <https://respectnet.eu/>).



A Study on Factors Influencing the Level of Job Satisfaction of Public Servants. The Case of Lugoj City Hall - Romania

Oana-Maria OPRIȘ-DAVID¹, Valentina TAUCEAN² and Claudiu ALBULESCU³

Abstract – The purpose of this research is an exploratory one, namely, to study the factors that may influence the level of job satisfaction of employees with a public function who work in the Lugoj City Hall. The study first presents the relevant aspects in terms of job satisfaction as they appear in literature. Subsequently, a description of the concerned institution is being provided, as well as details regarding methodological aspects of the research and the results obtained. In the last part of the research are examined the advantages and disadvantages of the institution as far as job satisfaction goes, and a possible action plan that aims to improve the situation is presented, as well as the conclusions.

Keywords: civil servants, job satisfaction, perceptions, influencing factors

that employee satisfaction is negatively associated with turnover intention, meaning that satisfied employees are more likely to stay at their job (Lee & Mitchell, 1994).

Research has shown that employee satisfaction is positively associated with job performance, including productivity (Kristof-Brown, Zimmerman & Johnson, 2005). In the public sector, where resources may be limited and demands for services provided in the interest of citizens are high, improving employee satisfaction can have a positive impact on productivity and the quality of services provided to the public.

Finally, the public sector is responsible for providing services that have a direct impact on the well-being of citizens. By studying public sector employees job satisfaction, researchers can identify strategies to improve the quality of services provided to the public and increase the well-being of citizens (Bhuian, Menguc & Bell, 2005).

I. INTRODUCTION

Studying the level of job satisfaction among public sector employees is important for many reasons. Firstly, employee well-being is crucial to the success of any organization and is particularly important in the public sector, where employees are responsible for delivering citizen-oriented services. Research has shown that employee satisfaction is positively associated with employee well-being, including physical health, mental health, and job performance (Bakker, Demerouti & Verbeke, 2004).

Also, the high flow of employment and dismissal of public sector employees can be costly for organizations and is especially challenging in the public sector where there may be limited resources for recruitment and training (Joo, Lim & Lee, 2021). Research has shown

II. MAIN ASPECTS REGARDING JOB SATISFACTION

1. The concept of job satisfaction

According to Robbins & Judge (2009), job satisfaction can be defined as the positive emotional state of an employee, which results from the positive evaluation of the workplace or his work experience. The authors point out that job satisfaction does not only refer to the objective features of the job, but also to the subjective perception of those features by the employee. They suggest that job satisfaction can be influenced by various factors such as pay, promotion opportunities, working conditions, relationship with supervisors and colleagues, and the level of control and

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autonomy the employee has over his work. The authors argue that satisfied employees are more likely to be engaged in their work, demonstrate higher levels of commitment to the organization, and experience less stress and burnout. For organizations, job satisfaction is linked to reduced absenteeism, lower staff turnover rates and higher levels of productivity. The level of job satisfaction plays a crucial role in the success of the organization. In addition, work satisfaction can be viewed as a multidimensional construct that encompasses different aspects of work, such as job design, compensation, and social relationships (Ackroyd, Batt, Thompson & Tolbert, 2011).

2. Factors that may influence the level of job satisfaction

Studies highlight the fact that the degree of employee satisfaction must be analysed in the context of the influence of several factors, such as job security, pay and benefits, work-life balance, promotion opportunities, job autonomy and social support (Ahmad, Shahzad, & Azam Roomi, 2019).

Numerous publications have addressed this subject, and in general there is consensus regarding the most relevant factors that may influence the level of job satisfaction among employees. Some of these factors, according to Jones & Joyce (2013), are the following:

- Job characteristics: the nature of the work itself, including the level of autonomy, variety, and complexity of tasks. Jobs that offer more autonomy and opportunities for skill development tend to lead to higher levels of job satisfaction.
- Social and organizational factors: relationships with coworkers, supervisors, and organizational culture can affect job satisfaction. A supportive and positive work environment can lead to higher levels of job satisfaction.
- Wages and benefits: Fair and competitive compensation can have a positive impact on job satisfaction.
- Opportunities for career development: Opportunities for growth can also have a positive impact on the level of job satisfaction.
- Work-life balance: flexible working schedules and other opportunities to maintain work-life balance tend to lead to higher levels of job satisfaction.

3. Consequences of the level of job satisfaction

High levels of job satisfaction can lead to improved employee health and well-being. Studies have found that employees who are satisfied with their jobs report lower stress levels and better physical health than those who are less satisfied (Judge, Bono, Erez & Locke, 2001; Warr, Cook & Wall, 1979).

On the other hand, low levels of job satisfaction can have significant negative consequences. A major result is decreased performance at work. Employees who are less satisfied with their jobs tend to be less motivated and engaged, leading to lower levels of effort and performance (Harter, Schmidt & Hayes, 2002; Steel,

Griffeth & Hom, 2002). This can lead to lower productivity, lower quality of work and reduced capacity for innovation and creativity.

Another important consequence of low job satisfaction is staff turnover, the continuous string of resignations and new hires. Employees who are less satisfied with their jobs are more likely to leave their current positions, which will lead to bigger costs associated with recruitment, training, and lost productivity for the organization (Griffeth, Hom & Gaertner, 2000). Additionally, high staff turnover can lead to decreased morale and engagement among remaining employees, leading to a vicious cycle of decreased satisfaction and increased staff turnover.

4. Improving the level of job satisfaction

One of the most important strategies used to increase employee satisfaction is to provide job-appropriate compensation and benefits. In their study, Perry & Hondeghem (2008) found that compensation is the most important factor influencing job satisfaction of public sector employees. Employees who feel they are paid fairly are more likely to be satisfied with their jobs. Employers may also offer additional benefits such as health insurance, retirement plans, and paid time off to increase the level of job satisfaction.

In addition, according to Maslow (1954), who developed the most popular theory of needs, any person has the same needs, which are divided into the following categories:

- Physiological needs (water, food, oxygen, sex);
- Security and safety needs (the need to be protected, to live in a safe, predictable environment);
- The need for belonging (social relationships, belonging to a group, the need for affection);
- Social status and esteem (the need to be respected and appreciated by others, to hold a position in the social hierarchy, within the group);
- The need for self-actualization (personal development).

Employers should be aware of the theory briefly described above because every employee is a person who has these needs, which means that the work conditions, payment, and other aspects will succeed to fulfil these needs or not.

5. Cultural differences in terms of job satisfaction

In the context of globalization, we must take into consideration the cultural differences that may lead to different levels job satisfaction, such as different values, expectations, and attitudes towards work. For example, in some cultures, work is seen as a necessary means to an end, while in others, work is seen as a source of fulfilment and personal identity.

Erez & Earley (1993) consider that in some cultures, such as Japan, employees tend to have a strong commitment to their organizations and a heightened sense of loyalty to their employers. As a result, these employees may be more satisfied with

their jobs when they feel that their work contributes to the success of the company entire. On the other hand, in some Western cultures, such as the United States, employees may be more motivated by personal goal achievement or recognition. Thus, employers who provide opportunities for growth and individual recognition may be more effective in increasing job satisfaction among American employees. In addition to these differences in terms of values and attitudes, there are also differences in communication styles that can affect job satisfaction. In some cultures, employees express their dissatisfaction indirectly through non-verbal cues, avoiding conflict. Employers who are aware of these communication styles can take steps to ensure that employees feel comfortable voicing their concerns. Additionally, in some cultures, there is a greater emphasis on work-life balance, while in others, work is seen as a priority. Employers who are sensitive to these cultural differences can create policies and practices that support work-life balance, which can lead to increased job satisfaction.

Finally, Erez & Earley (1993) also note that different cultures have different expectations about the employer's role in employees' personal lives. For example, in cultures such as India and China, employers are expected to provide more support and assistance to employees and their families, while in other cultures, such as the United States, employees are expected to manage their own lives personal independently.

III. CASE STUDY – LUGOJ CITY HALL (ROMANIA)

1. Description of the concerned institution

Lugoj City Hall is in the centre of the municipality, in Piața Victoriei, at the intersection of 20 Decembrie 1989, Ion Creangă, Victor Vlad Delamarina and Andrei Șaguna streets. The building, built between 1903 - 1905, housed the Financial Directorate of Caraș-Severin County in the past. Behind the City Hall is located one of the biggest parks of the city, and in the immediate vicinity there are numerous historical buildings.

The authorities of the local public administration are the mayor (executive authority) and the local council (deliberative authority). The headquarters of the Local Council of the Municipality of Lugoj is in Piața Victoriei, no. 4, and the plenary meetings take place at the Meeting Hall of the Local Council.

The subordinate structures of the Lugoj City Hall are: the local community public service for the record of persons; Voluntary service for emergency situations; Public service greenhouses and green areas; Medical assistance service, education; Public service markets, fairs and barns; Municipal library; Art gallery; House of culture; Popular school of arts; Sports club; The public administration and maintenance service of the

public domain; Museum of history and ethnography; Directorate of social and community assistance.

Regarding the employees with public functions within Lugoj City Hall, according to the latest organization chart displayed on the institution's official website, there are a total of 169 approved public functions, of which 130 are occupied (<https://primarialugoj.ro>).

2. Methodological aspects

The study was carried out in the form of an exploratory research, aiming to assess the possible influencing factors of the level of job satisfaction of civil servants of the Lugoj City Hall. The design of the research was a non-experimental one, the respondents being provided with the same data completion conditions and the group being already predetermined.

Participants - The present research analyses the answers of a group consisting of 55 people with public management or executive positions, that agreed to participate in the study, and their job satisfaction level was tested using a self-report type of questionnaire. All the participants of this research have at least medium level education, their gender distribution is slightly uneven (58.2% are women), and the predominant age category is that of employees over 50 years old, as can be seen in the following figures.

Tools - The tool used in the survey process was a questionnaire developed to carry out this study and has a total of 29 dichotomous or multiple-choice items. Of course, to build the items of the questionnaire, both similar research approaches in the targeted field, as well as aspects that were considered relevant in the report with the chosen sample, were considered.

The content of the items aimed different demographic information, such as gender, age, level of education completed. A series of questions were related to the specifics of the workplace or the individual preferences of the participants regarding the workplace, and the last part of the questionnaire tried to capture some potential influencing factors of the level of job satisfaction in response.

Research procedure - The participants completed the questionnaire described above via Google Forms application, their answers being centralized in a Microsoft Excel type file and then analysed through descriptive statistics. The participants were informed in advance about elements such as the topic of the questions or the purpose of the research and were advised to take approximately 5-10 minutes to complete the questionnaire. They were assured of the confidentiality of the collected data, being asked to be honest in the answers they provide.

The data collected from the respondents has been processed using the statistical program EVIEWS 12, which allowed the use of descriptive statistics techniques, as well as the cross-section analysis.

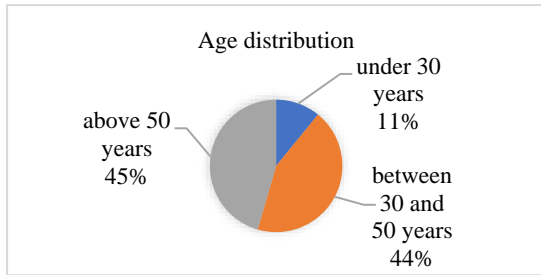


Fig. 1. Age distribution

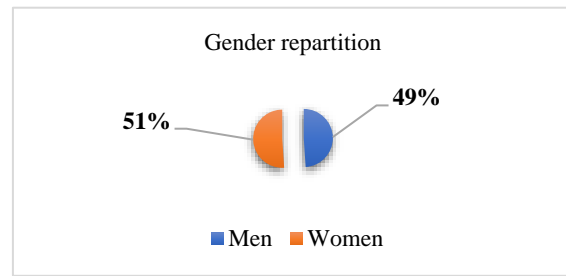


Fig. 2. gender repartition

Table 1. Cross-section analysis, Models 1 to 5

	Model 1	Model 2	Model 3	Model 4	Model 5
C	1.286*** [0.433]	0.664 [0.464]	4.049*** [0.284]	2.255*** [0.711]	1.669*** [0.406]
Salvsmd	0.368*** [0.137]				
Salvspr	0.339** [0.155]				
Dezv		0.326*** [0.082]			
Promov		-0.138 [0.101]			
Stabil		0.598*** [0.107]			
Nvrt (N)			-0.149* [0.079]		
Org (C)				0.163 [0.145]	
Detans (C)				0.693** [0.286]	
Sarech (A)					0.263** [0.108]
Supcapab (A)					0.277** [0.136]
Indech (E)					
Dact (E)					
Libvsreg (D)					
R ²	0.355	0.569	0.062	0.113	0.355

Notes: (i) ***, **, * means significance at 99%, 95% and 90% significance level; (ii) standard errors in squared brackets.

IV. RESULTS

1. Descriptive statistics

The dichotomous items have provided a lot of information regarding the respondents' options in terms of the way the work is carried out, as follows:

- Preferred way of carrying out the activity: 69.1% of the respondents said that they prefer to carry out their activity physically, in the office, while only 30.9% would prefer the home-office arrangement;
- Accomplishing a task: 29.1% of respondents declare that they would prefer to perform tasks that involve individual work, while 70.9% would prefer to work as a team member;

- Way of working: 83.6% of respondents declare that they usually focus on details, in order to work without errors, while 16.4% consider the overall picture, in order to work faster;
- Preference for clear rules/individual freedom: 63.6% of respondents state that they prefer to have clear rules and norms at work, while 36.4% expressed their preference for freedom in carrying out daily work tasks.

2. Empirical analysis

In order to observe the impact that the variables taken into account as potential influencing factors have on the level of job satisfaction of civil servants who agreed to participate in the research, we tested 9 models,

according to the following logic: through models 1 to 8, we tested the influence of each category of factors, and then, in model 9, we included all the factors

considered as exerting a possible influence on the level of job satisfaction of civil servants. Tables 1 and 2 present the main findings of the empirical analysis.

Table 2. Cross-section analysis, Models 6 to 9

	Model 6	Model 7	Model 8	Model 9
c	3.000*** [0.196]	3.475*** [0.183]	0.720 [0.791]	-0.127 [0.700]
Salvsmd				0.318** [0.141]
Salvspr				0.047 [0.147]
Dezv				0.234** [0.115]
Promov				-0.269** [0.110]
Stabil				0.357*** [0.130]
Nvrt (N)			-0.011 [0.087]	-0.012 [0.077]
Org (C)			0.120 [0.140]	0.087 [0.117]
Detans (C)			0.360 [0.289]	0.172 [0.238]
Sarech (A)			0.142 [0.150]	0.044 [0.154]
Supcapab (A)			0.347** [0.140]	0.170 [0.127]
Indech (E)	0.622* [0.312]		0.130 [0.308]	0.004 [0.257]
Dact (E)	.0163 [0.306]		0.193 [0.288]	-0.015 [0.244]
Libvsreg (D)		0.125 [0.229]	0.055 [0.235]	0.104 [0.188]
R ²	0.176	0.005	0.443	0.685

Notes: (i) ***, **, * means significance at 99%, 95% and 90% significance level;
(ii) standard errors in squared brackets.

First, we notice that the most significant models are Model 2 and Model 9. Consequently, the data obtained by testing Model 2 indicate that the perception of self-development offered by the institution (variable *Dezv*), as well as the perception of stability at work (variable *Stabil*) are influencing factors as far as the level of job satisfaction among civil servants that work in the Lugoj City Hall is concerned.

On the other hand, the data obtained by testing Model 9 indicate that the perception of the salary range in relation to the work performed (variable *Salvsmd*), as well as the perception of equity in terms of the promotion of each employee (variable *Promov*) are also influencing factors of the level of satisfaction among respondents.

Other factors that influence the level of job satisfaction of civil servants that work in the Lugoj City Hall seem to be the increased levels of the variables by which the *Agreeableness (A)* trait of the personality was measured, namely the perception of fairness regarding the way that responsibility is shared among

colleagues (variable *Sarech*) and the perception of the capability of hierarchical bosses (variable *Supcapab*).

V. SWOT ANALYSIS AND ACTION PLAN

The data obtained from responses of the participants in this research revealed quite conclusive information regarding the possible strengths and weaknesses of the institution when we refer to the ability to affect the level of job satisfaction among employees with public functions.

Starting from the identified strengths and weaknesses, we have considered a list of opportunities to which the institution could have access, as well as possible threats to which it is subject, as follows:

Strengths:

- The possibility of work promotion, considering only individual traits;
- Increased ability to organize work by employees;

- Stability of the workplace;
- The salary in relation to the work done;
- Respect offered by colleagues and superiors.

Weaknesses:

- Working conditions;
- Salary earnings in relation to salaries in the private sector;
- Dividing work duties in a way perceived as not being fair;
- Preoccupation with work duties outside working hours;
- Small possibility of professional development.

Opportunities:

- Personalized communication with employees, to identify their needs;
- A campaign to promote the institution and its goals;
- Offering financial rewards and facilities for contributions to the institution;
- Allocating more financial resources to improve working conditions.

Threats:

- National unstable economic situation;
- An increase in the inflation rate (the risk that salaries cannot be increased in proportion to advancement in rank);
- Opportunities offered by employers in the private sector (salary, flexible work schedule, holiday bonuses or others).

Action plan – The way of approaching and solving the needs of the personnel within the organizations can have a positive or negative influence on the individual or group performance of the employees, which means that to a large extent, the management of an organization can influence by encouraging them, but it can also lead to the annihilation of the desire for initiative, self-improvement, and low performance among employees.

Although it is possible that the methods of action in terms of motivating employees in the institution that we analysed may seem limited, in the context of small budgets allocated for the payment of salaries, there are still a lot of possible approaches, which would allow to increase the level of job satisfaction of civil servants, that imply allocating minimal financial costs, since the focus falls on other types of resources that would need to be allocated.

For example, as mentioned by Perry & Hondeghem (2008), compensation is the most important factor influencing the job satisfaction of public sector employees. This can be achieved by the management of the institution by providing salary-related benefits, considering, on the one hand, the limitations the institution faces and, on the other hand, the advantages it has, according to verbal or non-verbal feedback of employees.

Furthermore, considering the results obtained after analysing the data collected from the respondents, we suggest the following series of measures that could be put into practice by the people with decision-making capacity, to increase the level of job satisfaction of Lugoj City Hall civil servants:

- Ensuring good working conditions: in accordance with the needs of the employees, after discussing with them individually;
- Giving each one's employee credits in front of his colleagues when he successfully completes a project in which he was involved or which he coordinated;
- Providing benefits such as health insurance, retirement plans, paid time off and discounts available for employees only;
- Providing performance-based bonuses: public institutions, in this case the Lugoj City Hall, should be able to provide bonuses to employees based on their performance or the overall performance of the institution;
- Opportunities for professional development: the institution could offer employees more opportunities to develop their skills and advance their careers, such as training programs, mentoring or other opportunities for growth and self-development;
- Offering flexible working options/flexible schedule: as happened during the Covid-19 pandemic, employers, whether in the public or private sector, can establish flexible working arrangements, such as home-office or flexible work schedules;
- Creating a positive work environment: this can be done by promoting teamwork, encouraging open communication, and recognizing achievements among colleagues.

VI. CONCLUSIONS AND FINAL REMARKS

The purpose of this study was to evaluate different aspects related to the level of job satisfaction of civil servants who work in the Lugoj City Hall, with an emphasis on discovering the factors that may influence the level of satisfaction among respondents.

The obtained results reveal a high level of job satisfaction of employees, and some of the influencing factors of it are the perception of self-development offered by the institution, the perception of stability at work, the perception of the salary range in relation to the work performed, the perception of equity in terms of the promotion of each employee and the level of agreeableness personality dimension.

However, there are certain aspects related to the institution, such as the non-competitive salary in relation to that in the private sector, or the working conditions, as well as threats arising from outside the institution, such as the national unstable economic situation, or the opportunities offered by employers in

the private sector, which can endanger the level of job satisfaction of employees, thus, we consider that further research may be necessary.

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An Analysis of the Legal Implications of Data Security Risks of Teleworking in Romania

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Abstract – In March 2020 with the spread of the COVID-19 pandemic employees were forced to continue working office hours from their own homes and sometimes even on their own technological devices. The purpose of this article is to identify the legal implications of specific data security risks in the case of teleworking, from both the perspective of the organization and the individual, thereby facilitating managerial decision regarding privacy compliance and protection of intellectual property. Furthermore, the study opens to new research directions in the attempt to provide insights into the new challenges for Romanian management, that current work trends pose.

Keywords: Teleworking, data security, legal liability, critical review, implications

I. INTRODUCTION

In March 2020 with the spread of COVID-19 pandemic, in Romania, teleworking became the type of remote work most common within organisations, having employees working remotely from home using ICT, as opposed to working from an employer's workplace. During this time, the rules of teleworking have been temporarily amended to ensure that employers have been able to unilaterally change the work agreement and order their employees to telework. Home confinement was imposed by law and teleworking suddenly became a mandatory full-time practice. Employees were forced to continue working office hours from their own homes and sometimes on their own technological devices, with little preparation time.

Eurofound's unique e-survey administrated in 2020 in relation to "Living, working and COVID-19", offers some much-needed facts and figures regarding teleworking [1]. Over three-quarters of EU employees

in July want to continue working from home at least occasionally, even without COVID-19 restrictions, but very few people wish to telework all the time, with the preferred option being a mix of teleworking and presence at the workplace. Analysing results regarding Romania, the survey found that 55% employees continued working from employer's premises during the pandemic and 30% worked from their homes. These results would lead us to believe teleworking does not have a strong presence in Romania, but we must account for the fact that data is available for the June/July 2020 round only, when society and economies were slowly re-opening, compared to the harsh legal restrictions imposed during spring 2020. Not surprisingly, 60% of employees expressed the desire to occasionally work from home if there were no restrictions due to COVID-19. Regarding devices used, 66% respondents said that their personal equipment where enough to do the work properly but unfortunately the survey fails to provide the results for measuring whether the employer provided the equipment needed to work from home.

Remote working brings several data protection and intellectual property challenges because data is being generated, processed, and stored in/from multiple offsite locations. We believe a more focused approach on legal implications when teleworking is needed, to better illustrate the intricacy and complexity of law and IT, from both the perspective of the organization and the individual. This would help managerial decision regarding privacy compliance and protection of intellectual property in the case of teleworking even beyond COVID-19.

To address this, the article is structured in three sections comprising of literature review regarding teleworking aspects and terminology, an analysis of the legal framework of teleworking in Romania and an exposition of common security risks associated with teleworking. The article finishes with the analysis of

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the legal implications associated with identified risks, followed by conclusions.

II. LITERATURE REVIEW

1. *A brief overview of teleworking*

According to Oxford Languages, two words that have seen a huge surge in use since March 2020 are “remote” and “remotely”, as well as distinct changes in the words used in collocation with these two (remote/remotely studying, teaching, meeting, and voting) [2].

The terms “remote working” and “teleworking” each relate to the spatial distribution of work, however “remote work” can be considered the broadest concept and “telework” would be a subcategory [3]. Before the term “teleworking” permeated in our work arrangements, the first documented form of telecommunications-augmented decentralized work – also known as “telecommuting”, has emerged in the 1970’s in the USA [4] but the adoption of teleworking practices across Europe was much slower than anticipated, due to various human, social and organizational factors [5].

Before the current pandemic crisis, research conducted over a large amount of data collected in 2015 from 15 European countries concluded (amongst others) that most teleworkers were self-employed and there was a weakening connection between telework and permanent contracts, full-time jobs, and living in urban areas [6]. Since the start of the pandemic, legally imposed home confinement blurs the line within remote work and many aspects of “teleworking” can be assimilated to “working from home”. A teleworker does not always work from home, he can use a “hot desk” in a co-working place or travel as a “nomad worker” [7]. The present paper refers only to employed teleworkers that forcefully became home-based (hereafter, teleworkers), as this is congruent with the current recommendation in the prevention of the coronavirus disease. Moreover, self-employment and informal telework practices are beyond this analysis.

2 *The Legal frameworks for teleworking in Romania*

Teleworking is determined by the specific mechanisms of communication between teleworkers and employers that resulted from acceptance and use on a large, global scale of added information and communication technologies. The first definition of teleworking in Europe was adopted in 2002 with the European Framework Agreement on Telework. It was intentionally broad, to cover both mobile and home-based telework, so that it can be adapted flexibly to technological advancements and new forms of work [8].

Following the European framework, teleworking was regulated for the first time in Romania by Law no. 81/2018. Teleworking is not just a form of home working regulated by art. 108 of the Romanian Labour Code, Law no. 53/2003. Besides having a different

legal basis, the characteristic features of telework are the voluntary character, the legal context of an employment contract/relationship and the use of computers and telecommunications to change the usual location of work, away from employer’s premises, on a regular basis.

The Romanian legal definition of teleworking follows entirely the essential elements regarding agreement, place, and modality agreed in the European Framework, but its implementation was confusing and problematic. A recent study confirmed that, despite some differences between countries teleworking is regulated in Europe quite uniformly because of EU regulations. However, same study found that in Romania there are certain problems with regards to the issue of occupational safety and health and the recording and checking of working hours [9].

Discussions in Romanian legal literature ranged from practical aspects in relation to flexible work [10] and digitalization [11] to the meaning and legal terminology used by the legislator [12]. A controversy can be observed regarding specificity and distinction from other forms of work, especially working at home [13, 14, 15]. Other authors analysed the particularities of teleworking regarding the penalty for the non-compliance with legal provisions regarding work, as well as fiscal aspects [16]. Considering the current work trends, [17] expressed concerns that teleworking is not comprehensively regulated and suggested some improvements for future regulations in favour of the teleworker. An interesting opinion claims that teleworking is a form of “virtual migration” that implies movement not only of employee from the employer’s premises, but also movement of data from teleworkers to the organisation and vice versa [18].

3. *Some preliminary studies and facts on teleworking*

The lack of time for preparation became a particularity of telework induced by epidemic. This situation was noticed across many countries and not all were prepared. In France it reinforced the pressing need for a telework policy and rules regarding work at home equipment, professional IT tools access and costs compensation [19]. Spanish researchers noticed that an increasing number of companies have been adopting teleworking as an urgent solution to ensure their employees' safety and to provide continuity to economic activity, with low costs of implementation [20]. A survey in Portugal found that adapting to teleworking was easy or extremely easy and that it happened very quickly, but with a lack of resources related to technical support infrastructures at home, such as the internet or a printer [21]. But switching to teleworking was not smooth especially for those organizations with no or limited prior experience with teleworking, especially because of lack of appropriate ICT devices and tools, lack of skilled and trained employees to support the transition to telework practices and data security concerns [22]. In fact, a joint EC-Eurofound report discussing the extent of teleworking in the EU before and during the COVID-

19 outbreak, observed that organizations that had to move to telework may feel the need to adapt to this arrangement by trying to introduce increasingly intrusive forms of remote control and surveillance of the work carried out from home [3].

4. Security risks in teleworking

Besides organisational challenges with a remote workforce, finding a solution to protect data across several infrastructures and environments is still quite challenging and more critical than in the past. The most common security objectives for telework and remote access technologies are known as the “CIA Triad” consisting of confidentiality - ensure that remote access communications and stored user data cannot be read by unauthorized parties; integrity - detect any intentional or unintentional changes to remote access communications that occur in transit; and availability - ensure that users can access resources through remote access whenever needed [23].

Data security risks have been documented for more than two decades, like systems being used for multiple purposes, user’s systems not being directly controlled by the IT department, Internet connection sharing that may allow others to access corporate resources [24]. Present teleworking scenarios start from an ideal situation where the employer provides employees with data processing equipment for processing data securely; a riskier situation is when the teleworker uses his own devices (such as computers, tablets or mobile phones) and the employer cannot control the security of the data processed on the employee's system; a third situation is using cloud technology, meaning that both the teleworker and the employer are connected to a cloud platform where they find all necessary resources [25]. As a result, ensuring full security of computer systems has become the great challenge of any organization because security vulnerabilities arising from remote working increase the risk of cyber-attacks and is considered one of the main enemies of any organization, from SMEs to large corporations [26].

A literature review identified three triggers of risks: the teleworkers, the data /information, and the software, hardware, and network assets [27]. In the same lines, major security concerns for telework and remote access technologies include a lack of physical security controls of mobile devices that can be lost or stolen, unsecured networks used for remote access over the internet, as well as providing external access to internal-only resources that increases the risk of that resource being compromised [28]. Guidelines and reports confirmed that the use of technology for teleworking can present higher risks of cyber-attacks and confidentiality breaches, especially if employees are using personal laptops or devices for teleworking [28]. IT solution vendors added other risks like VPN brute-force attacks, phishing campaigns, and man-in-the-middle attacks [29].

Also, people’s behaviour has long been a weak link in the security of any business, responsible for careless

use of passwords and keeping confidential documents filled in paper form or unsecured equipment such as USB flash drives or accessing links to suspicious emails [30, 31, 32]. Without firewalls, proxies, BNS filtering and VPNs to protect them, it’s a “perfect storm for human error” [33].

When asked in a survey, employees teleworking said their top tech-specific concern is how it makes their companies more vulnerable to data breaches and expressed concerns around security and being heavily reliant on tech at home to get the job done [34]. Another research found that employees are confident in their company’s ability to keep personal identifiable information secure while working remotely [35] and are trusting of the cybersecurity protocols that their organizations implemented for teleworking during the COVID-19 crisis (like VPNs and teleconferencing platforms), but they consider these protocols to be vulnerable [36].

III. METHODOLOGY

In the context of the present research, the following methods were used: Scientific research; Comparative analysis; Systematic analysis; Logical analysis. This study employs document analysis to unravel the legal characteristics of teleworking agreements, data security risks and their legal implications. The analysis considers both review of the contemporary academic and non-academic literature, because teleworking has been widely covered in government regulatory guidelines and technical reports of IT companies. The research included all countries but was limited to those cases presented in papers published in English and Romanian languages.

IV. ANALYSIS OF LEGAL ASPECTS OF TELEWORK

The purpose of the paper is to explore legal implications of specific data security risks of teleworking in Romania, to support managerial decision regarding privacy compliance and protection of intellectual property in a teleworking situation. This section provides an analysis of the legal component of

1. The legal framework of telework

A textual analysis of the laws governing teleworking reveals the following key elements that define telework on a legal level:

- i) work is performed based on a specific teleworking agreement between the employer and employee,
- ii) telework always implies the use of computers and telecommunications in a work relation,
- iii) the employer is responsible for all expenses necessary to set-up and maintain home-based offices,
- iv) the employer will provide access to company-valuable information on technology or on any other

aspect of the business – that can be or already is being protected as intellectual property (IP),

v) as in any employment situation, within a teleworking arrangement, data and privacy protection are the employer's responsibility under the General Data Protection Regulation (GDPR) and

vi) the employer must explicitly inform the teleworker of regulations in matters relating to the protection of personal data (and the teleworker must comply).

The teleworker is an employee under the Labour Code and disciplinary actions can be taken against him, in certain conditions. This is a specific situation that only exists within a work agreement and not applicable if the teleworker is freelancing. Other types of legal liability that can affect both parties are administrative (includes GDPR fines), criminal, and civil/tortious liability, that are derived from general law principles.

It is also important to recall the fact that, according to the Labour Code, the employee has specific rights which he must be informed of. These labour rights include providing the employee correct and sufficient information regarding the handling of data and tools for doing so.

2. Legal aspects of data security in telework

We identified specific data security risks in teleworking such as physical security attacks on devices, unsecure or vulnerable internet connection and user's level of access to company systems. To keep business continuity during the pandemic, and without any time to prepare for teleworking, it is unlikely that all companies provided their employees with a work computer having a degree of cyber protection equal to company environments. Thus, employees would have used their personal devices for remote access to company IT-infrastructure, as well as their private Wi-Fi networks that create potential entry points for security threats, if insufficiently secure.

All data security risks involve one of the three outcomes: disclosure of data – which leads to loss of confidentiality; modification of data – which will result in the loss of information integrity; destruction of data – resulting in loss of availability of that data. Legal liability is engaged either way if the data is affected because of physical or software attacks, has been intercepted, accessed in an unauthorized way, or accidentally deleted. From a legal point of view, we can approach data from perspective of personal data (protected under GDPR), trade secrets and confidential information (protected under IP law, commercial and civil law).

3. Personal data breach

Companies are under threat of GDPR fines if the cyber-attack results in a personal data breach because integrity and confidentiality of data are fundamental principles for data processing. According to art. 4 (12) GDPR a personal data breach refers to a security breach leading to accidental or unlawful destruction, loss,

alteration, unauthorized disclosure of, or access to, personal data transmitted, stored, or otherwise processed. Employers, as data controllers, stay liable for any personal data processed by teleworkers on company or personal devices used for work purposes, shared devices, or unsecure Internet connections. For example, what starts with a simple email click in case of phishing attacks or a transmission over an unsecured network might engage the company in administrative liability. Liability of employer is questionable, however, if the company fulfilled (and can prove) the obligation to implement appropriate technical and organizational security measures to avoid personal data breaches [37], like the case of losing a laptop containing encrypted personal data if the data is still available in a back-up system [38].

In certain situations, the employer may also take legal action against the persons – even employees – who caused the incident, based on the contractual, civil, or disciplinary liability of these persons. During the first half of 2020, insufficient technical and organisational measures to ensure information security held second place in a top of reasons for fines and penalties in EU, that could be avoided by training of personnel, with little costs and avoiding high fines [39]. If the company has internal rules and regulations regarding data processing in place, an employee disregarding them is liable for disciplinary action. However, employee's tortious liability could be limited by the nature of telework that always implies the use of computers and telecommunications, making the management of data security risks a regular job aspect in the sense of art. 254 Labour Code. For these reasons we believe it crucial that employers assess the activity of their employees working from home, to determine whether this activity may be considered teleworking and amend the employment contracts accordingly.

4. Breach of intellectual property rights

Potential security breaches may put the confidential work files of companies at risk. Teleworkers need access to diverse types of documents that are either digital or digitalised, making them easily copied, modified, shared, or deleted. These documents are at least confidential if not secret, forming the pool of information and know-how that is not protectable or cannot be protected properly through patents, such as early-stage inventions, manufacturing processes, lists of suppliers and clients, recipes, the results of marketing studies, brand names, prices, and dates of launching of new products or the price offered in a public procurement or bidding procedure. When such documents are intercepted and stolen through attacks like ransomware, companies might have to pay to retrieve them from cyber criminals without a real possibility to sue for damages because it is difficult (although possible) to impose the liability for actions over the Internet, especially because of the presence foreign elements in legal proceedings [40]. Teleworking relies on computers and data rather than

paper, making these unintended consequences more frequent, and, while organizations often look to their general liability policies to cover them for accidental losses, an insurance policy might be the only way to mitigate the risk, including when the attack is happening through an employee-owned device. Moreover, lost or corrupted documents could lead to missing deadlines on ongoing contracts and open the company to damaging their clients.

Company data is not always their own, like data provided by business partners and clients, especially when we think Romania's economy is mainly centred on the services sector. We can imagine that employees might start downloading company files on their personal computers instead of working in the company's cloud, to be able to continue to work if remote access should be suddenly interrupted. Even accidental disclosure of confidential client information to a party outside the workplace, puts the company in breach of contract with their client. As such, based on civil or commercial law, the company would be responsible for paying compensation to the client for damages they faced due to this breach.

Employees could be held responsible for IP breaches, especially if they signed a non-disclosure agreement. When using their preferred file sharing systems or devices that are shared with family members, the employee is still responsible for the company data and even criminal charges can be brought if malicious intent can be proven.

V. CONCLUSIONS

Data security is a much wider issue that covers more than only the aspect of technology. From the legal point of view, the challenge is two-fold: protecting the teleworker through the security of personal data & privacy as well as protecting the employer by ensuring preservation of business data & proprietary information. Managing teleworking means balancing safeguarding personal data of employees and the need of securing business sustainability through protection of intellectual property.

Not all employees will be accessing sensitive information while they are working from home. For the management, the legal implications should be part of the risk assessment. This should start by asking the right questions: How is data being generated? Where is it stored? Which physical devices are storing data? How are documents being secured according to their classification? Is all data (no matter where it is located) being backed up? Is the device or devices the employee uses for work used for other purposes? Are employees aware of cyber-risks? As one senior practitioner said, the new remote-working reality calls for an "urgent rethinking of general security training" [41].

The contribution of this study, aimed at practitioners and managers, is seen as threefold: it can help organisations to successfully manage the introduction of teleworking for employees, create and

implement appropriate policies and also, assist the employees to learn about the legal risks related to remote work.

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Decoding Progress: Assessing R&D Institutes Performance in the Contemporary Landscape

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Abstract - In the dynamic landscape of research and development (R&D) institutes, performance measurement is a multifaceted challenge. This paper undertakes an exploration of the current state of R&D institutes, delving into their methodologies, achievements, and adaptability within the contemporary research ecosystem. Drawing insights from diverse perspectives, the study employs a comprehensive approach to assess the complicated factors influencing R&D institutes' performance. The focus extends beyond traditional metrics, including new criteria that capture the institutes' responsiveness to evolving research trends, interdisciplinary collaborations, and societal impact. Through this examination, the paper seeks to unravel the nuanced dynamics of progress within R&D institutes and contribute to the ongoing discourse on optimizing their efficacy in the ever-evolving scientific landscape.

Keywords R&D institutes, performance assessment, research and development, research ecosystem, scientific landscape, research efficiency

I. INTRODUCTION

In the domain of research and development (R&D), where innovation serves as the compass guiding societal advancement, the evaluation of R&D institutes performance emerges as a pivotal undertaking. This paper embarks on a comprehensive exploration of the multifaceted dimensions that define and shape the success of R&D institutes in the present era.

As we stand at the intersection of technological breakthroughs, collaborative networks, and evolving global challenges, understanding the nuances of R&D institutes performance becomes imperative. This paper endeavours to unravel the complexities inherent in the contemporary landscape, aiming to provide a nuanced framework for assessing the effectiveness of R&D institutes.

This paper begins with an examination of the frameworks that support the assessment of

performance, delving into the various metrics employed in gauging the impact and contributions of R&D activities. We will explore the comparative landscape of R&D institutes, scrutinizing their innovative capacities, collaborative dynamics, and the critical role played by human capital and expertise in driving research excellence.

Furthermore, the paper delves into the subtleties of funding and resource allocation, recognizing them as foundational elements that influence the trajectory of R&D institutes success. In the context of rapid technological evolution, we analyse the impact of emerging trends on the performance of R&D institutes and present case studies that show exemplary models of research excellence.

By synthesizing insights collected from various perspectives, we aim to provide a holistic understanding of the contemporary challenges and opportunities faced by R&D institutes, charting a course for the future.

Through this paper we aim to untangle the complex tapestry of R&D institute performance, fostering a topic that transcends disciplines and borders. As we embark on this intellectual exploration, we aspire to contribute meaningfully to the ongoing discourse surrounding the vital role of R&D in shaping the future trajectory of our societies.

II. DATA-DRIVEN INSIGHTS: ANALYTICS FOR R&D PERFORMANCE ASSESSMENT IN ROMANIA

Every year, the state authority for research and development in Romania (currently Ministry of Research, Innovation and Digitization) issues a report regarding the activity and performance of the national research & development institutes of Romania.

The report includes [3]:

a. Analysis of the key indicators quantifying the results achieved by the national research and development institutes mentioned in section 1.3. following research and development activities;

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b. Analysis of the main economic and financial indicators recorded by the national research and development institutes;

c. Analysis regarding the structure of the research and development human resources based on distribution by scientific degrees and age groups;

d. Analysis regarding the structure and utilization level of the research infrastructure facilities;

e. Analysis concerning the visibility and prestige of the national research and development institutes.

According to the report for the year 2022, regarding the activity and performance of the 43 research institutes under the coordination of the Ministry of Research, Innovation and Digitization we can highlight some observations.

The report emphasizes the continuous growth in scientific and technological performance achieved through the development of ongoing research projects and the exploration of new research themes won in national and international project competitions. The activities of the institutes align with the INCD's Strategic Institutional Development Plan, in harmony with national strategies for research, development, and innovation. Notably, efforts were made to attract European and international funds amid reduced national budgets and delays in project evaluations.

Rigorous directions were followed, including improving internal control systems, maintaining quality management certification, expanding laboratory test authorizations, increasing services to the private sector, and efficient cash flow management.

Efforts were directed towards fostering a positive research culture, acknowledging the role of leadership in setting values and the influence of younger researchers in shaping the institute's direction. Emphasis was placed on physical structures and regular events promoting team building and cohesion.

Despite financial constraints and unpredictability, INCDs focused on valorising research outcomes, resulting in a slight increase in patented inventions and a decrease in technological services. The private sector's increased participation in supporting research activities led to enhanced collaboration, fostering interdisciplinarity in project proposals. Strategic human resource management aimed at maintaining an optimal organizational structure, adapting to modern research directions, and addressing specific social and economic needs.

The report highlights challenges related to financial stability, including the impact of COVID-19, and the need for prudent economic and budgetary policies. Noteworthy performance indicators include the increased number of patents, copyrights, and researchers involved in national and international projects. In addition, the report acknowledges the need for modern, efficient management, organizational innovation, competitiveness, and technology transfer to ensure the sustained success of INCDs in the face of economic, political, and financial uncertainties.

Regarding managerial performance, it has been highlighted that National Research and Development

Institutes (INCDs) with a coherent strategic planning, considering the primary objectives and directions in research, integrated at both national and European levels of research, development and innovation, and aligned with the local socio-economic environment, have achieved effective management.

Research in Romania faces significant challenges, characterized by low performance, insufficient funding from both public and private sources, and a limited global impact. [1] The European Commission's evaluation (2022) highlighted recurring issues, including governance fragmentation, a focus on fundamental research, and underutilization of private potential, contributing to a non-coherent research sector [1].

In 2022, Romania occupied the 49th place among the 132 economies included in The Global Innovation Index 2022. The Global Innovation Index (GII) report is made by the World Intellectual Property Organization, "Cornell" American University and the French School of Management "INSEAD" and is published annually from 2007 (WIPO,2022) [1].

The poor performance of the Romanian research system is determined by the low level of RDI spending, underfunding, the fragmentation of RDI in the public sector and its insufficient orientation towards the needs of the industrial sector, the excessive priority given by some institutes to fundamental research, insufficient number of researchers [1]. Romanian public research institutes exhibit low collaboration rates with industries and struggle to commercialize R&D results.

At the European level, according to the European Innovation Scoreboard 2021, Romania is an emerging innovator and occupies the last position in the EU in terms of innovation performance [1].

III. GLOBAL PERSPECTIVES

The significance of research and development (R&D) in fostering productivity, growth, and competitive advantage within firms has been widely recognized. However, many European countries have experienced economic stagnation or setbacks due to inadequate investments in R&D. Evaluating the economic value generated by R&D achievements and the strategic infrastructure is crucial in assessing the role of R&D in creating economic value.

Efficient performance evaluation models are essential for enhancing productivity and fostering growth across various organizational levels, including personnel, teams, projects, departments, and the entire organization. However, evaluating and comparing R&D activities pose challenges due to their complex nature, characterized by risk, uncertainty, long-term development, and diverse output parameters.

The Triple Helix (TH) theory demonstrates the existence of nonlinear interactions in the innovation process in which actors from 3 helices are involved: universities/academia and research institutes form the first helix that conducts fundamental research; the

industries represent the second helix, producing commercial goods and services, and the government as the third helix, regulates the market [2].

The synergy among universities and research institutes, industry, state, and civil society is known as the Quadruple Helix (QH). QH is an improvement of the TH perspective, to which it adds the fourth dimension: civil society, media, and culture-based public [2]. Studies emphasize the importance of knowledge dissemination and its societal impact. Findings indicate that international cooperation positively impacts the research performance of public research institutes in terms of publications and citations, though technological transfer beyond national borders remains limited.

Scientific knowledge requires the collective effort of the scientific community to advance [4].

Collaboration within the scientific community is important and has a major role in advancing scientific knowledge and generating economic value. There are various aspects of this type of collaboration, including interdisciplinary cooperation, trust-building, and the exchange of ideas across different fields and geographical areas.

Public research institutes are identified as crucial players in knowledge dissemination and technological development, funded primarily by public funds and tasked with meeting societal needs. The literature suggests that research institutes can enhance their research outputs by forming close links with other organizations and engaging in interdisciplinary teams, both internally and externally. Collaboration with external partners, such as industries and universities, is shown to positively impact researchers' productivity and the overall scientific performance of research institutes.

Studies provide evidence that collaboration and internationalization of public research institutes activities have a positive effect on their scientific performance, both quantitatively and qualitatively.

Interactions with universities facilitate participation in new projects and provide opportunities for training and networking, positively impacting the research performance of public research institutes.

Collaboration with industries brings financial resources, technology transfer opportunities, and economic benefits, although it faces challenges such as intellectual property regulations and role conflicts.

Government involvement through funding and policy support enhances the quality of public research institutes' research and ensures continuous financing.

Interaction with civil society promotes social inclusiveness and evaluation of scientific knowledge based on public interest, leading to more efficient integration of technology producers and users.

The scientific performance of public research institutes is evaluated using bibliometric and technometric methods, which involve quantifying the number of articles published in ISI indexed journals (ISI_no), granted patents (PG_no), and citations in ISI indexed journals (ISI_cit_no) [2]. These methods are

widely utilized due to their accessibility, accuracy, comparability, and ease of analysis through statistical models, despite some limitations in providing a comprehensive picture of R&D productivity.

ISI_no reflects the scientific contribution of a public research institute and its ability to generate and disseminate knowledge within the scientific community. It serves as a proxy for measuring scientific accomplishment and is influenced by factors such as career advancement imperatives and the pressure to publish.

PG_no assesses a public research institute's engagement in innovation and technology transfer activities, representing a convergence of novelty production, legislative control, and wealth generation. Patents are crucial drivers of productivity and growth, particularly in the context of academic capitalism. Furthermore, scientific performance is not solely measured quantitatively but also qualitatively.

ISI_cit_no serves as a proxy for the quality of published articles, reflecting scientific reputation and impact within the academic community. Factors such as funding, authorship, affiliation, and prior citations influence citation metrics.

Overall, these metrics provide valuable insights into the scientific and technological contributions of public research institutes and their impact on research advancement and innovation.

To test the hypothesis of the impact of collaboration and internationalization on the research performance of public research institutes, besides the dependent variables described before (*ISI_no*, *PG_no* and *ISI_cit_no*) several independent variables are included in the model [2]:

- *Number of memberships in research networks (RsNet)*: This variable represents the public research institute's participation in international research networks and databases, which facilitate the emergence of new ideas, stimulate research projects, and provide access to additional resources, ultimately enhancing R&D productivity.
- *Number of papers presented at international conferences (No_conf)*: Conference participation serves as a channel for knowledge transfer and contributes to the development of social capital, positively impacting R&D performance.
- *Number of memberships in associations, clusters, technical and scientific boards, and committees (M_Assc_no)*: This variable reflects the public research institute's networking activities, which are essential for collaboration and knowledge exchange.
- *Number of partnership projects/contracts (PartPr)*: This indicator measures collaboration by tracking the number of research projects and contracts, which is crucial for attracting public and private research funding.

- *International partners (expressed as a weight in total partners - WIP)*: This variable signifies the importance of international connections in enhancing research quality and stimulating new projects, particularly for researchers in developing countries.

To test the hypothesis, these independent variables were grouped into the four dimensions of the Quadruple Helix (QH) model: interaction with universities, industries, government, and civil society.

Interaction with universities is represented by the number of teaching assignments in universities (TA) and the presence of academic representatives in the public research institute's Board of Directors, reflecting collaboration in training and research activities.

Interaction with the private sector is illustrated by the existence of industry representatives in the Board of Directors and the number of granted patents (PG_no), indicating collaboration for technology transfer and innovation.

Interaction with the government sector is represented by the weight of public partners in total partners (WPP) and the presence of governmental representatives in the Board of Directors, highlighting partnerships to improve competencies and attract funding.

Interaction with civil society is captured through variables such as press coverage (PC) and the number of memberships in associations, clusters, technical and scientific boards, and committees (M_Assc_no), reflecting the public research institute's engagement with the public and non-profit organizations for knowledge exchange and dissemination.

Various studies have explored the performance evaluation of Research and Development (R&D) organizations, employing different models and methodologies. While some studies have utilized the Data Envelopment Analysis (DEA) approach, a few have adopted a DEA-ANP hybrid combining DEA with Analytic Network Process (ANP) model for assessing efficiency.

There are studies that aim to address the gap by introducing new criteria, such as researchers' satisfaction and customers' satisfaction, to provide a more comprehensive assessment of R&D organizations' performance [5].

Moreover, recent research has shown that factors like gender diversity can influence R&D efficiency, emphasizing the importance of considering various dimensions in performance evaluations. By incorporating a wider range of criteria and methodologies, one study aims to provide a more accurate and practical evaluation of R&D organizations' efficiency, contributing to the advancement of performance evaluation models in this field.

A total of 6 input indicators and 7 output indicators were considered in the model, with 17 organizations - Decision Making Units (DMUs) included in the study. Each period under examination spans one year.

The input indicators of the model are as follows: budget (I1), tax rate (I2), researchers' work experience (I3), education level of researchers (I4), dedicated time for researcher training and updating (I5) and degree of researchers' satisfaction with their job (I6).

The output indicators of the model are as follows: Hirsch indicator (O1), publications (O2), patents (O3), project operationalization rate (O4), total income (O5), degree of satisfaction of client (O6) and increase/decrease rate of client (O7).

While the DEA method categorizes DMUs into "efficient" and "inefficient" classes, the DEA-ANP method offers a more precise and practical calculation of efficiency values.

The study introduces novel indicators such as "researchers' work experience", "degree of satisfaction of researchers with their jobs in the organization", "project operationalization rate" and "client satisfaction" and suggests focusing on enhancing specific indicators as the ones listed above to improve overall efficiency in R&D organizations.

Scientists working at research institutes understand that they are part of a larger ecosystem beyond their own labs. The culture, standards, social cohesion, and funding of the institute are crucial for its success. Institutes worldwide focus on creating environments propitious to generating and utilizing new scientific ideas. Education plays a significant role, as scientists continuously learn from each other through various means like emulation, discussion, collaboration, and competition.

Most research institutes prioritize freeing scientists' time for research, offering little teaching but providing internal funding. They often promote interdisciplinarity and collaboration. Notably, research institutes have made significant contributions to groundbreaking discoveries. Success is measured by scientific contributions, publication output, grant funding, and staff satisfaction. Creating a positive research culture involves leadership setting values, while younger researchers influence direction and contribute energy. Physical structures and social events also play a role. Research culture impacts creativity and discovery, thus institutions focus on nurturing it. Crafting a successful research environment requires collaboration, support, and inclusivity, recognizing contributions from all members.

The success of a research institute is influenced by various factors, forming a "golden triangle" comprising core facilities, supportive administration, and research group [6]. While there's no one-size-fits-all formula for an ideal institute, every aspect contributes to nurturing the next generation of scientists and their discoveries.

To maximize success within the golden triangle, research institutes should focus on several key concepts [6]:

Effective Feedback Mechanisms: Institutes should establish internal and external feedback mechanisms to continually evolve and optimize their organization and scientific endeavors.

Supportive Administration: An efficient and communicative administration with a deep understanding of research culture is essential to enable scientists to focus on their research.

Promoting Plug and Play Research: Institutes should invest in state-of-the-art facilities and operational infrastructure to facilitate research activities efficiently and effectively.

Building a Holistic Research Environment: Creating a supportive research culture that empowers scientists to develop and realize their potential is crucial for maximizing success.

Recruitment is a critical aspect of research institutes, impacting both scientific endeavors and organizational culture. Institutes may employ different recruitment strategies, from internally driven processes to external assessments, each with its benefits and risks. Once hired, fair remuneration, additional perks, and dual hiring options can enhance recruitment outcomes.

The institute's size, group size, and focus on technology are key considerations in recruitment and organization. Additionally, managing interdisciplinarity within an institute is essential for fostering collaboration while avoiding fragmentation.

Technology transfer and training are crucial for advancing discoveries and nurturing talent within institutes. Technology transfer systems manage intellectual property and promote entrepreneurial activities. Training programs equip researchers with essential skills. Mentorship plays a vital role in career development and addressing research misconduct.

Building an inclusive environment that values diversity fosters creativity and innovation. Instituting policies for equality, diversity, and inclusion at all levels is essential, with high-level support and dedicated funding. Diverse perspectives enrich the research culture and contribute to scientific excellence. It's crucial to acknowledge and address mental health and well-being among institute staff to maintain a positive research culture.

Table 1 Key ingredients for a successful research institute. [6]

Organizational component	Key ingredients
Funding review process	<ul style="list-style-type: none"> • Individual principal investigator-based review or collective (e.g., departmental) reviews depending on the institute • Review process designed to promote collaboration and interdisciplinarity • A carefully appointed scientific advisory board • A transparent and clear process
Administration and corporate services	<ul style="list-style-type: none"> • Proactive service mindset, customer-friendly • Fast turnaround and agility • Transparency in performance • Buy in to the institute's vision • Clear two-way communication channels
Core facilities	<ul style="list-style-type: none"> • Proactive and transparent user data distribution • Rapid training • Equipment shared across the institute • Fair governance • Commitment to career pathways, acknowledgement in papers
Technology transfer and innovation teams	<ul style="list-style-type: none"> • Management of intellectual property, external partnerships, and patents • Legal and business counsel • Promotion of entrepreneurship in researchers
Training	<ul style="list-style-type: none"> • Train scientists at all levels across the institute • Research methods and cutting edge techniques • Holistic skills: communication, research management, leadership, etc.
Faculty recruitment	<ul style="list-style-type: none"> • Transparency • Internal or external recruitment processes (and measures that counterbalance any potential negative consequences) • Attractive packages • Long-term versus short-term considerations • Distribution of experience
Institute culture	<ul style="list-style-type: none"> • Transparency in operations and management/governance, recruitment, packages, salary, space, and platform access • Promote collaboration and creativity by fostering an open research culture (e.g., open seminars with unpublished work, retreats, funding mechanisms that promote collaboration) • Provide training at all levels: scientific as well as communication and leadership • Enable people to call out bad behavior (e.g., bullying, scientific fraud), with clear escalation routes and consequences, even for highest levels of management • Culture of allowing mistakes • Build diversity in the workforce at all levels based on merit • Supporting needs of diverse groups (parents, religious groups, individuals with disabilities, etc.) in order to build truly inclusive environment • Senior leadership buy-in to demonstrate commitment from the top

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In addition to the challenges already mentioned - including funding constraints and the impact of global events such as the COVID-19 pandemic - research institutes also face other challenges in today's rapidly evolving landscape, such as climate change and the integration of artificial intelligence (AI) [6].

The climate crisis presents both operational and psychological challenges for institutes, requiring them to implement policies to reduce carbon emissions and address the psychological effects of climate change on staff. Additionally, the increasing integration of AI into research processes offers opportunities for transformative insights but requires careful consideration and involvement of all staff in decision-making.

Despite efforts such as the Europe 2020 strategy, many European Union members have not met R&D targets. The Multiannual Financial Framework for 2021–2027 [7] places a strong focus on innovation. The measurement of R&D achievements is crucial, with data envelopment analysis (DEA) being a common approach, although criticisms exist regarding traditional indicators. Sustainable development requires innovation, and objective measurement of R&D achievements is essential for decision-makers and policymakers. Economic efficiency in terms of maximizing outputs with minimal inputs is a key focus [8].

For nine EU countries (Austria, Bulgaria, Cyprus, Denmark, Germany, Latvia, Luxembourg, Malta, and the Netherlands), both the score of pure technical efficiency and that of scale efficiency are maximum for all three intervals analyzed (2011-2012, 2013-2014, 2015-2016) [9].

There are countries that excel both in terms of transforming human and financial resources into intermediate output but also in terms of transferring these results to the economic sector (Germany, Italy, Malta and Portugal) [9].

IV. EXAMINING THE IMPACT OF THE FRAUNHOFER GESELLSCHAFT (FHG)

The German science system is globally recognized for its excellence, producing cutting-edge knowledge, fostering its application, and contributing to various societal and economic goals.

Universities and research institutions are expected to promote interdisciplinary collaboration, internationalization, and diversity. Political and societal demands for accountability have led to a focus on demonstrating the impact of research beyond mere output.

Fraunhofer-Gesellschaft (FhG) is committed to delivering impacts across these dimensions.

The Fraunhofer Gesellschaft, established in 1949, is a prominent public non-profit organization dedicated to advancing applied research in Germany. Initially formed to aid in the post-WWII reconstruction of the industrial sector, it serves as a bridge between basic

research and industrial applications. Over the years, it has grown significantly, evolving from nine institutes with a modest budget in 1959 to becoming the largest non-profit organization for applied sciences globally.

With 72 centers and an annual budget of €2.3 billion, the Fraunhofer Society promotes innovation and technology transfer, bridging academia and industry.

Existing research mainly focuses on economy-wide treatments and pre-existing datasets, such as financial incentives and intellectual property protection's effects on R&D and patenting. However, there's a gap in knowledge regarding the impact of policies involving public sector participation in innovation and their effects on variables like productivity and employment. Unlike traditional innovation policies, FhG's aim is to provide technological solutions to specific company problems, rather than solely focusing on patent development.

Studies indicate a strong causal effect of contracting with FhG on turnover and productivity growth. Furthermore, the impact of FhG seems to be heterogeneous in characteristics of the participating firm as well as the project.[10].

An overview of the FhG interactions with firms from 1997 to 2014 [10] shows that approximately 6,500 projects were initiated per year, with a peak of 8,800 in 2009. The average project duration is one year and eight months, yielding around €37,000 in FhG revenue. A significant portion (26.55%) of projects report no registered revenue. Most firms collaborate with FhG once (42%), while 31% engage in more than three projects, and 90% of projects involve less than €100,000 in revenue.

According to the studies, the long-term effects significantly surpass the short-term impacts, with firms experiencing substantial increases in turnover and value added per employee over the 15-year period.

Econometric models reveal that increased collaboration with FhG correlates with higher turnover and productivity growth for companies. Interactions aimed at developing new technologies have a more substantial impact than those focused solely on implementing existing ones. Moreover, FhG's economic impact extends beyond direct effects, influencing macroeconomic productivity [12].

Recent analyses, using refined methodologies and additional data sources, further corroborate the substantial economic benefits of research organizations like FhG, highlighting their pivotal role in driving innovation and economic growth.

According to *A microeconomic perspective on the impact of the Fraunhofer-Gesellschaft* from 2022 [12], scientific institutions like the Fraunhofer-Gesellschaft play a crucial role in political, strategic, and economic decision-making, with stakeholders seeking to understand and evaluate the impact of investments. FhG has proactively assessed its economic and technological influence, its role in training young scientists, and its contribution to emerging technologies. Since 2016, FhG has commissioned

studies to delve deeper into its impact, focusing on economic effects and collaborations with industry, particularly small and medium-sized enterprises. The organization's mission emphasizes collaboration with industry to drive innovation for societal and economic benefit, positioning itself as a key player in the innovation system. There's a growing societal and political expectation for research institutions to address societal challenges, a goal Fraunhofer actively incorporates into its operations.

This study from 2022 Fraunhofer ISI report aims to assess the impact of collaborating with Fraunhofer Institutes and other German public research organizations (PROs) on companies' economic and innovation performance. Descriptive statistics, correlation analyses, and multivariate models were employed to analyze the relationship between research institution collaborations and company success.

Several databases were used:

1. BvD Orbis;³
2. The German Manufacturing Survey (GMS);⁴
3. Funding Catalog (Förderkatalog);⁵
4. Fraunhofer's contract data (SIGMA);⁶
5. Patent data and additional financial indicators⁷

Matching procedures like *matching using Levenshtein distance algorithm*⁸, *Time-window consideration*⁹, *Matching with patent data*¹⁰ and *Matching with financial data from Amadeus*¹¹ were involved in the study aiming to link information from various datasets, ensuring accurate analysis of cooperation between companies and research organizations.

According to the results of the study, the number of projects and the annual budget of contract research with industry have generally increased between 2010 and 2019. Despite the growth in the number of employees at Fraunhofer Institutes during this period, the compound average annual growth rate for projects, budget, and employees remains positive. The average size of each project has slightly increased in nominal terms but decreased in real terms. However, the average industry project budget per employee has remained relatively stable over time. These trends

indicate that the share of national industry contracts in FhG's total budget has increased, and FhG has effectively maintained the average budget of these contracts while growing in terms of employment, demonstrating success in fulfilling its mission of conducting research with and for industry [12].

The structure of contracted projects reveals that over two thirds (68%) of the companies involved are small and medium-sized enterprises (SMEs), with an additional 20% falling within the broader definition of the German "Mittelstand" (mid-tier business) with less than 5,000 employees. Large enterprises, with over 5,000 employees, make up only 5% of the companies. This distribution underscores FhG's mission of collaborating primarily with SMEs and Mittelstand. Although large enterprises represent a small percentage of the companies, their collaboration projects have a significantly higher average budget [12].

Publicly funded joint projects with industry play a crucial role in knowledge and technology transfer, often involving multiple industry partners and sometimes other research institutions. These projects typically focus on pre-competitive research, addressing medium- to long-term challenges for industry. For FhG, these projects serve as a bridge between basic research outcomes and potential industrial applications, aligning with its mission.

Overall, cooperation with the FhG in R&D projects is associated with innovation-driven, globally oriented firms with a focus on modernization and technological advancement in manufacturing [12].

V. DISCUSSIONS AND CONCLUSIONS

Despite facing challenges such as financial constraints R&D institutes of Romania have shown continuous growth in scientific and technological performance. Efforts to attract European and international funds, enhance collaboration with the private sector, and foster a positive research culture have been notable. However, there are persistent challenges including low funding, governance

³ This database contains information on 2.4 million companies in Germany, including location, sector, and ownership structures. It covers all sizes of firms from micro to large companies and forms the basis for large-scale analyses, primarily for recent years; [12]

⁴ This survey captures techno-organizational innovations in manufacturing at the level of individual manufacturing sites, providing data on performance increases. It covers the entire manufacturing sector in Germany and is conducted every three years, with data from 2012, 2015, and 2018 being used in this report; [12]

⁵ This catalog lists collaborative research projects between companies and PROs, including universities. It contains information on nearly 270,000 projects, with approximately 120,000 being joint research projects, starting from 1968 and being particularly comprehensive from 2000 onwards; [12]

⁶ This internal FhG database provides information on contracted research projects from firms, covering the period from 2010 to 2018. It allows the separation of contract research from joint research projects; [12]

⁷ Patent filings, including transnational patents and filings to the German Patent and Trademark Office, are matched to the datasets. Additionally, financial indicators such as EBIT and Return on Equity are sourced from Bureau van Dijk's Amadeus database to provide

further information beyond what is available in SIGMA or the Funding Catalog. [12]

⁸ Company names from SIGMA and the funding catalog were matched with those in the Fraunhofer GMS and BvD Orbis datasets using a string-matching algorithm based on Levenshtein distance. This measures the similarity between two text strings, enabling identification of matches even with variations in spelling or formatting. A similarity threshold of 0.89 was set to optimize precision and recall. [12]

⁹ To avoid bias, a time-window of three years (five years for the Orbis dataset) was applied to ensure that cooperation instances occurring several years ago do not influence the results.

¹⁰ Similar matching procedures were applied to merge companies from the GMS and Orbis datasets with the EPO Worldwide Patent Statistical Database (PATSTAT), focusing on the share of manufacturers filing for patents during specific time frames.

¹¹ For firms surveyed in the GMS, VAT numbers were used to search for financial indicators in the Amadeus database. For firms without VAT numbers, a string-matching algorithm on company names was applied. This two-step process enabled the assignment of a BvD-ID to a significant proportion of surveyed firms, though the coverage of financial information varied across waves and datasets.

fragmentation, and a focus on fundamental research, contributing to Romania's limited global impact in research and innovation.

The country's position in international innovation rankings remains relatively low, reflecting the need for significant improvements in R&D spending, collaboration with industries, and commercialization of research outcomes.

Moving forward, addressing these challenges through coherent strategic planning, increased funding, and a stronger focus on applied research aligned with industrial needs will be crucial for enhancing Romania's research and innovation landscape and fostering sustainable economic growth.

Research institutes play a pivotal role in advancing scientific knowledge and innovation. Creating a positive research culture, promoting interdisciplinary collaboration, and providing state-of-the-art facilities are crucial for nurturing talent and maximizing success. Effective recruitment strategies, technology transfer mechanisms, and training programs further support research endeavors and talent development.

The global perspective on research and development (R&D) underscores its crucial role in fostering productivity, growth, and competitive advantage within organizations. International collaboration and knowledge dissemination play vital roles in enhancing R&D performance, as evidenced by increased publications, patents, and project operationalization rates. Also, the Triple Helix and Quadruple Helix models highlight the interconnectedness of academia, industry, government, and civil society in driving innovation and economic development.

Statement regarding the ethics of using AI software

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The Use of Artificial Intelligence in Entrepreneurial Management – Creating the Ideal Customer Profile

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Abstract – This study aims to define the profile of the ideal customer by leveraging Artificial Intelligence (AI) through the ChatGPT application, based on a business plan summary for a "Gym with Wellness Area," which primarily offers table tennis table rentals. Employing a detailed research methodology, this paper identifies key traits of the market segment most likely to be attracted and retained by the business. The study explores interests and preferences, emotional states before and after service acquisition, fears and frustrations, desires and aspirations, and the self-perception of the ideal customer. The findings provide a comprehensive understanding of how to create and refine an ideal customer profile using AI, enabling the development of marketing strategies and services tailored to customer needs and preferences. The research results offer a strategic foundation for decision-making and promote sustainable and efficient business growth.

Keywords Artificial Intelligence, Entrepreneurial Management, Customer Profile

I. INTRODUCTION

In today's business landscape, understanding customer needs and behaviors is crucial for the success of any enterprise. Traditional methods of identifying and targeting potential customers often fall short due to the sheer volume and complexity of data involved. This inadequacy can result in suboptimal marketing strategies and missed opportunities for growth. Especially for new innovative businesses like for instance a table tennis gym with integrated wellness area can face real challenges of pinpointing their ideal customer profile to tailor their offerings effectively and stand out in a competitive market.

Effectively identifying and targeting the ideal customer profile is essential for several reasons. It allows businesses to optimize their market strategies, enhance customer satisfaction and improve retention rates. For a gym offering table tennis table rentals along

with wellness services understanding the ideal customer profile helps in designing services and promotional activities that resonate with the target audience's preferences and needs. This strategic alignment can lead to increased customer engagement, loyalty and ultimately growth of the business.

The limitations of traditional customer profiling methods highlight the need for advanced solutions. Artificial Intelligence (AI) offers a promising alternative by leveraging its capabilities in data analysis and pattern recognition. Specifically, AI applications like ChatGPT can process large datasets to uncover intricate customer insights that traditional methods might overlook. The motivation for adopting an AI-based approach in this study includes:

- **Efficiency:** AI can handle vast amounts of data, making the profiling process faster and more efficient.
- **Precision:** Advanced AI models can deliver highly accurate customer profiles by identifying subtle patterns and correlations in the data.
- **Innovation:** AI provides innovative tools and techniques that can significantly enhance the understanding and targeting of potential customers.

The primary objective of this study is to utilize Artificial Intelligence (AI), specifically the ChatGPT application, to create a comprehensive profile of the ideal customer for a gym offering table tennis tables rentals along with wellness services.

The literature review provides valuable insights into the application of Artificial Intelligence (AI) in customer profiling. It highlights the extensive use of machine learning techniques for customer segmentation, employing clustering algorithms such as K-means clustering, hierarchical clustering, and DBSCAN. These algorithms effectively segment customers based on diverse features, including purchasing behaviors, demographic aspects, and buying engagement patterns. In predictive modeling, supervised learning algorithms like decision trees, random forests, and gradient boosting machines are

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commonly used to forecast customer preferences and future behaviors. Natural Language Processing (NLP) plays a significant role in sentiment analysis, which involves examining customer feedback, reviews, and social media interactions to assess customer sentiment and satisfaction levels.

AI-driven chatbots and virtual assistants significantly enhance personalized customer service by gathering customer preferences and improving the overall customer experience. E-commerce platforms often implement recommender systems based on collaborative filtering to suggest products based on past user interactions and similarities with other users.

Additionally, content-based filtering recommends products or services by analyzing user profiles and item features. The prediction of Customer Lifetime Value (CLV) utilizes regression AI models to estimate the future value a customer will bring to a business over the entirety of their relationship. Furthermore, AI-driven behavioral analytics, such as pattern recognition algorithms, analyze customer behavior to identify high-value customers and those at risk of churn.

These advanced AI methodologies not only enable businesses to understand their customers better but also facilitate strategic decision-making processes to enhance customer satisfaction and loyalty.

The literature review provides insightful observations on the application of Artificial Intelligence (AI) in entrepreneurial management, with market analysis emerging as a pivotal area. For effective market analysis, AI-driven engines and specialized tools are employed to conduct trend analysis, enabling businesses to scrutinize market trends and consumer behaviors, thereby identifying novel and innovative business opportunities.

Another critical domain is competitor analysis, where AI-driven tools are extensively developed and utilized to monitor competitors' activities and market positioning. This information is crucial for informing strategic decisions within a business.

In the realm of product development, tools like CADENCE, which leverage AI and predictive analytics, are instrumental in developing and testing product prototypes, as well as forecasting market reactions. AI also plays a significant role in customer feedback analysis, allowing businesses to process and analyze large volumes of customer feedback, thereby guiding continuous product improvement processes.

Operational efficiency and process automation benefit greatly from AI, as it handles routine tasks, enhancing efficiency, and reducing operational costs. Additionally, personalized marketing is made possible through AI's ability to analyze customer data and create highly targeted and personalized marketing campaigns.

Finally, dynamic pricing is another area where AI proves invaluable. AI-driven pricing models enable businesses to adjust prices in real-time based on market demand and customer behaviors, optimizing revenue

and competitiveness. These applications of AI in entrepreneurial management not only facilitate more informed decision-making but also drive innovation and efficiency across various business operations.

II. METHODOLOGICAL APPROACH AND GUIDELINES

In this section, we will explore the utilization of ChatGPT version 3.5 for creating an ideal customer profile for a Business-to-Client (B2C) enterprise, using the business's summary as the initial source of information for artificial intelligence. The objective is to develop a comprehensive profile of an ideal customer by engaging with ChatGPT through a structured dialogue application.

Steps to create an Ideal Customer Profile:

1. Set up ChatGPT account:

Begin by creating an account at www.chatgpt.com. There are two versions available: a limited free version (3.5) and a more enhanced version (4.0). For demonstration purposes, we will use ChatGPT v3.5.

2. Understand the importance of input quality:

The quality of the AI's output is directly proportional to the quality of the input provided. Therefore, it is crucial to set the context accurately before querying the AI.

3. Prepare the AI context:

Start by ensuring that ChatGPT understands its role and the perspective from which it should read and respond to the business summary. This can be done with the following statement:

“ChatGPT, your role in the next upcoming scenario is to be a marketing expert for a company which primarily offers table tennis table rentals. Before continuing did you understand your expected role?”

4. Provide business plan summary:

Once the AI acknowledges its role, send the summary of the business plan as shown in Figure 2 below.

Follow up with a confirmation question to ensure the AI understands the summary and the type of clients the business might have:

“ChatGPT, did you understand the summary of the business plan and the type of clients the business might have?”

5. Define and Send Predefined Questions:

After receiving confirmation, send the predefined set of questions designed to extract detailed information about the ideal customer.

SUMMARY	
<p>Company Description</p> <ul style="list-style-type: none"> Newly established company. SC TTPRO SRL, CAEN code 7721 – activities of renting and leasing recreational goods and sports equipment. Mission: To inspire people to lead a more active, sports-based lifestyle, offering them the chance for a more relaxing and healthier life. Vision: We believe that everyone deserves to live a healthier, more relaxing life in harmony with each other. Products and services offered: <ul style="list-style-type: none"> Renting tables (4) for table tennis. Individual and group training. Wellness area. Therapeutic massage. <p>Market Analysis</p> <ul style="list-style-type: none"> New domain in Timișoara, growing with sponsorship opportunities and diversification of services offered. Significant trends in the coming years with the opening of new sports halls that could threaten the business. <p>Customer Analysis</p> <ul style="list-style-type: none"> Target market size: 500 adults in the southern area of Timișoara. Age range: 30-69 years. Net monthly income over 5000 LEI. <p>Competition Analysis</p> <ul style="list-style-type: none"> SC ROCKETSPIR SRL. The only modern table tennis hall in the western part of Romania. Covers the northern area of Timișoara. High quality rented products. Lack of additional services besides table tennis table rentals. <p>Team and Management</p> <ul style="list-style-type: none"> Company Administrator. Table Tennis Coach. Professional Qualified Masseuse. Receptionist/Saleswoman. 	<p>Marketing and Sales</p> <ul style="list-style-type: none"> Services will be sold through a newly arranged location in the southern area of Timișoara (Giroc), a rented and completely renovated 400m² space. Promotion of services online (website), socially (local tournaments), and in the business environment (contracts with multinational companies in the city). Access to services via a dedicated mobile application for each client. Customer loyalty through attractive weekly promotions, subscription discounts, and wellness area access discounts. <p>Financials</p> <ul style="list-style-type: none"> Initial Capital. Total Investment (renovation and equipment of the hall): 520,000 LEI / 104,000 EUR Monthly Operating Expenses: 41,850 LEI / 8,370 EUR Monthly Revenues (hall utilization rate): 153,000 LEI / 30,600 EUR Business Profitability (50% rentals/day): 93.431% Investment Recovery Term: 1.02 years <p>Funding Request</p> <ul style="list-style-type: none"> Borrowed Capital: 250,000 LEI / 50,000 EUR Own Capital: 270,000 LEI / 54,000 EUR Bank Loan / Investor (5 years): Transylvania Bank APR / Monthly Rate: 11.72% / 1000 EUR / Mo <p>Business Lifetime</p> <ul style="list-style-type: none"> Business Operation Duration: 30 years

Fig. 1. Summary of customized business plan.

The questions are as follows:

- Can you provide me with the demographic data, main interests, and preference of the business ideal customer?
- Can you give me the main information sources that the ideal customer may have access to before purchasing?
- How was the customer before buying the services and he did not like?
- How was the customer after buying the services and he started to love?
- What was the emotional state of the customer before purchase?
- What was the emotional state of the customer after the purchase?
- What was the customer's self-perception before the purchase?
- What was the customer's self-perception after the purchase?
- What were the customer fears and frustrations before buying the services?
- What desires and aspirations the customer could have after he bought the services?

6. Analyze AI Responses:

Gather and analyze the AI's responses to the following questions.

Question 1: Can you provide me with the demographic data, main interests, and preference of the business ideal customer?

AI-Answer 1:

Demographic Data:

- Age: 30-69 years.
- Location: Southern area of Timișoara.
- Income: Over 1000 EUR netto monthly.

Interests and Preferences:

- Recreational and sports activities: as individuals seeking a more active and healthier lifestyle, these clients are likely interested in sports activities such as table tennis and other wellness activities.
- Relaxation and well-being improvement: interest in wellness services and therapeutic massage indicates that these clients are looking for ways to relax and improve their mental and physical health.
- Socialization and participation in local events: participation in local tournaments or other sports events can be an attractive aspect for these clients, especially if they are involved in the local community.
- Personal skills improvement: clients may be interested in individual and group training to improve their table tennis skills or to stay fit.
- Comfort and accessibility: with an above-average income, these clients might also be interested in aspects such as comfort and accessibility, seeking quality services and convenient facilities.

Question 2: Can you give me the main information sources that the ideal customer may have access to before purchasing?

AI-Answer 2:

- Online research: the customer might have searched for information about locations in their area that offer table tennis table rental services. This could include visiting the websites of various sports facilities or reading reviews and ratings from other customers.

- Participation in local events: the customer might have participated in local table tennis tournaments or sports events where they had the opportunity to try the sport and learn more about it.
- Recommendations and references: the customer could have received recommendations from friends, family, or colleagues who have previously used table tennis table rental services and were satisfied with their experience.
- Interaction with staff: the customer might have interacted with the staff or managers of sports facilities to get additional information about the availability of table tennis tables and the services offered.

Question 3: How was the customer before buying the services and he did not like?

AI-Answer 3:

- Previous negative experiences: if customers have had negative experiences in the past with other similar businesses or services, they might be skeptical or hesitant before trying again.
- Lack of information or transparency: if information about the service, prices, or conditions was not clear or accessible before purchase, customers could have been disappointed by the lack of transparency.
- Quality of previous services: if they tried the service in the past and were dissatisfied with the quality or experience provided, they might be reluctant to try again.
- Negative feedback from other customers: if they have read or heard negative feedback from other customers about your service, this could be a barrier before purchasing.
- Perception of price: if customers felt that the price of the service did not reflect the value or quality offered, they might be discouraged from buying.
- Difficulties in communication or interaction with staff: if interacting with staff was difficult or unpleasant before purchasing, customers might be discouraged from continuing.

Question 4: How was the customer after buying the services and he started to love?

AI-Answer 4:

- Satisfying gaming experience: if the customer found the equipment and playing conditions to meet their expectations, they could have had a pleasant and enjoyable gaming experience.
- Adequate conditions and facilities: if the location offers a pleasant and comfortable environment for playing, as well as additional facilities such as locker rooms, showers, or relaxation areas, the customer might appreciate these aspects.

- Friendly services and staff: a team of professional, friendly, and well-trained staff can make a difference in the overall customer experience. If they received prompt and efficient service and interacted with kind and responsive personnel, this could have contributed to a positive experience.
- Value for money: if the customer felt that they received value for their money and that the services provided were in line with the price paid, they might have been satisfied with their experience and inclined to return or recommend the business to others.
- Additional benefits: if they benefited from promotions, discounts, or other special offers, as well as access to additional facilities such as a wellness area or therapeutic massage, the customer might have considered these aspects as adding value to their table tennis rental service.

Question 5: What was the emotional state of the customer before purchase?

Answer 5:

- Curiosity and interest: the customer might have felt curiosity and interest regarding the gaming experience and facilities offered by the business before making a reservation.
- Anticipation: looking forward to a new and fun experience, the customer could have felt pleasant anticipation about the possibility of playing table tennis and spending time in a specialized sports hall.
- Concern: in some cases, the customer might have been worried about aspects such as equipment availability, quality of facilities, or the overall gaming experience. This could have generated some anxiety or unease before deciding to rent a table tennis table.
- Enthusiasm: a customer enthusiastic and passionate about sports could have felt a high level of excitement and eagerness regarding the opportunity to play table tennis in a dedicated and professional environment.
- Indecision: for some customers, the decision-making process could have generated feelings of indecision or uncertainty regarding choosing the most suitable table tennis rental option or the facilities offered by the business.

Question 6: What was the emotional state of the customer after the purchase?

Answer 6:

- Satisfaction: if the gaming experience and facilities offered by the business met or even exceeded expectations, the customer might feel a strong sense of satisfaction. This could be generated by aspects such as the quality of equipment, the atmosphere in the sports hall, or the level of professionalism of the staff.
- Enthusiasm: if the customer had a pleasant and fun experience during the table tennis

game, they might be excited and delighted by the possibility of returning in the future to use the business's services again.

- Gratitude: if the customer received assistance or advice from the staff regarding equipment use or game proceedings, they might feel gratitude and appreciation for the services offered by the business.
- Relaxation: for some customers, the gaming experience could generate a state of relaxation and unwinding, providing them with a pleasant break from daily stress and an opportunity to spend their free time in an active and enjoyable way.
- Frustration or disappointment: if the gaming experience did not meet expectations or there were issues related to equipment or facilities, the customer might feel frustration or disappointment. This could be generated by aspects such as delays in reservations, faulty equipment, or lack of attention from the staff.

Question 7: What was the customer's self-perception before the purchase?

AI-Answer 7:

- Motivation and interest: the customer might have a variety of reasons for using the service, including the desire to spend their free time in an active and fun way, to socialize with friends or family, to practice and improve their sports skills, or to participate in competitions and events.
- Confidence level in abilities: for some customers, their level of confidence in their sports abilities and their capacity to perform in table tennis might influence how they perceive themselves before purchasing the service. Those with previous experience in this sport and confidence in their abilities might have a more positive self-perception compared to those who are less familiar or confident in this area.
- Expectations and anticipations: customers' self-perception might also be influenced by their expectations related to the gaming experience and what they hope to gain from using the service. Those who expect to have fun, relax, or improve their skills might have a more positive self-perception before purchasing, while those who feel unsure or anxious about the game might have a less optimistic perception.

Question 8: What was the customer's self-perception after the purchase?

AI-Answer 8:

- Achievement and satisfaction: the customer who feels satisfied with their experience with the service and who has been successful in the table tennis game might have an increased perception of their own abilities and achievements. Achieving personal goals or performing well during the game could

reinforce self-confidence and a sense of satisfaction.

- Competence and confidence: participating in table tennis and improving skills in this area could contribute to increasing the customer's level of confidence and feeling of competence. Success in a sport or physical activity can strengthen self-esteem and a sense of self-efficacy.
- Socialization and connection: for many customers, participating in social activities and interacting with other participants during the table tennis game could reinforce a sense of belonging and social connection. These positive interactions can influence customers' self-perception and their social relationships.
- Enjoyment and relaxation: a pleasant and relaxing experience during the table tennis game could contribute to improving the customer's well-being and overall self-perception. Engaging in recreational and fun activities can provide a break from daily stress and concerns, reinforcing a positive self-perception.

Question 9: What were the customer fears and frustrations before buying the services?

AI-Answer 9:

Fears:

- Poor performance during the game: some customers might fear they won't be able to handle or enjoy table tennis, especially if they lack prior experience in the sport.
- Feeling of incompetence: people unfamiliar with table tennis might fear appearing incompetent or making mistakes in front of more experienced players.
- Lack of pleasure or satisfaction: some customers may fear not having fun or enjoying the gaming experience while renting the table tennis table.

Frustrations:

- Negative experience during the game: customers could be frustrated by their performance during the game or by the difficulty in learning the techniques and strategies needed to play table tennis.
- Inadequate playing conditions: if the equipment or facilities provided for rental are not in good condition or suitable for table tennis, customers may be frustrated by the service quality.
- Negative interaction with other players: customers may be frustrated by the behavior or attitude of other players during the game, such as lack of fair play or excessive competitiveness.

Question 10: What could be the customer's desires and aspirations after they bought the services?

Answer 10:

- Improving table tennis skills: many customers aspire to become better at this sport and

enhance their playing abilities from one session to another.

- Experiencing fun and joy: the desire to have fun and relax during table tennis games can be a common aspiration for many customers.
- Having a positive experience: customers may aspire to have a pleasant and memorable experience while renting the table tennis table, including enjoyable interactions with other players and facility staff.
- Building community and social relationships: some customers may aspire to meet or spend time with others who share the same passion for table tennis, thereby contributing to community building or social relationships.
- Positive physical and mental outcomes: some customers may aspire to achieve positive physical and mental benefits from playing table tennis, such as improving physical fitness, reducing stress, and boosting self-esteem.

III. RESEARCH RESULTS

The study focused on leveraging Artificial Intelligence (AI) to develop effective marketing strategies and construct an ideal customer profile tailored to a personalized business plan for "Gym with Wellness Area". Key findings and recommendations include the following ideas:

- **Market segmentation**: The study utilized detailed demographic data and insights into ideal customer preferences to effectively segment the market. This approach significantly enhanced the precision of targeting strategies, resulting in the delivery of more relevant marketing messages and increased effectiveness of marketing campaigns.
- **Relevant interests and needs**: Analysis identified that ideal customers prioritize an active and healthy lifestyle, alongside a strong demand for relaxation and wellness services. This understanding guided the customization of services and the creation of targeted marketing content designed to resonate effectively with the intended audience.
- **Useful feedback**: Identifying aspects that were less favorable to ideal customers before purchasing services provided actionable insights. Addressing these concerns presents opportunities for process improvement and enhancing overall customer satisfaction. This proactive approach is crucial for refining service delivery and strengthening customer relationships.
- **Customer loyalty growth**: Addressing negative experiences and improving service quality based on customer feedback can significantly enhance customer loyalty. This proactive approach transforms dissatisfied customers into loyal advocates who not only continue to patronize the

business but also contribute positively to its growth and reputation. This cycle of feedback-driven improvement is essential for cultivating strong, long-term customer relationships.

- **Innovation opportunities**: Insights gathered have identified significant opportunities for business innovation, particularly in the expansion of wellness and relaxation service offerings. This strategic initiative aims to align with evolving customer preferences and to strengthen the business's competitive advantage in the marketplace. By leveraging these insights, businesses can position themselves as leaders in meeting the dynamic needs of their target audience while driving growth and differentiation.

Overall, the integration of AI in crafting the ideal customer profile and refining marketing strategies for "Gym with Wellness Area" demonstrates significant potential for enhancing customer engagement, satisfaction, and business performance.

IV. CONCLUSIONS AND FINAL REMARKS

If we look at the challenges of using AI solutions in entrepreneurial management, they may appear such as data privacy concerns, integration issues, and the need for specialized skills. Regarding future directions I can strongly outline the extremely high potential of further developments using AI-driven applications for ideal customer profiling and further usage within the complete spectrum of entrepreneurial management. As a final remark we could state that such a data collection method has provided a solid foundation for creating the ideal customer profile for the business - Gym with Wellness Area. Using this information to develop marketing strategies and improve customer experience can significantly contribute to the success of the studied business as well as any other business using this approach.

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Enhancing Viscosity Quality Testing Accuracy in the Automotive Industry

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Abstract – The present study aims to examine an issue pertaining to the precision of viscosity measurements crucial to the rubber processing industry within the Western side of Romania, where viscosity is being tested using the PREMIER™ MDR MOVING DIE RHEOMETER by Alpha Technologies. Control charts have raised the alarm regarding the consistency of the analysis results, and therefore a root cause analysis has brought to light a mechanical issue of the rheometer for which a solution has been proposed and implemented. Ultimately, the study shows the enhancement of the viscosity quality testing from the initial state identified until the actual situation, after action was implemented and proven to be efficient.

Keywords: Viscosity, Quality testing, Rubber processing, Rheometer, Control chart, Root cause analysis

I. INTRODUCTION

Rubber materials are increasingly widespread in the automotive engineering applications today, playing an indispensable role in various mechanical components such as tires, seals, and hoses (Nafeesa, Azura, 2018). The selection of suitable rubber types is paramount, as they primarily contribute to the elastic properties of the final rubber products. Therefore, two major categories of rubber are used within the industry: natural and synthetic. Natural rubber originates from the milky sap of the Hevea tree, containing a mixture of organic and inorganic impurities (Maláč, 2009). Synthetic rubbers however, they have enhanced properties and are easier to obtain.

Another publication highlights the same information but focusing on tire production. The composition of the tread compound, which directly impacts tire performance, typically comprises natural and synthetic rubbers. Extensive scientific research has been conducted on liquid rubbers (synthetic) as they offer advantages such as reducing the need for

process oils in tire manufacturing and enhancing dispersion (Demir, Altundal, Gerengi, Yüksel, 2023).

In a similar approach, other researchers have emphasized the impact of viscosity on silica dispersion and its correlation with the mechanical and performance characteristics of Natural Rubber compounds. Compound viscosity was measured using a viscometer, while filler flocculation and dispersion were monitored through changes in torque and storage modulus at low strain using a rheometer MDR 2000 and DisperGrader (Kamal, Teku, Ahmad, 2013).

Another similar research available is analyzing the viscoelastic characteristics of rubber compounds containing natural rubber and reinforced with carbon black, commonly employed in rubber bearings, are analyzed using various methods. These include the moving die rheometer, compression set tests, and assessments of mechanical properties through cyclic uniaxial compression and shear tests, as well as tensile tests. Additionally, transient tests such as stress relaxation and creep tests are conducted at ambient temperature. The experimental findings from these laboratory examinations on standardized specimens are assessed, can be correlated with the damping properties, and time-dependent mechanical characteristics of rubber compounds utilized in laminated rubber bearings. (Sánchez, Giraldo-Vásquez, Sánchez, 2020). Viscosity testing stands as one of the prevailing procedures executed within the rubber industry today. It serves as a standard method for assessing the viscosity of raw rubbers and characterizing the quality of both natural and synthetic rubber varieties (Maláč, 2009).

Other researchers have addressed the topic of Mooney viscometer testing, as it is probably the most widely used method for measuring the quality of the natural rubber such as Maláč (2009). Various statistical quality control methods can be effectively employed across different applications within the rubber industry, including the viscosity testing control. Statistical quality control, a component of quality control, utilizes statistical techniques for this purpose (Gunaratne, Wijesooriya, Gunaratne, 2005). Within this paper, the use of control charts will be

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presented to show the accuracy of viscosity testing. However, “the decisions made as a result of the analytics process are only as good as the data on which they are based” says an article (Jones-Farmer, Ezell, Hazen, 2014).

II. PREMIER™ MDR VISCOSITY TESTING PROCESS FOR QUALITY CONTROL

Within this study, the quality output of the viscosity testing has been observed at a rubber processing company from the Western part of Romania, where viscosity is being testing using the PREMIER™ MDR MOVING DIE RHEOMETER by Alpha Technologies, firstly introduced in 1989, which boasts an impressive array of features tailored to the company's needs, its user interface includes a touchscreen for settings management and Online Manager for data analysis. The device design incorporates an LED light in the printed logo to indicate the test status (Dick, 2021). In this test, a serrated rotor is rotated within a rubber specimen enclosed within a sealed, pressurized chamber, as depicted in Fig. 1 (Maláč, 2009).

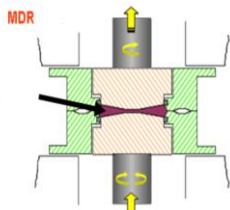


Fig. 1. Viscosity testing principle

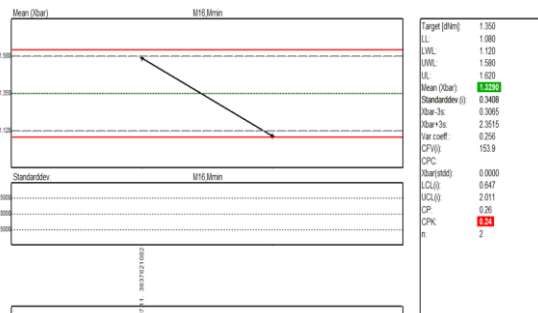


Fig. 2. Example of control chart data for two samples of the same batch analyzed one after the other

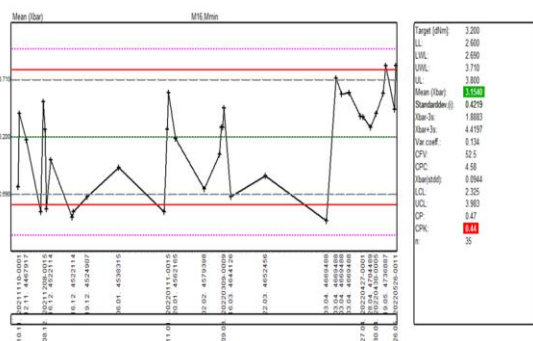


Fig. 3. Example of control chart data for viscosity testing (“x” material)

To obtain and store the results obtained with the help of the rheometer, an Online Manager program is installed on the server and on the computers of those responsible for this process (the operators who test and the engineers who interpret the data), which makes possible the communication between the production equipment and the server that transmits the data to the equipment Testing. This program displays the type of mixture tested, the number of the test, the pallet of which the tested sample is a part, the name of the test, the result of the test, the date and time of the test, as well as the specification based on which the test is performed.

Furthermore, it converts and sends the results to another interface, Quality Data Analysis, for easier statistical analysis, this software being able to automatically generate a series of analyzes such as: Pareto graphs, Gaussian curve, and point cloud graph statistics. It makes it easier to interpret the results by automatically calculating the standard deviation between successive tests of a production batch.

III. PROBLEM DESCRIPTION

The Quality Data Analysis program has been programmed to directly put the data obtained from testing into a control sheet format. This made it easier to observe a discrepancy between two tested samples of the same lot (sample). Thus, one sample was within tolerance, while the other was well outside the lower or upper limit, as seen in Fig. 2.

The example above depicts what the limits for this measurement are: Lower Limit (LL) - 1.080 and Upper Limit (UL) - 1.620. The first sample tested has a value of 1.5700, which is close to the upper limit, while the second sample tested from the same batch of material has a much lower value of 1.0880, even exceeding the lower limit. Being a cleverly designed program (Quality Data Analysis), it already gave all the data needed for analysis, so it becomes readily apparent that this process lacks stability (CPK = 0.24).

When the values on the control sheet are outside the control limits, it means that there are some special causes of variation that have intervened in the process. This means an investigation must be started to determine the cause or causes. On the other hand, random variation between control limits means that certain common causes are present. Within this paper, the investigation will focus on the cause or causes that determine results outside the accepted tolerances.

Over the weeks numerous cases were identified, which involved extra work for the operators, through the retesting process. In Fig. 3 and 4 it is shown the tests done over a period of 2 months, on two different types of material (different recipes used), made by different operators, on random days. With this data available, next steps is evaluating the possible (special) causes that could lead to such variations in the process, using specific quality management methods.

IV. ROOT CAUSE ANALYSIS

1. SIPOC Diagram

The first step in this analysis is the SIPOC (supplier-input-process-output-client) diagram from Table 1, to have a clear picture of the process preceding and immediately following the process of viscosity testing in the rubber processing company chosen for this analysis.

In the previous chapter we identified a problem: the instability of the viscosity testing process obtained with the MDR tester. At this point, absolutely all hypothesis that can lead to this problem should be considered and analyzed. Thus, with the help of the Ishikawa diagram below we can draw a series of conclusions, as seen in Fig. 5.

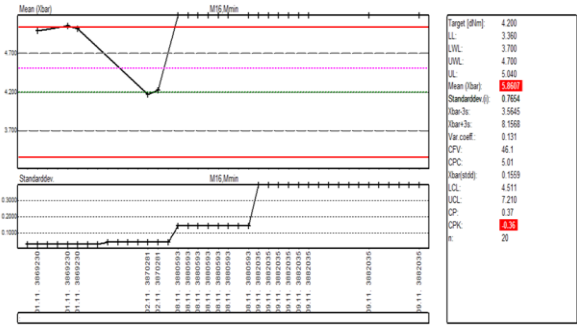


Fig. 4. Example of control chart data for viscosity testing (“y” material)

Table 1 Ishikawa Diagram

Supplier	Input	Process	Output	Client
Resinex	Natural rubber	Viscosity testing	Rubber Mix	Production
Caron Onex	Synthetic rubber		Quality issues	Laboratory
ET10	Carbon black		Production stoppage	Maintenance technicians
Lubexp	Oil		Machine breakdown	Maintenance engineer
ECHA	Chemicals		Quality issues reporting	Quality engineer
EUROPAG ES	Reinforcement and textiles		Scrap	Process engineer

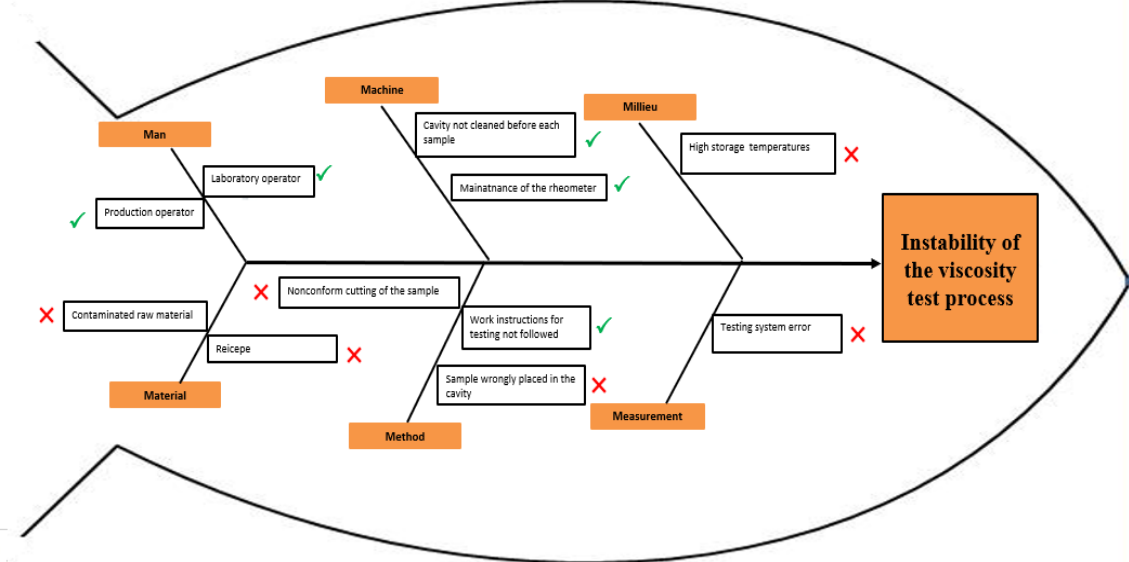


Fig. 5. Ishikawa Diagram for instability of viscosity test process.

2. Hypothesis validation

All the possible hypothesis from the Ishikawa diagram have been verified to prove or not their contribution to the problem identified. The ones who could be verified or proven are listed below.

In terms of Man, the laboratory operator was considered because he is the one testing the viscosity of the sample, which means that human error can make its presence felt. He may contaminate the sample before introducing it into the rheometer cavity, which would explain such large deviations. Since other types of materials (chemicals, oils, carbon black, etc.) are tested in the laboratory, the operator may have a contaminated glove from a previous test. Production operator brings the testing sample to the laboratory and can contaminate during the transport.

Regarding the Material, one reason why the final viscosity has unstable values, may come from the fact that the raw material used is non-compliant. To verify this hypothesis, tests done on the material used in the composition of the mixture were verified, and it has a stable trend, so this hypothesis was canceled by the evidence of the tests. In the first phase, there was also the possibility that the recipes for certain mixtures are not well dosed, and this could be the reason for the instability of the viscosity. However, over time, these deviations and instability were felt for all mixtures, which ruled out this hypothesis.

Within the Machine cluster, rheometer cavity not cleaned after the last test is a possible root cause. It is very important that after testing the sample, once the cavity is opened, the previously tested sample is completely removed and thrown into the sample bin. If there are any remnants from the previous test, they will affect the result of the next test. This hypothesis was validated, as the operators admitted that they do not always have enough time to clean the cavity. Also, preventive maintenance for the MDR rheometer is done once every two weeks or every 300 measurements, by replacing the standard gaskets (S0402 and S0403), but the hypothesis is validated as measurements tend to be more accurate right after maintenance activities.

In terms of method, improper cutting of the sample has been analyzed. Cutting of the sample is done with a special knife, which could not be compliant: either they do not cut well, or they are not cleaned after each sampling, etc. However, by checking their condition, it was found that they are not degraded at all, and at the time of the check they were being cleaned before the next sampling. What was also considered within this cluster is that testing is not in accordance with work instructions. There is a possibility that the test parameters can be influenced by the operator by changing the settings for example, or by mistakes like overlapping two samples (as they

are sticky). Also, for the test to be accurate, the sample must be placed firmly on the mold. If the sample is placed incorrectly, there is a possibility that the test will not be relevant, or that pieces of the sample will fall inside the apparatus, which could lead to additional damage.

In terms of Milieu the hypothesis that there are high temperatures in the storage area, but it was not confirmed as there is centralized climatic control for the temperature and the records show no issue here. Lastly, for the Measurement it was considered the hypothesis that the problem comes from an error in reading the data emitted by the test system. IT engineers have checked this track, but there is no loss of communication between the machine and the servers.

3. "5 whys" questionnaire

Following questionnaire "5 Why" presented in Table 2, multiple conclusions regarding the root cause of the problem are brought to light. Firstly, the sample may be contaminated by the production operator due to the gloves he wears and uses for all actions he undertakes. The reason is that he only gets a pair of gloves, which means they are used for everything the same. This cause may have a contribution of up to 10% in producing the deviation. Then, the sample may also be contaminated by the laboratory operator, who uses the same gloves to perform several tests, although special gloves are used for this test. This comes down directly to the level of responsibility of the operator, as it cannot be continuously verified, and this cause can contribute 10%. What is more the cavity not cleaned after each test can have a small influence, of 10%, on the testing process, and the reason why cleaning is not performed is the large volume of samples for testing, which can make the operator skip certain steps.

Non-compliant testing comes very close to the previous reason, because with a large workload and limited time for each action, some checks are done more superficially, which can lead to nonconformities such as two glued samples. This cause has a weight of 10% and like the previous one, it is difficult to intervene on the operation. There are human mistakes, and the only solution that has this risk is automation.

However, the main cause identified is the need for the maintenance rheometer, having a weight of 60%. Following the analysis of the data available, it was obvious that after the maintenance day, which takes place every two weeks, on a Wednesday, the process is stable, and the test data are in the parameters (there are no tests with values much above the lower or upper limit), but the effect is short-lived, because after just a few days, variations begin to appear.

Table 2 Develop the “5 whys” questionnaire

Causes	Sample contamination by production operator	Sample contaminated by laboratory operator
Why? (1)	Because the operator takes the sample with dirty gloves	Because he uses gloves for protection
Why? (2)	Because he uses gloves for other machine cleaning operations	Because the operator tests other sub-stances
Why? (3)	Because it uses only one set of gloves for all operations	Because gloves can contaminate the sample
Why? (4)	Because it is more convenient not to change gloves every time, he takes samples	Because a special glove was not used
Why? (5)	Because this is a typical human mistake	Because this is a typical human mistake
Contribution	10%	10%
Corrective actions	Operators retraining related to taking samples of the final mixture, so as to use special gloves, not the standard ones offered daily	Retraining of the test operator related to sample handling prior to testing
Causes	Uncleaned cavity after last test	Rheometer maintenance
Why? (1)	Because the operator does not clean it after the test	Because the maintenance plan needs changes
Why? (2)	Because it has a lot of samples to test	Because the process is stable after maintenance of the device
Why? (3)	Because the production volume is large	Because the appliance needs gasket replacement
Why? (4)	Because staff and production capacity are reduced compared to demand	Because the standard gaskets used are not suitable for such frequent testing
Why? (5)		Because the model was purchased with such gaskets
Contribution	10%	60%
Corrective actions	Opening a new position for laboratory operator so that all tests can be done in a timely manner	Optimizing rheometer maintenance by replacing standard gaskets

V. SOLUTION AND RESULTS

As shown in Fig. 6 immediately after maintenance, under ideal and controlled conditions, the viscosity test results are stable. After 3-4 days, the situation gets out of control, and the results randomly exceed either the upper limit or the lower maximum allowed. From questionnaire 5 Why and from this analysis was generated a possible solution for establishing the viscosity testing process with the MDR rheometer, produced by Alpha Technologies. The solution identified is related to the maintenance policy of the device, because as seen above, a period of two weeks too long for maintenance, considering that more than 300 tests are done during this period. In the past, when the production volume and implicitly the test volume was not so high, the device worked very well with those standard gaskets changed every two weeks, because no more than 300 tests were done in that interval.

Therefore, the solution identified was to replace standard seals with smart seals, the latest innovation of Alpha Technologies. What's the difference between the two and how did they improve this piece?

The classic seal provides for a one-piece sealing plate provided with an upper polymer seal, as seen in Fig. 7 in the right corner.

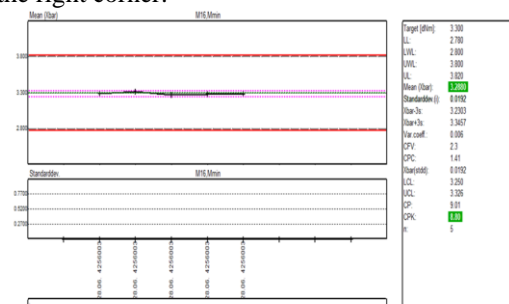


Fig. 6. Viscosity testing immediately after the maintenance day

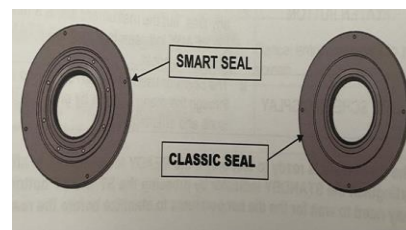


Fig. 7. The two types of seals: classic and smart

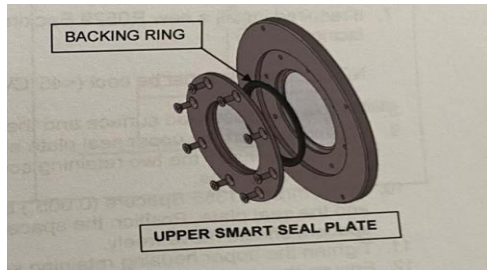


Fig. 8. Smart seal

The smart seal is an upper mold seal to eliminate conventional elastomeric sealing while maintaining a closed, pressurized cavity for improved long-term data stability and reduced the need for torque calibration. Thus, with the change of this seal, its maintenance will be done once a month.

In Fig. 9 and 10, the improvement in the stability of the viscosity testing process can be seen. The results from one sample to another are close in values, but most importantly, those errors no longer occur due to special events, values that exceeded either the upper limit or the lower limit of the maximum allowed. In the two figures below the improvement over a period of two months from the moment the standard seal was replaced to the smart one, for two different materials. What is observed from the start is the disappearance of those erroneous results, which far exceeded the upper or lower permissible limit and clearly came from special causes. The process is now stable, which makes it much easier to detect real problems with the material, ensuring that if the value is far outside the limits, then investigations must be directed towards the material and its possible contamination. Moreover, the improvement is also reflected in operator's workload, who no longer must retest samples as frequently, and preventive maintenance is now done once a month, compared to once every two weeks, and all this is due to the smart gasket, which has a much higher sealing capacity.

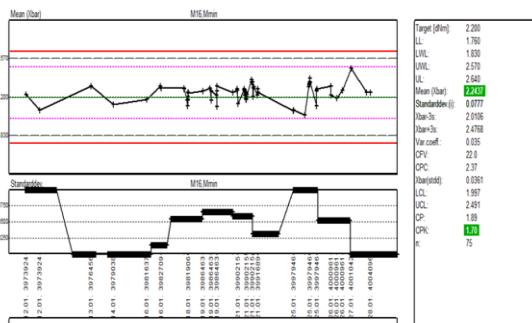


Fig. 9. Viscosity test results after improvement ("x material")

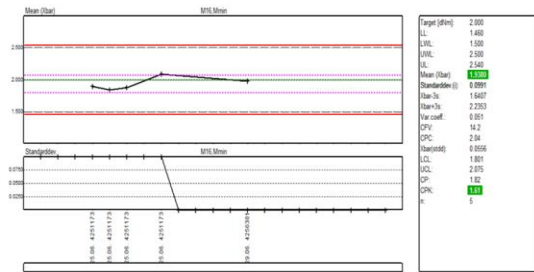


Fig. 10. Viscosity test results after improvement ("y" material)

CONCLUSIONS

Accuracy in viscosity testing is essential for all rubber processing industries. Tools such as Control Chart has proven to be highly efficient in their interpretations and as a trigger for a possible inconsistency. In the case presented, there was a mechanical issue which needed to be improved to obtain process stability in terms of viscosity testing.

Quality tools such as SIPOC, Ishikawa, 5 why have been used for the root cause analysis, successfully revealing the root cause of the problem identified. The reached output of this article is the enhancement of the viscosity quality testing for the rubber processing company from the Western side of Romania, used a case study.

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Critical Evaluation of Individualized Progressive Lens Functions through Value Analysis

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Abstract – This paper aims to analyse the functions of the individualized progressive lens, to improve them. The determination of the functions will be based on the value analysis, which aims to eliminate unnecessary costs, which do not influence the quality and utility of the product.

Keywords: Value analysis, individualized progressive lenses, vision, presbyopia.

I. INTRODUCTION

Along with the evolution of the optical industry, new products appeared on the market, which help glasses wearers to obtain good vision at all distances. One of these products is the progressive lens, considered a small wonder of the optical world. This lens meets the visual needs of presbyopes, helping them see clearly and comfortably at almost any distance [10].

The difference between multifocal, bifocal and progressive lenses is both aesthetic and technical. The bifocal lenses have visible lines, which separate the focus area. On the surface of the progressive lenses, no lines are present, and the visual progression is made without interruptions. Progressive lenses can be customized according to the customer's lifestyle, frame and facial anatomy [10].

Based on the value analysis carried out in this paper, the functions that require improvements will be identified, to obtain a product with higher performance compared to the existing products.

II. VALUE ANALYSIS CONCEPT

Value analysis as a problem-solving system is implemented using specific techniques, knowledge and a group of learned skills. This analysis method aims to efficiently identify unnecessary costs, which

do not influence the quality, utility, appearance, characteristics and life of the product [6].

Through this problem-solving system, the essential elements of the problems and the capabilities of the human brain work together to solve difficult problems. The competition for goods and services led to the emergence of the problem of ensuring the lowest possible costs of the two elements mentioned above. Thus, as a response to that request, the problem-solving system was developed, which includes specific techniques and methods by which to obtain what customers want at lower costs [6].

The identification and analysis of functions are the basic elements of value analysis. The key to success in business lies in understanding the customers perception of value, but also in identifying and prioritizing the functions of the products offered to users [7]. Therefore, by analysing the value, it is checked how the necessary function can be fulfilled in the shortest possible time, as well as with the lowest cost. This aspect marks the difference between the usual cost reduction methods and value analysis [5].

2.1. Function Analysis Principle

The main feature of value engineering is function analysis. The product functions are defined based on its constructive characteristics. Thus, the first step in determining the constructive solutions of the product consists in drawing up the function's nomenclature.

Functions analysis studies the following aspects:

- What are the necessary functions to fulfil the conditions of the beneficiaries;
- How to get better options, with lower cost, not considering the existing solutions;
- How the established functions can be performed with minimal expenses and how the products can be sold advantageously.

The starting hypothesis consists in the fact that for each function is necessary a minimum of costs and there are several possibilities to perform a function [1].

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The principle of double dimensioning of functions says that the functions of a product have two dimensions: the technical dimension expressed by a unit of measure; the economic dimension expressed by cost. Thus, the function cost is not related to a physical body, but to a certain characteristic of the product, which is measurable. The sum of the functions costs represents the total cost of the product. The principle of maximizing the ratio between use value and cost is stated as follows: maximum competitiveness is achieved when the product has the highest use value and the lowest exchange value, so it must be manufactured with low costs.

The functions costs, in most cases, are not proportional to their contribution to the general use value of the product. Thus, appears the need to establish an optimal ration between the product's functions and the necessary costs for their realization, to maximize it [1].

According to the principle of the systemic approach to the use value, the object of study is represented, first, by the product. Value analysis is only applied to utility values that meet social needs. Thus, parts of the product cannot constitute the object of study of this analysis, because the part exists as a utility only within the product, as its component element, individualized does not respond to a social need. However, there may be cases when, due to the complexity of the product, the value analysis should only be applied in stages. To comply with the principle, in the case of complex products, the analysis must start from identification of the functions of the system as a whole and then the parts and subassemblies must be grouped and studied as such. In this way, the functions of the product are realized [1].

III. FUNCTION ANALYSIS OF THE PROGRESSIVE LENS

To present the way of the analysis, the case study will be done on an individualized progressive lens. The customized varifocal lens is recommended for presbyopes, more precisely for people with distance, intermediate and near vision problems. Individualized progressive lenses bring the following benefits to wearers [2]:

- Peripherally positioned areas with reduced aberrations;
- Increasing the intermediate zone by up to 6 mm more than conventional progressive lenses;
- Comfortable view at all distances;
- Very wide visual fields;
- High clarity and detailed details;
- Very fast adaptation;
- Minimal subsequent adjustment.

In Fig. 1, the individualized progressive lens is represented, before mounting in the frame. To be used by the customer, the lens will be mounted in the frame, resulting the complete glasses, according to the image in Fig. 2.



Fig. 1. Individualized progressive lens [8]



Fig. 2. Progressive glasses [8]

In the following subchapter, the product will be presented from a technical and technological point of view.

3.1. Technical and Technological Characteristics of the Product

The technical specifications of the individualized progressive lenses are presented in the Table 1.

Table 1. Technical specifications of the varifocal lens

Technical specification	Description	Unit of measure
Lens type	Individualized progressive lens	-
Use	Correction of presbyopia	-
Length of progression	14-18	mm
Diameter	55/60 – 75/80	mm
Refraction index	1.5 – 1.78	n _e
Colour	White, coloured and photochromic	-
Treatments	Antireflection, hardening and hydrophobic	-



Fig 3. Component elements of the individualized varifocal lens [9]

In Fig 3, the components of the individualized progressive lens are represented by markings ((1) Reference area for distance vision, (2) Alignment reference marking, (3) Reference area for near vision, (4) Prism reference point, (5) Fitting point)

To obtain progressive lenses, it is necessary to go through the following stages of the technological process:

- Lens calculation based on the customer's dioptries;
- Protecting the convex part of the lens by automatically applying a protective film;
- Application of the manipulation pill by alloy fusion on the concave surface of the lens;
- Milling is done to obtain the desired concave radius;
- The polishing is done by the action of several rotating instruments with different surfaces, giving the necessary clarity to the lens;
- The micro-engravings are made with the help of the laser, thus applying the markings for assembly;
- Removal of the handling pill in two ways: by mechanical shock, for organic glass lenses or by melting, for mineral glass lenses;
- The intermediate quality control is carried out at the level of the diopters of the lenses;
- Washing the lenses in several waters, using automatic brushes;
- Automated intermediate control;
- Applying the hardening treatment is done by washing the lenses in hard washes, which does not conduct electricity;
- Then, the lenses are placed in the oven at a temperature of 80 degrees, for 40 minutes, to remove the water molecules remaining on the lens;
- Once taken out of the oven, the lenses are introduced into the hardening installation, where the following three processes are carried out: washing, baking and deposition of hardening treatment;
- The application of the anti-reflective treatment is carried out by going through the following stages: baking for 30 minutes; preparation and introduction of the sarge in the anti-reflection installation;
- Filling the micro-engraved markings with yellow ink.

The last phase of the technological process consists in carrying out the final quality control, packaging and labelling of the product. [3] [4]

3.2. Function Nomenclature. The Importance Level of the Functions

Based on the information obtained from the lens manufacturing company, in the Table 2 are presented the product functions and their level of importance.

Table 2. Individualized progressive lens functions nomenclature

Function symbol	Function description	Importance level	Importance level weight
F1	Ensures vision at all distances	9	0.164
F2	Provides protection against blue light	6	0.109
F3	Scratch resistance	5	0.090
F4	Resistance to temperature changes	4	0.073
F5	Rejects traces of dirt and grease	3	0.056
F6	Repels water	2	0.036
F7	Repels dust	1	0.018
F8	Allows mounting in all frame models	8	0.145
F9	Ensure the correctness of the assembly	10	0.182
F10	Determines the thickness and resistance of the lens	7	0.127
Total		55	1.00

Table 3. The elements that make up the total cost of a progressive lens

Cost elements	Quantity	Total cost/component (Lei)
Semi-finished HEP materials	1	100
Optimization according to the shape of the frame	1	25
Treatments	1	16.4
Special processing	1	25
Colouring	1	50
Other direct or indirect costs	1	50
Total		266.4

The functions of the progressive lens were determined based on the varifocal lens components presented in subchapter 3. 1. Table 3 shows the elements that make up the manufacturing cost of the individualized progressive lens.

Analysing the product from a technical, technological and economic point of view, the ideal and real costs of the functions were calculated and presented in the Table 4.

Table 4. The ideal and real costs of the functions

Function symbol	Ideal function costs (Lei)	Ideal function costs weight	Real function costs (Lei)	Real function costs weight
F1	43.69	0.164	50	0.188
F2	29.04	0.109	25.78	0.097
F3	23.98	0.090	26.288	0.099
F4	19.45	0.073	15.468	0.058
F5	14.92	0.056	15.288	0.057
F6	9.59	0.036	12.788	0.048
F7	4.80	0.018	7.788	0.029
F8	38.63	0.145	38	0.143
F9	48.48	0.182	42.5	0.160
F10	33.82	0.127	32.5	0.122
Total	266.40	1.00	266.40	1.00

Table 5. Information centralizer for critical analysis

F	I	C _{IF} weight	C _{RF} weight	Δ weight	Cost structure
F7	1	0.018	0.029	-0.011	Large
F6	2	0.036	0.048	-0.012	Large
F5	3	0.056	0.057	-0.001	Ideal
F4	4	0.073	0.058	0.015	Low
F3	5	0.090	0.099	-0.009	Optimal
F2	6	0.109	0.097	0.012	Optimal
F10	7	0.127	0.122	0.005	Optimal
F8	8	0.145	0.143	0.002	Ideal
F1	9	0.164	0.188	-0.024	Optimal
F9	10	0.182	0.160	0.022	Optimal

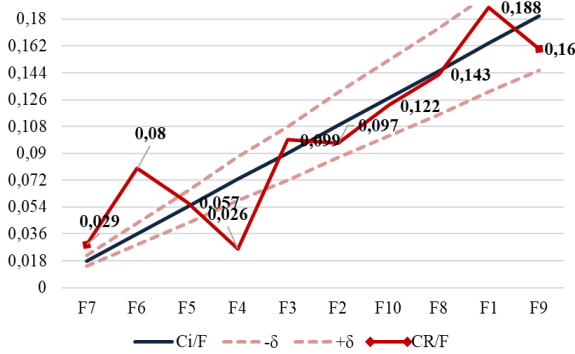


Fig 4. Correlation of importance and cost weights of individualized varifocal lens functions

Based on the information presented in table 4, the graph of the correlation of the weights is represented in the following figure.

Analysing the graph presented in Fig 4, the following oversized and undersized functions were identified:

- F5 and F8 functions present ideal cost structures;
- F1, F2, F3, F9 and F10 functions present optimal cost structures;
- F6 and F7 functions present large cost structure;
- Function F4 presents low-cost structures.

Using the information presented previously, in the following chapter, a critical analysis of the analysed product functions will be carried out.

IV. CRITICAL ANALYSIS OF INDIVIDUALIZED PROGRESSIVE LENS FUNCTIONS

To carry out the critical analysis, all the necessary information for this stage is centralized in Table 5.

Analysing the graph represented in figure 2 and the information contained in table 5, it can be observed that functions F6 and F7 are functions whose costs exceed the right of accepted deviations. They are made with high-cost structures, in relation to their weight in the value of use [2].

The F4 function has a low-cost structure. In this case, it is recommended to radically improve it, since it was below the required performance level.

Functions F5 and F8 present an ideal cost structure, which means that the usage value and the production cost are in a perfect state of proportionality.

The other functions, F1, F2, F3, F9 and F10, present optimal cost structures, which means that the costs are within the limits of accepted deviations. These are considered optimal because they bring useful value to the product; they are demanded by consumers and do not present significant disproportionalities between ideal and real costs.

V. CONCLUSIONS AND FINAL REMARKS

According to the information presented in the 3rd chapter, the functional analysis was carried out on a complex product, the individualised progressive lens. It offers the wearer of presbyopic glasses an increased comfort for seeing at all distances.

After performing the critical analysis, it could be observed that it is necessary to reduce the manufacturing costs of F6 and F7 functions. Therefore, it is necessary to establish an optimal ratio between the product functions and the necessary costs for their realization. Considering the components that participate in the materialization of these functions, it is necessary to reduce the costs related to the application of the hydrophobic and antistatic treatment. Due to the disproportionality present between the real and ideal costs of the F6 and F7 functions, the second directions of improvement consist in the implementation of new technical and/or technological solutions for depositing the two treatments with a lower consumption of resources.

Functions F1, F2, F3, F9 and F10 present optimal cost structures, but not ideal ones. To eliminate the existing small disproportionalities, it is necessary to improve these functions. Thus, an increase in product quality will be obtained, but there may also be possible increases in production costs. The proposed improvement solutions are the following:

- Function F1: replacing the existing semi-finished product with one of a higher quality;
- Function F2: improving the depositing technology of anti-reflective treatment to offer greater protection against blue light;
- Function F3: improving the hardening technology, to increase the scratch resistance of the lens;
- Function F9: replacing the existing marking application technology with a more efficient one;
- Function F10: the development of a lens with a new refractive index, so that at high diopters, the lens to be even thinner.

Considering the previously mentioned information, the possibility of modernization or redesign must be considered, by replacing components and technological processes to create the individualized progressive lens. Thus, can be taken into consideration the development of a more performant individualized varifocal lens, with a longer progression length so that it can also be worn by people who have problems with accommodation.

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Occupational Health and Safety Risk Assessment Using the MAXM Method

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Abstract – This study proposes a new calculation method for the evaluation of hazards for occupational safety and health called Multiple AXes Matrices – MAXM. The protection of workers from workplace threats that can cause unwanted events is a basic condition for guaranteeing these fair, safe and humane working conditions for employees. The purpose of this risk assessment activity is to determine the severity and likelihood of hazardous consequences (i.e., possible occupational accidents and diseases). Acute and chronic effects on worker safety and health must be considered.

Key words: Risk Assessment, Hazard, Occupational Health and Safety Risk, Severity, Probability, Occupational Accidents, Occupational Diseases, Multiple AXes Matrices – MAXM.

I. INTRODUCTION

Risk assessment can be defined as the process of assessing the risk to the health and safety of workers during work, arising from the circumstances of the occurrence of a hazard at the workplace.

Risk assessment is the overall process of (1) risk identification (the process of finding, recognizing, and describing risks), (2) risk analysis (the process of understanding the nature of risk and determining the level of risk), and (3) evaluating of risks (process of comparing the results of the risk analysis with the risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable).

Hazard is a source or situation with the potential to cause harm and health problems, i.e., a negative effect on a person's physical, mental or cognitive state.

Risk is the effect of uncertainty. Occupational health and safety risk: the combination of the probability of occurrence of a hazardous work-related

event or exposure and the severity of injury and ill health that may be caused by the event or exposure.

Work accidents and occupational diseases are dysfunctions of the work system, generated by the irregularities, qualities, intrinsic properties, etc., of its constituent elements.

Dysfunctions in the work system do not always lead to injury or changes in the health status of the performer (worker), but only in the situation where a causal chain is established, the last link of which is the meeting between the victim and the factors that harm him (risks of injury and occupational disease).

However, the analysis of the biunivocal relationship risk factor - prevention measure within the work system offers the possibility of a systematic approach to the issue of safety and health at work, respectively the etiology and prevention of work accidents and occupational diseases. Often a risk assessment will use a risk scoring system to assign a numerical value to each risk based on its severity and likelihood of occurrence. A risk assessment matrix consists of a two-dimensional grid with adverse effect categories on one axis and likelihood or probability categories on the other axis. Grid cells are used to indicate risk [1].

II. OCCUPATIONAL RISK ASSESSMENT – CONCEPTS, METHODS, APPROACHES, CLASSIFICATION, RISK CALCULATION AND ESTIMATION TECHNIQUES

Several risk assessment methods are available, ranging from expert methods to participatory methods, from simple methods to complex methods.

Risk assessment concepts

There are two possibilities for assessing the level of risk in a work environment:

a. post-accident / occupational disease evaluation ("a posteriori") - statistical analysis based on work accidents and occupational diseases;

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b. pre-accident/occupational disease assessment ("a priori") is based on risk analysis, before it becomes an accident or occupational disease [2];

Categories of methods in occupational health and safety risk assessment.

Risk assessment based on exposure [03], tasks (task-based risk assessment) [4], observations and inspections, there and accident analysis, literature and standards [7], consultation and involvement of workers [8], based on advanced technologies [6], [9].

Main approaches to risk assessment: inductive and deductive.

A. *The inductive method of risk assessment relies on observations and empirical data to draw general conclusions.*

The deductive method of risk assessment is based on logical and rational deductions. Several examples are given below: historical data analysis [10], incident analysis [11], cause and effect analysis (FMEA) [12], Delphi method [13], cluster analysis [14], decision tree method [15], incident history analysis [16], brainstorming method [17], case studies: [18], direct observations [19], future event analysis (AEA) [20],

Examples of deductive methods: scenario analysis [21], rule-based method [22], qualitative and quantitative analysis [23], hazard and operability analysis (HAZOP) [24], failure mode and effects analysis (AMDE) [25], risk assessment matrix (MER) [01], hazard analysis and critical control points (HACCP) [26], cost-effectiveness analysis method (ACE) [27], mathematical risk analysis [28], formal risk assessment method (FERA) [29], cost-benefit analysis (ACB) [30], criteria-based method [31].

Examples of combined (inductive and deductive) risk assessment methods are:

a. The risk analysis method based on event trees (Event Tree Analysis - ETA) [32]

b. Decision tree method (Decision Method) [33]

B. *Occupational risk assessment methods – Deterministic, probabilistic and mixed methods.*

Deterministic methods are based on the identification and assessment of risks based on existing experience, expertise and knowledge. Probabilistic methods, on the other hand, use mathematical and statistical models to estimate risk based on probabilities and frequencies.

The combined approach: integrating deterministic and probabilistic aspects

Classification of methods from the point of view of the results obtained.

The results obtained from occupational risk assessments are qualitative determinations (recommendations) or quantitative (risk level indices). The main difference between qualitative and quantitative risk analysis is the basis of risk assessment. Qualitative risk analysis is based on a person's perception or judgment, while quantitative risk analysis is based on verified and specific data.

III. RESEARCH METHODOLOGY

Theoretical definition of the risk assessment method

Through an integrated and continuous approach to risk, organizations can create a safe, healthy and sustainable work environment, contributing to the well-being of employees and the long-term success of the business. The use of data and information gained from experience and periodic adjustments in the occupational health and safety program reduce the probability / severity of the consequences of undesirable events.

This investigation proposes a new method called MAXM for determining the level of risk. MAXM is a pre-accident / occupational disease assessment ("a priori"), based on risk exposure, considering the combined risk approach, the results obtained from occupational risk assessments are qualitative (recommendations) or quantitative (risk level index).

The assessment (assessment = determination + analysis + estimation) of work processes and the identification of potential critical points are essential aspects for the development of an effective occupational health and safety risk assessment plan.

A. *Proposed stages for the evaluation*

The stages proposed for the evaluation method are:

- a. Identification of work processes:
 - listing all the work processes carried out in the organization;
- b. Identifying critical points:
 - identifying the stages or places within each process that present significant risks for safety and health at work, we will pay attention to activities with potential serious or frequent consequences;
- c. Risk analysis:
 - for each critical point identified, we will perform a risk analysis to determine the probability and potential impact of unwanted events;
 - using a risk assessment matrix to classify and prioritize risks according to their severity.
- d. Planning measures to eliminate or reduce the risk.
- e. Elaboration of organizational management recommendations for each risk identified and evaluated according to the type of response (strategy adopted) considered the most appropriate, the final decision in this regard belongs to the leader of the organization.
- f. Recording findings, monitoring and reviewing risk assessment and updating when necessary. (Risk monitoring)

The risk management and review report clearly consist of two parts in relation to:

- risks with a high and very high level of exposure, which can influence the achievement of the objectives specific to the organizational structure;
- the implementation stage of the preventive measures, at the reporting date.

B. Risk matrix for risk calculation

The Risk Assessment Matrix, also known as the Risk Matrix, is a tool used in risk management to assess and classify risks according to their probability and the impact they can have on the objectives of a project, organization or activity. This matrix is useful for prioritizing risks and guiding risk management efforts.

The risk assessment matrix is represented in the form of a table with two main axes:

- Probability (or frequency): This indicates how likely a particular risk event is to occur.
- Impact (or severity): This measures the extent of the negative consequences of a risk event should it materialize.

C. Likelihood and Impact Assessment

In this stage of the methodology several actions should be considered as following:

- Determine the probability: we estimate the probability of the occurrence of the risk on a scale from 1 to 5 (1 - unlikely, 5 - very likely).
- Determine the impact: we evaluate the impact of the risk if it materializes, on a scale from 1 to 5 (1 - low impact, 5 - major impact).

Depending on the assignment for probability and impact, each risk event is placed in one of the categories of the matrix. This generates five distinct zones:

1. Minimal risks: events of low probability and impact that may require only routine attention or light management.
2. Moderate risks: no action is required, but the hazard must be monitored (eg worker training);
3. Significant risks: actions are needed and small measures must be implemented in the medium term;
4. Major risks: actions are needed, but work can continue if at least organizational measures have been taken;
5. Critical risks: immediate action is required and the cessation of work until this severity and/or probability of risk is reduced by technical measures.

In data analysis, the use of evaluation matrices with different reporting axes (Multiple Axe's Matrices – MAXM) can be essential to obtain a detailed investigation of the performance of a model or method. This is important because different reporting axes can highlight different aspects of performance, providing a completer and more accurate picture.

For each danger / risk factor identified, the highest consequence of the possible possibilities is established depending on the exposure / frequency as shown in Fig 1.

The calculation formula for determining the risk value is:

$$R = (R1 + R2) * R3 \quad (1)$$

where **R** – total risk;

- **R1** – the risk determined using the matrix with the axes: severity / probability;
- **R2** – the risk determined using the matrix with the axes: R1 / time scale (represents the actual working time in the areas with maximum risk);
- **R3** – risk determined using the axis matrix: frequency of unwanted events / duration of exposure.

Characteristics of R1 - the risk determined using the matrix with the axes: severity / probability:

- Purpose: Provides an overview of the probability of an incident occurring and its severity;
- Axes: severity / probability as shown in Fig 2, Table 1, and Table 2.

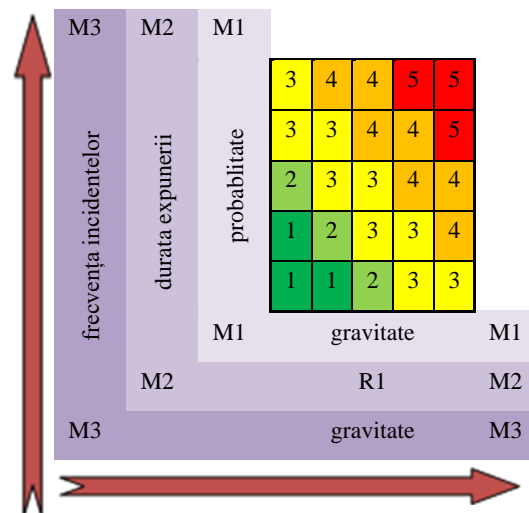


Fig 1 Establishing the maximum consequence depending on exposure and frequency

	negligible	minority	significantly	majority	severe
almost sure	3	4	4	5	5
probable	3	3	4	4	5
moderate	2	3	3	4	4
unlikely	1	2	3	3	4
rare	1	1	2	3	3

Fig 2. The risk determined according to the axis of probability and the axis of severity

Table 1 Probability

probability	1. Rare – unlikely to happen and/or have minor or negligible consequences;
	2. Unlikely – likely to happen and/or have moderate consequences;
	3. Moderate – likely to happen and/or have serious consequences;
	4. Likely – almost certain to happen and/or have major consequences;
	5. Almost certain – certain to happen and/or have major consequences.

Table 2 Severity

severity	1. Insignificant - will not cause serious injury or illness;
	2. Minor – may cause injury or illness, only to a slight extent;
	3. Significant – may cause injury or illness that may require medical attention, but limited treatment;
	4. Major – can cause irreversible damage or diseases that require constant medical care;
	5. Severe - can lead to death.

Duration of exposure		R 1	R 1	R 1	R 1	R 1
	almost sure	3	4	4	5	5
	probable	3	3	4	4	5
	moderate	2	3	3	4	4
	unlikely	1	2	3	3	4
rare	1	1	2	3	3	

The activities are performed in high-risk areas

Fig 3. The risk determined according to the duration of the exposure and R1

Table 3 Duration of exposure

Duration of exposure	1. 0 - 10 % of the daily work schedule
	2. 10 - 25 % of the daily work schedule
	3. 25 - 50 % of the daily work schedule
	4. 50 - 75 % of the daily work schedule
	5. 75-100% of the daily work schedule

Table 4 Activities performed in high-risk areas

Activities performed in high-risk areas	1. Initial risk value
	2. Initial risk value
	3. Initial risk value
	4. Initial risk value
	5. Initial risk value

Characteristics of **R2** – the risk determined using the matrix with the axes: R1 / time scale (represents the actual working time in the maximum risk area): Purpose: determining the activities to be performed in high-risk areas; Axes: R 1 / duration of exposure, as shown in Fig. 3, Table 3, and Table 4.

Characteristics of **R3** – risk determined using the axis matrix: frequency of previous incidents / severity: Purpose: determination of work tasks with a high risk of injury; Axes: frequency of previous incidents / severity as shown in Fig 4, Table 5, and Table 6.

Frequency of previous incidents		negligible	minority	significantly	majority	severe
	weekly	3	4	4	5	5
	monthly	3	3	4	4	5
	annual	2	3	3	4	4
	1-5 years	1	2	3	3	4
	over 5 years	1	1	2	3	3

Severity

Fig 4. The risk determined according to the previous incidents and their severity

Table 5 Frequency of previous incidents

frequency of previous incidents	1. over 5 years
	2. 1 - 5 years
	3. annually
	4. monthly
	5. weekly

Table 6 Severity

severity	1. Insignificant - will not cause serious injury or illness
	2. Minor – may cause injury or illness, only to a slight extent
	3. Significant – may cause injury or illness that may require medical attention but limited treatment
	4. Major - can cause irreversible damage or illness that requires constant medical care
	5. Severe - can lead to death

By properly evaluating and interpreting the risk assessment matrix, we can make informed decisions and implement effective strategies to manage and control risks appropriately, here is a guide on the numerical values and their representation as a result of the analysis:

- 1-10: Acceptable – no further action may be required and maintenance of control measures is encouraged;
- 11-30: Tolerable – should be reviewed in due time to realize improvement strategies;
- 31-50: Unacceptable – we must implement cessation of activities and immediate action.

Among the main advantages of the proposed MAXM methods, one can mention:

- Determining the level of exposure: exposure time provides a clear perspective to assess how long a worker is likely to be exposed to specific workplace hazards. This information is necessary to calculate the associated risk.
- Prioritization of prevention measures allows the organization to identify and prioritize prevention and protection measures according to the duration and frequency of risk exposure. Thus, resources can be allocated effectively to address the most critical aspects of occupational safety and health.
- Employee awareness: provides a basis for awareness and training of employees in relation to the specific risks to which they are exposed and the necessary precautions.

- Worker Involvement: Integrating exposure time into the risk assessment process can stimulate active worker involvement in identifying and managing workplace risks. This can help raise awareness and improve collaboration to promote a safe working environment.
- Flexibility in risk reduction strategies: knowledge of exposure time can facilitate the development and implementation of specific risk reduction strategies to lessen the impact on workers. This provides the organization with a useful tool for continuous adaptation to changes in the work environment.
- Addressing deficiencies in employee training: identifying high-risk periods can lead to improved training and education programs, focusing on critical aspects of occupational safety and health depending on the duration of exposure to risks.
- Efficiency in the allocation of resources: detailed knowledge of exposure time allows the organization to allocate resources efficiently, focusing on those aspects that have the greatest impact on safety and health at work.
- Measuring the effectiveness of preventive measures: the use of exposure time can also serve as an indicator of the effectiveness of implemented preventive measures. Monitoring this parameter over time can highlight possible improvements or necessary adjustments in risk management strategies.
- Individual level monitoring: the use of exposure time can allow for individual level monitoring of workers, identifying those who are at higher risk. This aspect can contribute to the implementation of personalized protection and training measures.
- Improving safety culture: focusing on exposure time can promote a safety culture in the organization, where employees become more aware of the impact of exposure to risk and take greater responsibility for adopting safe behaviors.
- Identifying trends over time: analyzing long-term exposure time can reveal trends and patterns that can be useful for identifying potential risks in the future and for developing proactive prevention strategies.
- Management of psychosocial factors: exposure time can contribute to the assessment of psychosocial factors, such as stress and fatigue, having a significant impact on the mental and physical health of workers. This aspect can be integrated into risk management strategies.
- Involvement of external collaborators: when the organization works with subcontractors or external partners, exposure time assessment can be useful in communicating and managing risks throughout the supply chain, ensuring an integrated approach to occupational safety and health.
- Stimulating innovation in workplace safety: using exposure time can stimulate innovation in the

development and implementation of new technologies or practices that reduce exposure time and improve workplace safety.

- Holistic approach to employee well-being: exposure time-based risk assessment can serve as a tool in a holistic approach to employee well-being, addressing both physical and psychological aspects of workplace health.

Several disadvantages were also identified from the outset:

- Sensitivity to the variability of work activities: certain activities may involve exposure to variable risks, depending on various conditions. Using exposure time alone may not account for this variation and may underestimate or overestimate the true risk.
- Difficulty of accurate estimation: accurate calculation of exposure time can be difficult, especially in situations where workers carry out multiple activities or in unstable working conditions.
- Neglecting other relevant factors: Focusing exclusively on exposure time may lead to the neglect of other critical factors, such as individual worker characteristics, equipment used or additional protective measures.
- Variability in data interpretation: different people or teams may interpret and quantify exposure time in different ways, which can lead to inconsistencies in risk assessment and the development of prevention measures.
- Costs associated with data collection: Collection and analysis of exposure time data can require significant resources, including monitoring devices, specialized software, and staff training, generating additional costs for the organization.

IV. DISCUSSION

"Risk" is the product of hazard and exposure. Therefore, risks can be reduced by controlling or eliminating hazards or by reducing worker exposure to hazards. Risk assessments help employers understand workplace hazards and prioritize hazards for ongoing control.

The frequency index of previous incidents has the greatest influence in the calculation formula because it specifically shows the real situation of safety and health within the organization because unwanted events (accidents and occupational diseases) show the degree of risk assumed, being interconnected with experience and the skills of the performer, the situation of the work environment, the size of the work load and the condition of the means of production.

- Calculating the frequency of previous incidents can serve as a basis for a better risk management. Assessing specific risks: By analyzing the frequency of past incidents in different areas or for different activities, organizations can identify the specific risks they face and prioritize prevention and protection measures accordingly.

- Setting improvement goals: If the frequency of incidents is high in certain areas or activities, organizations can set specific goals to reduce it and develop action plans to improve safety and prevent accidents.
- Monitoring progress by tracking the frequency of incidents over time, organizations can assess the effectiveness of the prevention and intervention measures taken. A reduction in the frequency of incidents over time may indicate improved workplace safety and the effectiveness of risk management programs.
- Compliance with regulations and standards: Calculating the frequency of past incidents can help organizations stay compliant with occupational health and safety regulations and standards. By identifying and mitigating the risks associated with past incidents, organizations can avoid penalties and fines for non-compliance with safety regulations.
- Improved safety culture: The frequency of previous incidents can serve as an indicator of the safety culture in the organization. A low frequency of incidents may reflect a strong commitment to occupational safety and health, while a high frequency may indicate a need to strengthen workplace safety awareness and involvement.

V. CONCLUSIONS AND FURTHER WORK

Calculating the frequency of past incidents is an essential tool in managing risk and promoting a safe and healthy work environment for all employees. By analyzing and using this data correctly, organizations can take concrete steps to reduce risks and protect the health and safety of employees.

The proposed method aims to be an applicable tool for identifying the main sources of risk and prioritizing the implementation of control measures.

The method serves as a basis for integrating the occupational health and health (OSH) management system with the requirements of European legislation and known methods used by expert occupational risk assessors. It can be modified and created by each specialized user based on the directions established by the MAXMR method, emphasizing the importance of organization management in OSH and the effects of the external environment that are not sufficiently addressed in current methods.

This work should be considered as the result of an initial implementation phase, and researchers and practitioners are invited to contribute to its further development. Further work aims to validate the proposed MAXM method via a series of case studies and comparison with existing methods.

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Significance of CAx Technologies in Industry 4.0: The Path from Education 4.0 to Industry 4.0 Through Lifelong Learning in Metal Processing Industry

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Abstract – The implementation of CAx in Industry 4.0 (I4.0) enhances product development, manufacturing processes, and maintenance activities by leveraging digital technologies, connectivity, and data analytics. These implementations enable increased automation, improved productivity, better decision-making, and enhanced product quality in the context of Industry 4.0. One of the goals of the Education 4.0 is to define plans and programs for retraining, continuous learning and training of students, engineers, etc., that is, the development of higher technical education during the implementation of CAx technologies in accordance with the requirements of I4.0. This will lead to improve the level of competence and skills of teachers, engineers and students, related to CAx technologies. The Education 4.0 is significant from the point of view of connecting the University and the enterprises through the development of lifelong education in the the enterprises, as well as from the aspects of the application of smart technology in I4.0

Keywords: CAx, Lifelong Learning, Industry 4.0, Education 4.0

I. INTRODUCTION

The metal processing industry (MPI) is the starting point of all production activities and is currently undergoing rapid and continuous changes, because of the Fourth industrial revolution Industry 4.0 (I4.0). Metal processing industry (especial automotive and machine tools manufacturing) is a major driver of Industry 4.0 (I4.0) technologies and of economic wealth in industrialized countries. Although the main sources of professionals for this industry are still universities and research institutes, teaching and training have not kept pace with the advances in

technology [1]. Although Industry 4.0 aspects have been deployed within the automotive industry, educational institutions are striving hard to adapt to this latest industry trend [2]. I4.0 is primarily associated with digitization, robotization, the Internet of Things, etc., basically with smart technologies. But the basis of I4.0, which derives from its very name, is production systems, and in them the systems and methods of CAx technologies. Most of the smart technologies used by I4.0 in the metalworking industry are based on digital CAx models. The integration of CAx technologies from the aspect of I4.0 requires the development of new technological and transversal skills among the workforce, especially engineers, as carriers of the economic development of a country. The main requirement for the creation of this highly qualified workforce is the retraining and training of the existing and new workforce to easily adapt to the introduction and use of smart technologies. Significant support can be provided to the metal processing industry, especially to micro, small and medium enterprises (MSMEs) through training and professional development in schools, universities, and other higher education institutions. MSMEs face significantly more challenges in the digital transformation process than large corporations. They may struggle to keep up with digitalization, especially in terms of implementing new technologies and training the workforce. In the last few years, many authors have been dealing with Education 4.0 and its implementation in Industry 4.0. Akyazi et al. [3] presented the current and foreseen skills requirements demanded by the machine tool industry workforce. To this end, they generated an integrated database for the sector with the present and prospective skills needs of the metal processing sector professionals. Transformations based on the definition of three pillars (didactic, integrative and engineering) for the development of a learning factories were

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proposed in [4]. Other hand, the current technological transformation, and the main developments funded by European Research Programs was analyzed in [5]. Chen et al. [6] proposed hierarchical architecture of the smart factory, and then the key technologies were analyzed from the aspects of the physical resource layer, the network layer, and the data application layer. Within the context of modern manufacturing techniques in the Industry 4.0 era and advanced tools for analysis and mechanical design, in [7] is describes the development of a virtual/augmented reality.

(VR/AR) laboratory to support learning, training, and collaborative ventures related to additive manufacturing for the automotive industry. Computer supported technology (CAx) is used today in all phases of development and production cycle of a product, from development of a concept products, through designing, prototyping and testing, to preparation of processing programs on CNC machines. Fernandes et al. [8], presented a teaching methodology based on a Problem-based learning (PBL) approach as a learning tool for integration of CAx in mechanical engineering curricula. Teaching CAx tools with project-based learning in virtual distance education was shown in [9]. Markovic et al. [10] presented the relevance of the traditional education system, which is still dominant in Bosnia and Herzegovina, and the need for faster changes in teaching programs and plans, with an emphasis on the high school level of education, as a preparation for higher education.

II. EDUCATION 4.0: SIGNIFICANCE AND MOTIVATION

Education 4.0 aims to prepare students for the challenges and opportunities presented by emerging technologies, automation, and digitalization. The main objectives of Education 4.0 include:

- *Developing Future-Ready Skills:* Education 4.0 focuses on equipping students with the skills necessary for the digital age. These skills include critical thinking, problem-solving, creativity, collaboration, digital literacy, and adaptability. The goal is to prepare students for the changing job market and enable them to succeed in a technology-driven society.
- *Integrating Technology:* Education 4.0 emphasizes the integration of technology in the teaching and learning process. This includes leveraging tools such as computers, tablets, interactive whiteboards, educational software, and online platforms. Technology is used to enhance the learning experience, provide personalized learning opportunities, and enable access to a wealth of educational resources.
- *Promoting Active and Experiential Learning:* Education 4.0 encourages active and experiential learning approaches. Students are actively engaged in the learning process through hands-on

activities, project-based learning, simulations, virtual reality, and augmented reality. These methods promote student-centered learning, encourage critical thinking, and foster creativity.

- *Emphasizing Lifelong Learning:* Education 4.0 recognizes the importance of lifelong learning in a rapidly changing world. It aims to develop a culture of continuous learning, where individuals have the motivation and skills to update their knowledge and adapt to new technologies throughout their lives. Education 4.0 promotes self-directed learning, online courses, and other flexible learning options to support lifelong learning.
- *Fostering Global Citizenship:* Education 4.0 emphasizes the development of global citizenship skills. It promotes cultural understanding, empathy, and collaboration across borders. Students are encouraged to think globally, appreciate diversity, and address global challenges such as sustainability, climate change, and social justice.
- *Enhancing Personalized Learning:* Education 4.0 recognizes that every student has unique strengths, weaknesses, and learning styles. It promotes personalized learning approaches that cater to individual student needs and preferences. Adaptive learning platforms, data analytics, and artificial intelligence are used to tailor educational experiences and provide personalized feedback.
- *Encouraging Entrepreneurship and Innovation:* Education 4.0 aims to foster an entrepreneurial mindset and cultivate innovation among students. It encourages creativity, problem-solving, and risk-taking. Students are encouraged to develop an entrepreneurial mindset, think critically, and identify opportunities for innovation.

These objectives of Education 4.0 are aligned with the demands of the modern workforce and society, aiming to prepare students to thrive in a technology-driven, interconnected world.

Industry 4.0 refers to the integration of advanced technologies, such as artificial intelligence, automation, robotics, big data, and the Internet of Things, into various industries. In this context, the importance of Education 4.0 becomes crucial. Main reasons why Education 4.0 is essential in Industry 4.0:

Preparing a future-ready workforce: Industry 4.0 is characterized by rapid technological advancements that reshape job requirements. Education 4.0 equips students with the skills, knowledge, and competencies needed to thrive in the digital era. It focuses on critical thinking, problem-solving, creativity, digital literacy, and adaptability, enabling individuals to adapt to new technologies and job roles effectively.

Bridging the skills gap: Industry 4.0 demands a highly skilled workforce, but there is often a gap between the skills required by the industry and those possessed by the workforce. Education 4.0 aims to bridge this gap by aligning educational curricula with the evolving needs of the job market. It incorporates

emerging technologies into educational programs, providing students with hands-on experiences and practical skills relevant to the digital age.

Fostering innovation and entrepreneurship: Industry 4.0 thrives on innovation and entrepreneurship. Education 4.0 encourages a mindset of innovation, creativity, and risk-taking. It emphasizes problem-solving, design thinking, and collaboration, empowering students to develop innovative solutions to real-world challenges. By nurturing an entrepreneurial spirit, Education 4.0 prepares individuals to drive innovation and contribute to economic growth.

Lifelong learning and adaptability: In the fast-paced and ever-changing landscape of Industry 4.0, continuous learning and adaptability are crucial. Education 4.0 emphasizes lifelong learning by promoting a culture of curiosity, self-directed learning, and continuous skill development. It equips individuals with the ability to learn and adapt to new technologies, ensuring their employability and relevance in the evolving job market.

Ethical and responsible use of technology: Industry 4.0 brings ethical challenges and considerations related to data privacy, cyber security, AI ethics, and automation's impact on jobs. Education 4.0 addresses these concerns by incorporating ethical frameworks and fostering responsible digital citizenship. It promotes ethical decision-making, critical evaluation of technology's impact, and the development of responsible practices in utilizing advanced technologies.

Collaboration and global connectivity: Industry 4.0 emphasizes global connectivity and collaboration. Education 4.0 utilizes digital tools and platforms to facilitate global collaboration among students, educators, and experts. It encourages cross-cultural understanding, teamwork, and the exchange of ideas and knowledge across borders, preparing individuals for globalized workplaces and enhancing innovation through diverse perspectives.

In summary, Education 4.0 plays a vital role in Industry 4.0 by preparing individuals with the necessary skills, knowledge, and mindset to navigate the digital era successfully. It bridges the skills gap, fosters innovation, promotes lifelong learning, addresses ethical considerations, and enhances collaboration and global connectivity. By embracing Education 4.0, societies can leverage the opportunities of Industry 4.0 and empower individuals to thrive in the digital age.

III. THE NEED FOR CA_x TECHNOLOGIES IN INDUSTRY 4.0

A. CA_x technologies in metal processing industry

The metal processing industry (MPI) is the starting point of all production activities and is currently undergoing rapid and continuous changes, because of the Fourth industrial revolution Industry 4.0 (I4.0).

The MPI is under increasing pressure due to competition, the need for lower prices and shorter production time and the decline in the skill level of employees in the industry. This industry enables the production of both machine tools and components for key industries such as automotive, aviation, medical and many others. Due to the high degree of customization and variety in terms of size and material being processed, degree of automation, regime processing, MPI is currently undergoing rapid and continuous changes, because of the fourth industrial revolution Industry 4.0. Key the principle of Industry 4.0 is to increase knowledge of the process through data collection and monitoring. One of the primary technologies in the Industry 4.0 concept refers to Smart maintenance or predictive maintenance that includes continuous or periodic sensor monitoring of physical changes in the condition of manufacturing resources [11]. The production processes are deeply transforming with the development of digitalization. Fourth industrial revolution is usually identified with broadly understood digitization. Digital transformation is a dominant factor of the ongoing industrial revolution leading to revolution of traditional industries through intelligent (smart) production. As a result, the development of digitization has changed the progress in the most industries, in addition to the metalworking industry. Models' production continues to develop with ongoing progress in smart technologies such as the new generation of sensors, advanced robotics, artificial intelligence (AI), virtual reality (VR), augmented virtual reality (AVR) Internet of Things (IoT), machine learning, Internet of Service (IoS), digital twins, cyber-physical systems (CPS), cloud computing, machine-to-machine (M2M) communication, etc. These technologies can equally apply to new production facilities or to existing production facilities, which leads to transformation of traditional manufacturing companies into intelligent manufacturing systems called "smart factories".

Since the MPI, responsible for providing a wide range of customer services, including maintenance, collection and analysis of data in real time through internet, sensors, machine learning, etc., smart technologies have a significant advantage for them. Industry 4.0 represents an invaluable opportunity for the MPI because it reshapes and improves not only all production processes and business models but also the quality of their services. Therefore, Industry 4.0 could be seen as an invaluable opportunity for MPI, only if the industry has competent workforce capable of handling the implementation of new business models, technical and technological development. Generally, the integration of digital innovations requires the development of new technologies and transversal skills among the workforces. The main condition for creating this highly qualified workforce is retraining of the existing workforce and training of new ones to easily adapt to the introduction and use of smart technologies.

The MPI urgently needs to build a competent, multi-skilled workforce that is capable to deal with technological development and implementation of new one's business models. Only engineers with upgraded skills, knowledge and credentials will have enough ability to quickly adapt to the digital transition and newly adopted work systems, so as to enable the industry to keep pace with digitization. Disruption of traditional industrial practices and processes is inevitable. The MPI is no exception. The development of smart technology opens new and extremely powerful possibilities for us that help us gain a much deeper understanding of the fundamental processes in this industry.

On the other hand, all phases are applied in the MPI product life cycle from development through design, analysis and optimization, to the development of prototypes, testing, production of technical documentation and at the end of production, etc. which are supported by CAx technologies. Development and introduction of smart technology allows companies to optimize these processes, increase efficiency and reduce scrap through the new phase of automation. Today's competitive market has created a very challenging environment for product development. Companies are under bigger pressure to maintain their competitive advantages by reducing the time and costs of product development with maintaining a high level of quality. Therefore, it is necessary to take all measures to enable a robust, error-free and economical production in the early design phase.

The new era of digitization opens a completely new environment with powerful new possibilities for achieving economic production and the required processing quality. Production remains a key activity for any nation. Production itself is facing rapid progress in production technologies, tools and techniques. Therefore, production is entering a new era, in which students, workers and engineers need new schemes of continuous learning to keep pace with this progress. Education in production and education for production is considered the main driver for creation of new generations of "knowledge workers" in production. However, teaching and training in and for production did not keep pace with the progress of production technology, nor with requirements of the labor market. Current practice has shortcomings in providing continuous, multidisciplinary education and training of employees in production. Therefore, there is a lack of guidelines for policy makers in the field of education, which enables that relevant subject curricula and programs of continuing education are compatible with needs of the industry. In fact, traditional methods of training and education show limited efficiency in the development of competences of employees and students for current and future production environment. Cutting processing as a dominant factor in the metal processing industry occupies an important place in industrial practice and university research. Today, cutting processing does

not cover the narrow-specialized field of metal cutting, but as a part of production technologies stimulates development in a wide range of machine tool production, such as innovative products, machine tool performance, advanced materials, new ways organization of production, implementation of the CAx system in processing technologies, etc.

B. *CAx technologies in Education 4.0 and Industry 4.0*

It is striking that most of the research and studies dealing with industry 4.0, are focused mainly on IT aspects. Smaller attention is paid to the activities carried out in the areas of development, design, analysis and product control, preparation of production process or its execution, that is, areas of the product life cycle that takes place in a certain manufacturing company (from product design to its sales). It is in these activities that products acquire properties which their future customer and user expects. To properly use smart technologies (e.g. created model VR, AVR and digital twin, etc.), knowledge of CAD/CAE program systems is required. Also, to perform processing of the physical or digital model on CNC machines with tools (physical or virtual) and performe physical or digital model control some CAD/CAM/CMM software systems skills are required. Most of the smart technologies useful to Industry 4.0 in the metalworking industry is based on CAx models. As is known, Industry 4.0 is a collective term that stands for the integration of intelligent machines, systems and introduction of changes in production processes aimed at increasing production efficiency and implementing the possibility of flexible changes in product range. But the basis of Industry 4.0, which derives from its very name, are production systems, and within them the systems and methods of CAx technologies. These technologies are essential for achieving the goals of I4.0, which include increased automation, connectivity, data exchange, and intelligent decision-making.

Computer-Aided Design (CAD): CAD systems enable engineers and designers to create digital models of products or components. In I4.0, CAD systems facilitate the integration of digital models with other systems, such as simulation, virtual reality, and augmented reality. This integration allows for virtual product testing, rapid prototyping, and real-time collaboration between designers and other stakeholders.

Computer-Aided Engineering (CAE): CAE tools are used for simulating and analyzing product performance under various conditions. In I4.0, CAE systems leverage data from sensors, Internet of Things (IoT) devices, and digital twins to perform real-time simulations and predictive analysis. This helps in optimizing product designs, predicting maintenance requirements, and improving overall efficiency.

Computer-Aided Manufacturing (CAM): CAM systems generate instructions for manufacturing

processes based on the digital models created in CAD. In I4.0, CAM systems are integrated with other manufacturing technologies such as robotics, additive manufacturing, and CNC machines. This integration enables the automation of production processes, adaptive manufacturing based on real-time data, and improved production flexibility.

Computer-Aided Inspection (CAI): CAI systems use various inspection techniques such as coordinate measuring machines (CMMs) and optical scanners to verify product quality and dimensions. In I4.0, CAI systems are integrated with other technologies like IoT, data analytics, and machine learning. This integration allows for real-time inspection data analysis, early detection of defects, and predictive maintenance of inspection equipment.

Computer-Aided Process Planning (CAPP): CAPP systems assist in creating optimized manufacturing process plans for producing a product. In Industry 4.0, CAPP systems integrate with other technologies such as digital twin simulations, IoT, and real-time data analytics. This integration enables dynamic process planning, adaptive manufacturing, and efficient utilization of resources based on real-time production data.

Computer-Aided Simulation (CAS): CAS tools enable the virtual simulation of manufacturing processes, assembly operations, and production lines. In E4.0 and I4.0, CAS systems leverage digital twins, IoT data, and machine learning algorithms to simulate and optimize complex manufacturing scenarios. This helps in reducing production lead time, identifying bottlenecks, and improving overall production efficiency.

Computer-Aided Robotics (CAR): CAR systems focus on the integration of robots and automation technologies in manufacturing processes. In I4.0 and E4.0, CAR systems leverage advanced robotics, collaborative robots (cobots), and artificial intelligence (AI) algorithms to enable flexible and intelligent automation. These systems enhance productivity, safety, and adaptability in manufacturing environments.

Computer-Aided Training (CAT): CAT systems provide virtual training and simulation environments for workers to learn and practice manufacturing processes and operations. In Education 4.0, CAT systems incorporate augmented reality (AR) and virtual reality (VR) technologies to create immersive training experiences. This helps in improving worker skills, reducing training time, and ensuring safety in complex manufacturing settings.

Computer-Aided Collaboration (CAC): CAC tools facilitate collaborative work and communication among different stakeholders involved in the product lifecycle, including designers, engineers, manufacturers, and suppliers. In Industry 4.0, CAC systems incorporate cloud-based platforms, digital workspaces, and real-time communication tools to enable seamless collaboration, version control, and

knowledge sharing across geographically dispersed teams.

These CAx technologies play a key role in the transformation of traditional industries into digitalized and connected production environments that characterize Industry 4.0. They enable companies to achieve greater efficiency, quality and innovation, leading to a competitive advantage in the global market.

Integrated CAx systems are of great importance in implementation smart technologies, especially in cases where components of the same purpose can differ from one another due to variety of assemblies in which they are used. In such cases, engineers try to use CAx systems which, on the one hand, enable a flexible response to customer requests, and on the other hand, maximize the standardization of used technical solutions. CAx integration provides efficient data exchange between all parties involved in product development and product launch, as well as ease of editing and changes in the project. Thanks to the work into the cloud (Cloud Computing) access to all system resources (i data and executable applications) is possible from any device connected to the Internet, and designers have great flexibility in exchange of information. On the other hand, thanks to the numerical simulation (CAE technology, digital twin VR, AVR) each change to the product and/or process can be made quickly, easily and analyzed with relatively low costs.

Transition of labor force cannot be solved by conventional training in companies. Nor can this vital transition be fully handed over to manufacturers of CAx system programs; most of their training courses are focused on their latest software and therefore probably lacks the necessary depth and breadth especially in areas of process improvement. Therefore, constant improvement and the education of the workforce, students, etc., is based on CAx systems basis for their easy adaptation, use and introduction of smart technologies into the production environment.

Application of smart technologies in development of new and improvement of existing production processes in regional companies and MSMPs will represent a key activator of productivity growth, and therefore, economic development and prosperity for the whole population of the Western Balkan region. MSMP, according to opinion of many experts, are the basis of the economies of developing countries. That specially applies to the economy of Central European countries, which previously had a non-market economy.

IV. CONCLUSION

Development of the mentioned industrial enterprises today depends on the appropriate level of knowledge and engineers who deal with design, production of mechanical engineering and production management. Significant support can be provided to

the metal processing industry, especially to micro, small and medium enterprises (MSMPs) through well-targeted support measures at EU and national levels, as well as through European training and professional frameworks development in schools, universities, and other higher education institutions and companies. Given that about 98% of active companies engaged in metal processing in the Western region Balkans (Serbia, Montenegro, Bosnia and Herzegovina, Croatia) categorized as MSME, with needs and operational procedures completely different from those in large corporations, education should be focused on the development of global system support in continuous education, training and courses for engineers, students and teachers for those companies. The MPI is characterized by intensive use of computers, communication and information technology. Listed facts that are related to this issue suggest that the educational system should prepare plans and programs, for retraining, continuous learning and training of the workforce for future practice. This is the main task of the university, but it could be done only with close cooperation between the Industry and the University. As is known, each university (technical institution) has its strong point in research and education. Therefore, experts based in knowledge and skills must be well prepared to use these strongholds for continuous education and training of students, engineers and cooperation teacher.

Overall, the implementation of CAx in I4.0 enhances product development, manufacturing processes, and maintenance activities by leveraging digital technologies, connectivity, and data analytics. These implementations enable increased automation, improved productivity, better decision-making, and enhanced product quality in the context of Industry 4.0. The integration of these tools and systems with emerging technologies such as IoT, AI, and data analytics is instrumental in achieving the vision of a connected, intelligent, and highly efficient manufacturing system.

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Redefining Communication Standards in Academia and Society: The Role of Media Competences and Respectful Engagement

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Abstract – The Covid-19 pandemic had a positive impact on the accelerated development of the digital capabilities of Higher Education Institutions (HEIs) so that they can react adequately to cyber attacks or to the manifestation of negative phenomena we foresee such as the attack on scientific thinking, aggression on digital media and a distortion of public discourse through conspiracy narratives, fake news and hate speech. etc. In recent years, there has been a jump in the level of digital media literacy of university staff and students, which has led to a change in the way internal and external communication is carried out (university - civil society). Behavioral changes in communication were accompanied by the awareness of ethical aspects and regarding the content of the messages conveyed, but also a redesign of the curriculum in the field of communication and academic ethics. This article presents the set of open educational resources created on topics such as democracy and inclusive democratic participation, media literacy and the fight against disinformation and the prevention of aggression in the context of the implementation of the RespectNET project "Respectful communication through the media education network" (Erasmus + project, 2021-1-IT02-KA220-HED-000027578, <https://respectnet.eu/>). The main objective of the paper is to present the impact of RespectNET resources created at the level of HEIs that were intended to provide reliable educational resources for the formation of critical media and communication skills of university members and civil society activists.

Keywords: Media literature, communication, education, ethics, respect, democracy, dialogue, civil society, university, RespectNET project.

I. INTRODUCTION

The acceleration of digitization and the large-scale use of media technologies has caused negative phenomena (fake news, cyberbullying, cyber harassment, sexism, psychological disorders, especially among young people) to spread on a larger scale and produce unwanted effects. In this context, strengthening the involvement of the higher education institutions' community in addressing the new social and environmental challenges is a necessity (for example, through declarations, commitments and professional actions, support for health crisis situations, war situations and refugees, mitigating the effects of changes climate, natural disasters or catastrophes, but also issues related to gender, poverty, accessibility, inclusion and addictions, LGBT discrimination or other small-scale events or phenomena at the local, regional level) [1-4]. Moreover, it can be observed that the current ubiquitous media space has an important impact on the values and principles associated with an employed citizen, shaping his behavior. HEIs students are also citizens of that society where civic commitment and ethical involvement are necessary [4, 5].

Normative values for engagement voting, participation in civic groups is eroding in the context of online advocacy, social protest, liking, sharing and remixing. This new context for the manifestation of civic behavior offers vast opportunities for new and innovative approaches in learning about social-political involvement in the context of new media platforms and technologies, in the AI Era [5, 6].

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The exploration of digital media literacy, as a basic competence for citizenship involved in participatory democracy, becomes a topic that must be addressed in specific academic courses on communication, ethics and integrity, culture and civilization, etc. This type of transversal competences is recognized as being extremely necessary for future specialists with higher education who will have to fully manifest themselves in society [1-6].

The RespectNET project approach and support combines new models of engaged politics and participatory citizenship with frameworks for digital and media education to develop a framework for media education as a core political competence for active, engaged and participatory citizenship [7]. Using the MATRIX OF MEDIA competencies and targeted transmedia campaigns, this discussion shows how universities can model positive discourse and productive exchange with civil society, setting new standards for respectful and effective digital communication.

II. THE PROJECT CONTEXT

Higher education institutions can use all communication channels to become strong voices of society and important actors in solving the problems faced by civil society. A two-way communication between universities and civil society stakeholders (effective dialogue!) will ensure the truthful, real and professional space for listening, understanding, providing feedback for a respectful communication based on a real and true content, fighting myths, rumors, conspiracy narratives, hate speech and misinformation [1-3].

The present article is related to the activities developed by the international consortium that have successfully implemented the Erasmus+ RespectNET project, RespectNET - Respectful Communication through Media Education Network, (2021-1-IT02-KA220-HED-000027578, <https://respectnet.eu/>). Four partners (Universita Telematica Pegaso, Italy; International School for Business and Social Studies, Slovenia; Politehnica University of Timisoara, Romania and Verein für Sozialwissenschaftliche Beratung und Forschung e.V., Germany) have agreed to collaborate for the project implementation, to share their knowledge and experiences to create an innovative and open educational resource for training.

RespectNET project aims to develop a training programme with practices related to a common code of conduct for responsible media use and media communication literacy training multipliers (transmedia campaigns on four actual and challenge topics) as a resource for higher education institutions staff, as well as civil society activists as role models for the young generation [7]. The target groups (addressed by the training programme) are training designers and responsible people in universities (e.g., teaching and research staff, marketing, and ethics responsible

persons), civil society, policymakers, and other stakeholders. The project objectives are as follows:

1. Developing the media literacy of university staff and students to foster a culture of respectful scientific dialogue within the university and as members of the civil society;
2. Increasing the exchange of experiences and interchange with the wider regional civic society to build a knowledge partnership between universities and civil society for a respectful societal dialogue;
3. Develop a code of respectful dialogue in university and (social) media for all university members;
4. More attractive education and training programmes, according to individual needs and expectations, modern, dynamic, committed, and professional environment inside the organization ready to integrate good practices and new methods, including digital capabilities into daily activities;
5. Develop multimedia modules on media competences and respectful communication;
6. Develop a transmedia learning platform on media and communication competences for university members.

All the implemented project activities for dissemination and training were meant to contribute in a wider context to support achieving the project objectives [7]:

(1) Contribution of science to mitigating societal tensions, as expressed in phenomena like conspiracy narratives, hate speech, and cyberbullying;

(2) Consideration of European values in the further internal development of universities and in their collaboration with civil society.

Furthermore, one of the European values that the RespectNET project is planned to carefully address is the related to the multi-dimensional diversity in all its activities. The following (overlapping) target groups have been considered for the project implementation: universities; civil society activists; actors of science communication within universities and civil society; users and producers of social media. The final beneficiaries of the platform of transmedia learning on media and communication competences are university staff, students, and other members of civil society [7]. Furthermore, the main target groups are: (a) higher education teachers, (b) tutors of digital teaching and learning at higher education institutions.

In this challenge context of research, a reliable resource for planning and prioritizing training for critical media and communication competences of university members and civil society activists has been provided, which was based on the matrix of competencies. Furthermore, the created open education resources were made available to different groups of learners in the HEIs partners in the RespectNET project (faculty staff groups, departments staff groups, research centers groups, different groups of students from Bachelor, Master of PhD levels etc.) [7].

II. THE PROJECT APPROACH AND RESULTS

A. *The project activities*

The development and implementation process of the project consists of a series of activities as the work packages were defined [7]:

- Project Management and Implementation (Leading by Pegaso Telematic University, Italy) with five project meetings of the consortium members;
- PR1 Matrix of Media Competences and Respectful Communication for University Staff (Leading partner Politehnica University of Timisoara, Romania) which consists of desktop research, a collection of good practices, a series of focus groups research and a survey based on a questionnaire. These research activities were focus on defining the matrix of media competences that has been the basis for the training programme structure and content;
- PR2 Multi-Media Modules on Media Competences and Respectful Communication (Leading partner International School for Social and Business Studies, Slovenia) were focuses on the development of four modules: Media competence, Communication with university stakeholders, University-society dialogue and University and science-society dialogue;
- Dissemination and exploiting the training materials and the transmedia campaigns materials during several events as following:
 - C1 International training of civil-socially active students in advanced semesters from partner organizations with multi-media modules (hybrid activity) with a 3 days F2F training in Slovenia + 8h ZOOM over 4 weeks online;
 - C2 International training for university members by civil society activists (hybrid activity) with a 3 days F2F training in Romania + 8h ZOOM over 4 weeks online;
 - Nine Multiplier Events organized in Italy, Slovenia, Romania and Germany with large groups of students and teaching staff involved or having activities in the civil society.

B. *Details about the project results*

The created training materials are available online and are ready to be used and transferred into HEIs practices, courses or curricula (https://elearningproject.eu/all-courses/?course_catid=99). “This e-learning platform

was created to host online courses and learning materials created and produced within Erasmus+ projects. All materials available on this platform are considered Open Educational Resources (OER). The site is regularly updated. For most courses, registration is not required; however, it is needed to participate in courses' forums or receive certificates of attendance.”

The trainees are invited to carefully read the “GUIDE ON HOW TO STUDY - Starting and Sustaining Self-Study Success” available on the e-learning platform, at the beginning of each module.

A playlist of created multimedia materials are available on the YouTube channel (https://www.youtube.com/playlist?list=PL7Ij3-xTzrJJzL-cV7-AH-y5_GSVPje7p). In Table 1 are presented in brief, the content of each training module with relevant information.

The most valuable project results were the RespectNET transmedia campaigns, presented online at: <https://elearningproject.eu/courses/respectnet-campaigns/>. In Table 2 are presented valuable details about the created four transmedia campaigns.

The creators of the campaigns are as presented in the following:

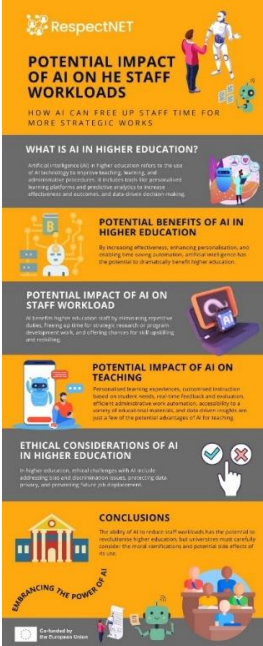
- “The International School for Social and Business Studies (ISSBS) from Slovenia takes us into the interesting world of Artificial Intelligence (AI), investigating its function in university communication. The campaign analyses the intersections between AI and academic discourse through videos, podcasts, infographics, and essays, untangling the complexity.
- University Politehnica Timisoara (UPT), based in Romania, focuses on social equality and multicultural communication, notably in the context of university internationalization. The campaign uses diverse media, such as videos, podcasts, infographics, posters, flyers, articles, and social media posts, to traverse the pathways towards a more inclusive and courteous global academic environment.
- The German partner, SoWiBeFo (Verein für sozialwissenschaftliche Beratung und Forschung e. V.) digs into the critical topic of universities assisting refugees through their third-mission activities. Videos, audiograms, articles, social media postings, graphic posts, and eBooks become the transmedia tools for amplifying support and resilience narratives in the face of relocation.
- The Italian partner, Pegaso Online University (POU), focuses on ecology and environmental conservation inside the university system. Their campaign investigates how educational institutions may support sustainability and environmental consciousness through appealing podcasts and social media posts”.

Table 1. Overview of the created ReaspectNET training programme – modules and lessons content (the created Open Educational Resources, https://elearningproject.eu/all-courses/?course_catid=99)

Modules	Aims	Course specific objectives	Lessons
Media competence	Through the course, learners will develop their understanding of how media influences our perception of the world and learn strategies for analyzing and evaluating media content. The course is designed for individuals who want to improve their media literacy skills or for professionals working in fields related to media and communications. It is available online and can be accessed through the eLearning Project website.	<ul style="list-style-type: none"> • Present theoretical frameworks and backgrounds of communication-related content. • Involve the students in productive discussions to deepen their understanding of the contents and make them connect the theory with their practical experience. • Introduce the students to the basics of the content-related aspects and show them further study possibilities. • Activate students and motivate them to introduce improvements in their everyday work. 	<ol style="list-style-type: none"> 1. Contents aspects and technical characteristics of media competence (literacy); 2. Media business models and approaches (public media, profit-driven media, state media); 3. Social media and its aims (e.g., generating attention, advertising); 4. Use of AI in media and media bias.
Communication with university stakeholders	The course aims to help university staff overcome potential threats of disrespectful communication among university stakeholders. This course aims to give a theoretical background of higher education institutions' communication processes, stressing communication problems and ethical issues leading to poor and inefficient communication and interactions. In the course, various practical approaches are suggested to solve such issues.	<ul style="list-style-type: none"> • Present theoretical frameworks and backgrounds of communication-related content. • Involve the students in productive discussions to deepen their understanding of the contents and make them connect the theory with their practical experience. • Introduce the students to the basics of the content-related aspects and show them further study possibilities. • Activate students and motivate them to introduce improvements in their everyday work. 	<ol style="list-style-type: none"> 5. Media for promotion and advertising of educational and training programmes; 6. Internal communication targeting students and staff; 7. HEI's communication with external stakeholders and media.
University-society dialogue	This course covers the theoretical foundations of media competence in University-Civil Society dialogue. We will discuss the role of media in the public sphere, emphasizing the importance of genuine communication for democracy. We will also explore the interdependence of media and democracy competencies and the threats posed by societal and technological developments. The course will highlight the role of universities and civil society in promoting competence development and public deliberation. This course aims to give insight into the foundation of media competence in the concept of deliberative democracy, universities, civil society and media as core actors in the public sphere, as well as main threats to public deliberation and university-civil society cooperation as main mitigation to these threats.	<ul style="list-style-type: none"> • Present theoretical frameworks and backgrounds of media competencies. • Involve the students in productive discussions to deepen their understanding of the contents and make them connect the theory with their practical experience. • Introduce the students to the basics of the content-related aspects and show them further study possibilities. • Activate students and motivate them to introduce improvements in their everyday work. 	<ol style="list-style-type: none"> 8. University and Society in Deliberative Democracies; 9. Threats to Deliberative Democracy 10. What Universities and Civil Society can do about it 11. Practical cooperation between Universities and Civil Society
University and science-society dialogue	This course will explore the complex relationship between scientific research and society. We will discuss how scientific knowledge is generated and communicated and how it shapes our understanding of the world. We will also examine the ways in which scientific research is	<ul style="list-style-type: none"> • Foster an understanding of the social, economic, and political factors that influence scientific research and how science, in turn, impacts society. • Develop critical thinking skills and a nuanced understanding of 	<ol style="list-style-type: none"> 12. The role of dissemination: communicating science to a general public; 13. Sharing scientific results as a precondition for

	<p>influenced by social, economic, and political factors and how it, in turn, impacts society. Throughout the course, we will focus on the role of universities in facilitating dialogue between scientists and society and the importance of engaging with diverse stakeholders in the scientific process. By the end of the course, you will have a deeper understanding of the challenges and opportunities of science-society dialogue and the role that universities can play in fostering a more inclusive and equitable approach to scientific research. The course aims to promote a more collaborative and inclusive approach to scientific research and equip students with the knowledge and skills necessary to engage in science-society dialogue in a meaningful and impactful way.</p>	<p>the strengths and limitations of scientific knowledge.</p> <ul style="list-style-type: none"> • Explore the role of universities as key institutions in fostering dialogue between scientists and diverse stakeholders, including policymakers, community groups, and the public. • Encourage students to engage with diverse perspectives and learn how to communicate complex scientific concepts to different audiences effectively. • Promote an awareness of the ethical, social, and environmental implications of scientific research and how these should be considered in the scientific process 	<p>equitable social growth; 14. Ethics in communication of scientific results to stakeholders: main issues.</p>
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Table 2. Overview of the created ReaspectNET transmedia campaigns (the created Open Educational Resources, https://elearningproject.eu/all-courses/?course_catid=99)

<p>Transmedia Campaigns: Shaping Narratives for Social Impact.” Our course is more than just a set of courses; it is a synthesis of various ideas and efforts, each aimed at catalysing constructive change in our society. We go into the fields of AI in society, social equality, refugee help, ecology and environmental conservation, focusing on exploiting digital media. Let us explore the potential of storytelling across multiple digital channels to communicate knowledge, start important conversations and motivate good action. Welcome to the world of transformational transmedia campaigns!</p> <p>Learning objectives (by spreading the campaign materials in the HEIs communities):</p> <ol style="list-style-type: none"> [1] Understand AI’s role in university communication. [2] Explore social equality in university internationalization. [3] Foster inclusivity through various media forms. [4] Examine challenges in universities supporting refugees. [5] Investigate how higher education institutions champion sustainability. [6] Explore ethical considerations in transmedia storytelling. [7] Communicate findings through transmedia campaigns. [8] Develop skills in crafting impactful transmedia campaigns. [9] Understand the strategic use of digital media platforms. [10] Identify effective storytelling techniques. [11] Reflect on the responsible use of digital media for social impact. 		
Campaign title	Objectives and details	Infographics / Visual materials - examples
<p>Artificial Intelligence (AI) in University Communication</p>	<p>This campaign introduces transmedia-based learning about using AI in HEIs. Several videos, short podcasts, and textual materials are implemented in the campaign.</p> <p>A campaign summary is available in the PDF file below and in the Materials tab, where you can also find German, Italian, and Slovene translations.</p> <p>The individual content elements of the transmedia campaign have been distributed across various media channels, including the eLearning platform Elearningproject.eu, YouTube video and podcast playlists, Facebook and LinkedIn posts and reposts, Spotify, and printed media like stickers, posters, and roll-ups.</p> <p>Target groups from HEIs are invited to join our campaign! Read the below reading for a short overview of the campaign.</p>	

<p>Multicultural Respectful Communication</p>	<p>This campaign introduces transmedia-based learning about social equality and multicultural communication in the context of university internationalization. Several videos, textual materials, PowerPoint presentations and images are implemented in the campaign. A summary of the campaign is available in the PDF file below and in the Materials tab, where you can also find German, Italian, and Slovene translations.</p> <p>The individual content elements of the transmedia campaign have been distributed across various media channels, including the eLearning platform Elearningproject.eu, YouTube video and podcast playlists, Facebook and LinkedIn posts and reposts, Spotify, and printed media like stickers, posters, and roll-ups.</p>	
<p>Representing Environmental Sustainability in the University System</p>	<p>This campaign introduces transmedia-based learning about environmental sustainability in the university system. Several podcasts are implemented in the campaign. A summary of the campaign is available in the PDF file below and in the Materials tab, where you can also find German, Italian, and Slovene translations.</p> <p>The individual content elements of the transmedia campaign have been distributed across various media channels, including the eLearning platform Elearningproject.eu, YouTube video and podcast playlists, Facebook and LinkedIn posts and reposts, Spotify, and printed media like stickers, posters, and roll-ups.</p>	<p>A series of podcasts highlights the importance of environmental sustainability awareness in universities. To promote sustainability, the podcasts suggest integrating it into the curriculum, establishing sustainability centres, reducing resource consumption, and using sustainable procurement practices. These efforts have multiple benefits, such as changing mindsets and creating a more sustainable campus environment. In summary, universities can lead the way in promoting environmental sustainability and educating environmentally conscious leaders.</p>
<p>University Third Mission Activities to Support Refugees</p>	<p>This campaign introduces third-mission activities to support refugees in higher education. The campaign implements several videos, short podcasts, and social media posts. A campaign summary is available in the PDF file below and in the Materials tab, where you can also find German, Italian, and Slovene translations.</p> <p>The individual content elements of the transmedia campaign have been distributed across various media channels, including the eLearning platform Elearningproject.eu, YouTube video and podcast playlists, Facebook and LinkedIn posts and reposts, Spotify, and printed media like stickers, posters, and roll-ups.</p>	<p>The video below introduces the idea of the university's third mission – beyond teaching and research and dedicating it to societal impact. Innovation, community outreach, and knowledge sharing are essential in addressing real-world challenges.</p>

II. THE IMPACT OF THE RESPECTNET TRANSMEDIA CAMPAIGNS – RESEARCH RESULTS

A. Methodological aspects

The following section analyses the feedback collected via a survey based on a questionnaire on the four RespectNET transmedia campaigns developed by the partners of the RespectNET project. In addition, partners preliminary implemented four focus groups, one per each participating country (Italy, Slovenia, Romania, Germany). They prepared an online questionnaire with 14 questions to assess the content, format, and impact of the four the Transmedia Campaigns about “Shaping Narratives for Social Impact” developed by the project partners <https://elearningproject.eu/courses/respectnet-campaigns/>:

- 1) Artificial intelligence in university communication (ISSBS, Slovenia);
- 2) Multicultural respectful communication (university internationalization) (UPT, Romania);
- 3) Representing the environmental sustainability in the University System (Pegaso University Italy);
- 4) Third Mission Activities to Support Refugees (SoWiBeFo Germany).

The online questionnaire was hosted by ISSBS on the university server.

Each national focus group was invited to give feedback on the campaign from their country. The respondents also had the opportunity to evaluate multiple campaigns. According to the project

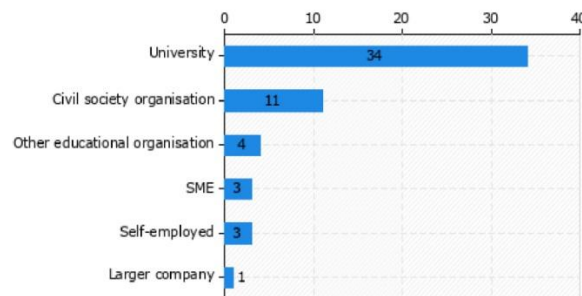
application, each focus group was expected to have 10 members (40 persons overall). However, the online questionnaire was filled in by 60 respondents, showing a pronounced interest in the campaign topics developed by the consortium.

In the following there will be presented the research results on the perception of the transmedia campaigns.

B. Research results: Perception about the RespectNET campaigns

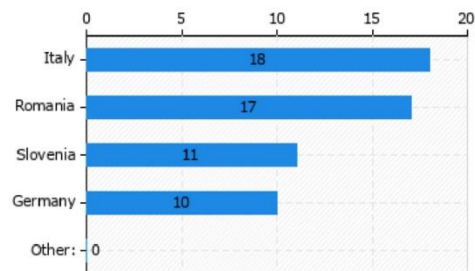
The first four questions are introductory. They describe the institution of the focus group members, their country, their work area and the campaign they evaluated. Of the 56 respondents to this question, 34 participants belong to a university. 11 persons are members in a civil society organization, 4 are involved in other educational organizations, 3 are employed in SMEs, 3 are self-employed, and 1 respondent works in a larger company (Fig. 1). 58 persons chose to name their country: the highest number of respondents (18) come from the country of the project lead Italy, 17 persons are Romanian, 11 participants live in Slovenia, and 10 are German residents (Fig 2).

As shown in Fig. 3, 57 participants in the focus group answered this questions. Most of them work in a university. 37 % of the respondents are university teaching staff, 19 % are university non-teaching staff, and 5 % are top-level university members. 2 % are students. 21 % of the respondents are professionals, 12 % belong to the civil society and 4 % of the participants (2 persons) have other work areas: one person works in public administration and another is a doctoral student.



What institution do you come from? (n = 56)

Fig. 1. Institution of the respondents



What country do you come from? (n = 58)

Fig. 2. Country of the respondents

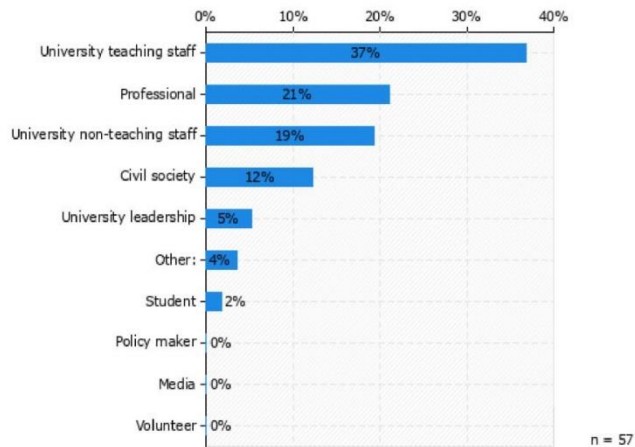


Fig. 3. Working area of the respondents

Which transmedia campaign do you select for evaluation? (n = 66)
Multiple answers are possible

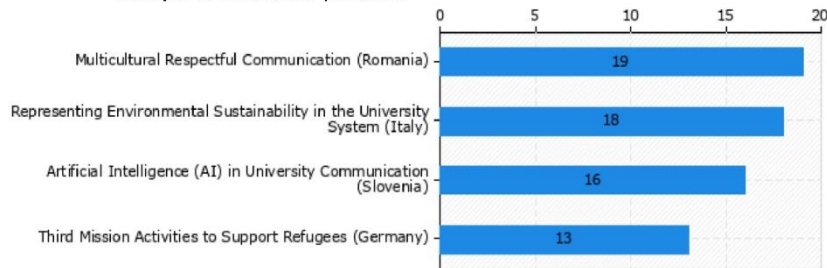


Fig. 4. Transmedia campaigns selected for evaluation.

Please evaluate the following aspects of the Artificial Intelligence (AI) in University Communication (ISSBS, Slovenia) campaign against the stated criteria. (n = 15)

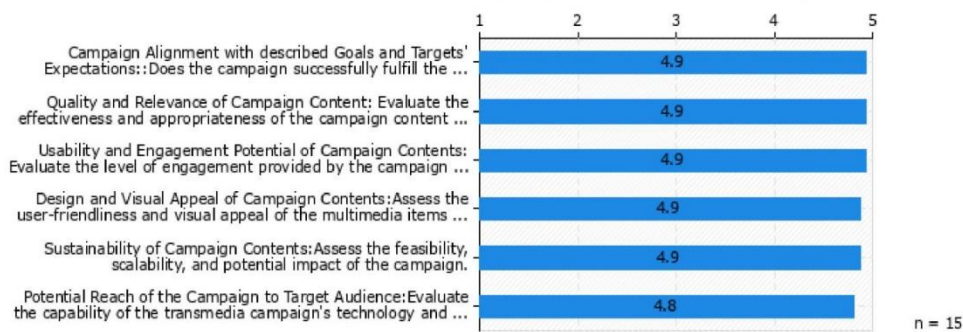


Fig. 5. Feedback collected for the transmedia campaign developed by ISSBS, Slovenia

Please evaluate the following aspects of the Multicultural Respectful Communication (UPT, Romania) campaign against the stated criteria. (n = 19)

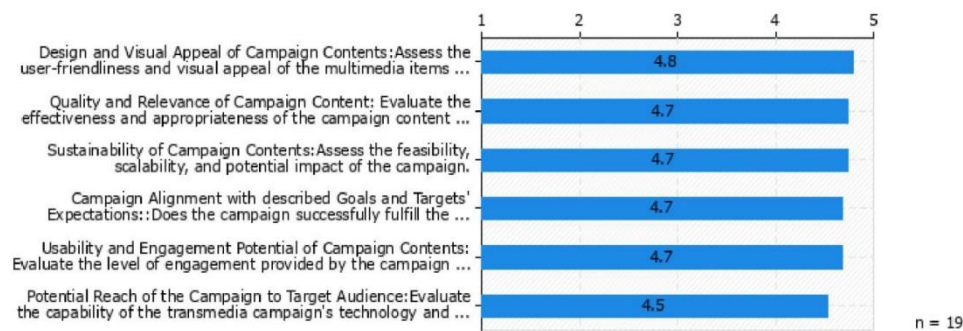


Fig. 6. Feedback collected for the transmedia campaign developed by UPT, Romania

Please evaluate the following aspects of the Representing Environmental Sustainability in the University System (POU Italy) campaign against the stated criteria. (n = 17)

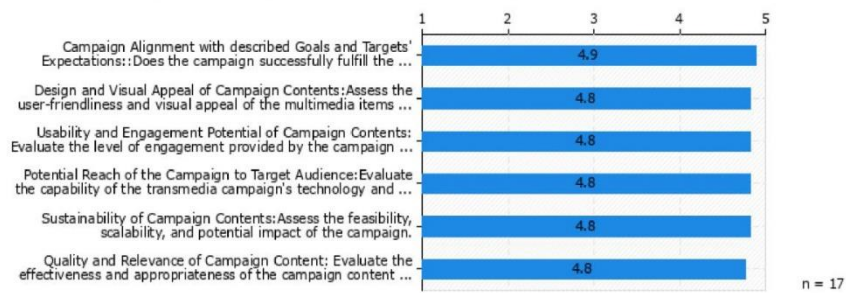


Fig. 7. Feedback collected for the transmedia campaign developed by POU Italy

Please evaluate the following aspects of the Third Mission Activities to Support Refugees (SoWiBeFo, Germany) campaign against the stated criteria. (n = 13)

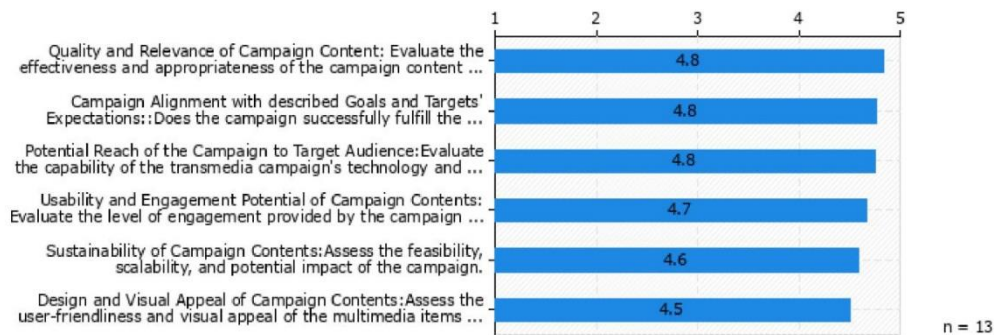


Fig. 8. Feedback collected for the transmedia campaign developed by SoWiBeFo Germany

As described in Fig. 4, multiple answers were possible to this question. Overall, the four transmedia campaigns were analyzed 66 times as follows:

- 19 responses referred to the campaign from Romania: Multicultural Respectful Communication;
- 18 responses were about the Italian campaign: Representing Environmental Sustainability in the University;
- The Slovenian campaign: Artificial Intelligence (AI) in University Communication was analyzed 16 times;
- The German campaign: Third Mission Activities to Support Refugees was evaluated by 13 persons.

Regarding the **transmedia campaign designed and developed by ISSBS, Slovenia**, the first set of questions invites participants to assess the campaign against stated criteria on a Likert scale (5 = Very much; 4 = rather much; 3 = to some extent; 2 = a little; 1 = not at all). As can be seen from Fig 5, 15 persons answered the first set of questions as follows:

- Campaign Alignment with described Goals and Targets' Expectations: Does the campaign successfully fulfill the objectives outlined in the project application and meet your expectations? 4,9 points;
- Quality and Relevance of Campaign Content: Evaluate the effectiveness and appropriateness of the campaign content for the target audience: 4,9 points;

- Usability and Engagement Potential of Campaign Contents: Evaluate the level of engagement provided by the campaign contents for the target audience: 4,9 points;
- Design and Visual Appeal of Campaign Contents: Assess the user-friendliness and visual appeal of the multimedia items within the campaign: 4,9 points;
- Sustainability of Campaign Contents: Assess the feasibility, scalability, and potential impact of the campaign: 4,9 points;
- Potential Reach of the Campaign to Target Audience: Evaluate the capability of the transmedia campaign's technology and techniques in reaching the intended target audience: 4,8 points.

All 15 respondents declared they would highly recommend the transmedia campaign to peers and colleagues (100 %). Overall, the participants praised the crucial relevance of the selected topic for the campaign. They recommend encouraging universities to produce similar campaigns as a dialogue with students and civil society (among others). They also suggest giving more advice to universities about producing similar campaigns. Another recommendation is to continue the discussion started by the Slovenian campaign about AI.

The recommendations for improvement highlight the clarity and usefulness of the Slovenian campaign. Some participants recommend promoting the campaign and disseminating the content among the

stakeholders and NGOs. A recommendation is to improve some visual aspects of the videos on the website. Another suggestion is to translate the campaign into Slovenian language. Additionally, they suggest incorporating interactive elements like quizzes, polls, or immersive experiences.

Regarding the **transmedia campaign designed and developed by UPT Romania**, 17 persons assessed the campaign prepared by UPT Romania. The first set of questions uses the Likert scale for analyzing the campaign against the stated criteria (5 = Very much; 4 = rather much; 3 = to some extent; 2 = a little; 1 = not at all). As can be seen from Fig. 6, 19 persons answered the first set of questions as follows:

- Design and Visual Appeal of Campaign Contents: Assess the user-friendliness and visual appeal of the multimedia items within the campaign: 4,8 points;
- Quality and Relevance of Campaign Content: Evaluate the effectiveness and appropriateness of the campaign content for the target audience: 4,7 points;
- Sustainability of Campaign Contents: Assess the feasibility, scalability, and potential impact of the campaign: 4,7 points;
- Campaign Alignment with described Goals and Targets' Expectations: Does the campaign successfully fulfill the objectives outlined in the project application and meet your expectations? 4,7 points;
- Usability and Engagement Potential of Campaign Contents: Evaluate the level of engagement provided by the campaign contents for the target audience: 4,7 points;
- Potential Reach of the Campaign to Target Audience: Evaluate the capability of the transmedia campaign's technology and techniques in reaching the intended target audience: 4,5 points.

The 18 respondents would strongly recommend (89 %) or advocate (11 %) the transmedia campaign from Romania to others. Overall, the participants agreed that the campaign supports the internationalization process of the university. A recommendation is to introduce the materials in the educational process and for preparing international student mobilities. The respondents mentioned the diversity of topics, formats, and material support used (integrating digital and non-digital material) as a positive aspect. They highlighted the practical guide to academic mobility ethics as strongly positive. Among the recommendations for improvement, the participants mentioned the need to promote the campaign within the university (among others, on the Instagram channel).

Another suggestion is to translate the materials into the Romanian language. Another recommendation was to connect this campaign to initiatives with similar topics within the university (like International Week). Another suggestion was to approach the campaign actively for implementation.

Regarding the **transmedia campaign designed and developed by POU Italy**, 19 focus group participants evaluate the campaign prepared by project lead POU Italy. The first set of closed questions uses the Likert scale (5 = Very much; 4 = rather much; 3 = to some extent; 2 = a little; 1 = not at all). As can be seen from Fig. 7, 17 persons answered the first set of questions as follows:

- Campaign Alignment with described Goals and Targets' Expectations: Does the campaign successfully fulfill the objectives outlined in the project application and meet your expectations? 4,9 points;
- Design and Visual Appeal of Campaign Contents: Assess the user-friendliness and visual appeal of the multimedia items within the campaign: 4,8 points;
- Usability and Engagement Potential of Campaign Contents: Evaluate the level of engagement provided by the campaign contents for the target audience: 4,8 points;
- Potential Reach of the Campaign to Target Audience: Evaluate the capability of the transmedia campaign's technology and techniques in reaching the intended target audience: 4,8 points;
- Sustainability of Campaign Contents: Assess the feasibility, scalability, and potential impact of the campaign: 4,8 points;
- Quality and Relevance of Campaign Content: Evaluate the effectiveness and appropriateness of the campaign content for the target audience: 4,8 points.

All 17 persons would recommend the campaign prepared by POU “very much” (76 %) and “to some extent” (18 %). Only one person would recommend the campaign “a little” (6 %). Overall, the participants highlight the effective presentation of the highly relevant topic and the attractive graphical presentation. One person focuses on innovative communication means and formats aiming to reach a broad audience and support social equality in higher education. Among the suggestions for improvement, the participants recommend integrating the campaign into other social media formats (Twitter, LinkedIn, Facebook, Instagram). A respondent suggested publishing new materials and content periodically. Another person recommended focusing more on clear pronunciation in English for non-native speakers. Another focus group member suggested looking for overlapping content in the developed material and reducing redundancies. A few respondents considered not needing any improvement to the highly qualitative material.

Regarding the **transmedia campaign designed and developed by SoWiBeFo Germany**, 10 respondents assessed the campaign prepared by the NGO SoWiBeFo Germany. The first set of questions gives options for answers on a Likert scale (5 = Very much; 4 = rather much; 3 = to some extent; 2 = a little; 1 = not at all).

As can be seen from Fig. 8, 13 persons answered the first set of questions as follows:

- Quality and Relevance of Campaign Content: Evaluate the effectiveness and appropriateness of the campaign content for the target audience: 4,8 points;
- Campaign Alignment with described Goals and Targets' Expectations: Does the campaign successfully fulfill the objectives outlined in the project application and meet your expectations? 4,8 points;
- Potential Reach of the Campaign to Target Audience: Evaluate the capability of the transmedia campaign's technology and techniques in reaching the intended target audience: 4,8 points;
- Usability and Engagement Potential of Campaign Contents: Evaluate the level of engagement provided by the campaign contents for the target audience: 4,7 points;
- Sustainability of Campaign Contents: Assess the feasibility, scalability, and potential impact of the campaign: 4,6 points;
- Design and Visual Appeal of Campaign Contents: Assess the user-friendliness and visual appeal of the multimedia items within the campaign: 4,5 points.

All 13 respondents would recommend the campaign prepared by SoWiBeFo to others very much (83 %) and to some extent (17 %). Most respondents highlighted using different formats to reinforce a clear message as highly effective. The participants perceived the topic (empowerment of refugees to find their voice and reach out to the public) as very positive. Another positive element was involving the refugee community while adding innovative digital methods of communication. Another participant considered that the campaign highlights the importance of universities as a societal actor. A first recommendation was that civil society organizations adopt the campaign and integrate it into their regular activities. Another recommendation was to include more scientific information and additional readings. Other suggestions were to have more routine in some technical parts and develop longer podcasts and videos on the topics selected and sharing good practices from other universities. Another respondent considered that no improvements are needed.

As a final remark of the collected feedback from the respondents, based on the overall comments, the focus group members from the four countries suggest making the four campaigns available on the project website and the four institutional web pages. They recommend creating presentations about preparing similar campaigns and using the campaigns as educational material in university courses. Another recommendation is to simplify the text in some materials, as it is difficult to follow. The focus group members highlighted the transmedia campaigns as helpful channels for learning and strengthening the communication between universities and civil society.

Thus, the four campaigns reached their goals. They develop innovative material and disseminate it in different formats with a prospective high impact.

Finally, Overall, the focus group members perceived the four transmedia campaigns as channels for learning and strengthening the respectful communication between universities and civil society. They highlighted some positive aspects but also had some recommendations for improvement. A summary with the most relevant suggestions and comments on the four transnational campaigns is presented below:

- Make the four campaigns available on the project website and the four institutional web pages;
- Create presentations about preparing similar campaigns and encouraging universities to produce such material as a dialogue with students and civil society;
- Use the campaigns as educational material in university courses;
- Simplify the text in some materials, as it is difficult to follow;
- The topics selected are highly relevant for universities and society;
- Continue the discussion started by the campaigns;
- Disseminate the campaigns through diverse social media channels (Instagram, LinkedIn, Facebook, Twitter etc.). Promote the campaigns within the organizations and connect them with similar initiatives (like International Week);
- Improve some visual aspects of the videos on the website;
- Translate the campaign into the national languages of the partner universities;
- Incorporate some interactive elements (like quizzes, polls, immersive experiences, etc.);
- The diversity of topics, formats, and material support (integrating digital and non-digital material) is a positive aspect;
- Focus more on clear pronunciation in English for non-native speakers in some of the materials produced;
- Include more scientific information and additional readings;
- Develop longer podcasts and videos on the selected topics and share good practices from other institutions.

Based on the recommendations of the respondents from the collection of feedback on the transmedia campaigns, changes and improvements will be made to them to exploit them in the future, during the sustainability period of the project.

V. CONCLUSIONS AND FINAL REMARKS

The approach and the results presented because of the implementation of the ReaspectNET project have a high degree of generalization and interest for all

universities, European HEIs and not only. The open educational resources created and the materials of the respectful communication campaigns have proven particularly attractive for their assimilation in training programs, courses in the field of communication, ethics and academic integrity, culture and civilization, sociology, multimedia, etc., for different groups of students, from different specializations (e.g., economics, engineering, communication, multimedia, etc.). As a result, we recommend this approach of total or partial transfer of RespectNET materials in the practice of the university educational space to obtain positive effects in the university third mission by improving the dialogue between HEIs and actors of their community or civil society, in general.

As a result of the positive results of the research on the perception of a large group of trainees who got acquainted with the training materials and especially with those of the campaigns, we are convinced that the sustainability of the project is ensured and is reliable. Thus, the results of the implementation of the RespectNET project will help different university communities, in the coming years, to raise awareness and adopt ethical communication practices and to identify which skills need to be improved (especially among students or younger staff). In addition, the research findings presented will help define the skills to understand and respond to anti-scientific, conspiratorial narratives and encourage reasoned, evidence-based communication through essential skills of effective science communication. The research presented highlighted a common ground of competency areas that are needed but not sufficiently developed in the project's partner organizations and countries.

Using the defined matrix of media competencies and targeted transmedia campaigns, this article and the presented research activities, have discussed and demonstrated how universities can model positive discourse and productive exchange with civil society, setting new standards for respectful and effective digital communication.

Based on the results, the feedback obtained in the numerous dissemination activities, training and workshops dedicated to different groups of potential users of the RespectNET results, recommendations were formulated for the assimilation, integration and exploitation of the RespectNET training program in the specific contexts of HEIs. Future trainers will have to focus on explaining the foundations of democracy (in the new post-pandemic but also European socioeconomic context) and on the civic skills needed by members of higher education institutions to improve dialogue with civil society actors. At the same time, RespectNET training and propaganda materials will provide explanations of the concept of civic

mindedness, based on the debates on individual rights and the rights of civic participation, as understood by current theories of democracy at the European level.

ACKNOWLEDGEMENT

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