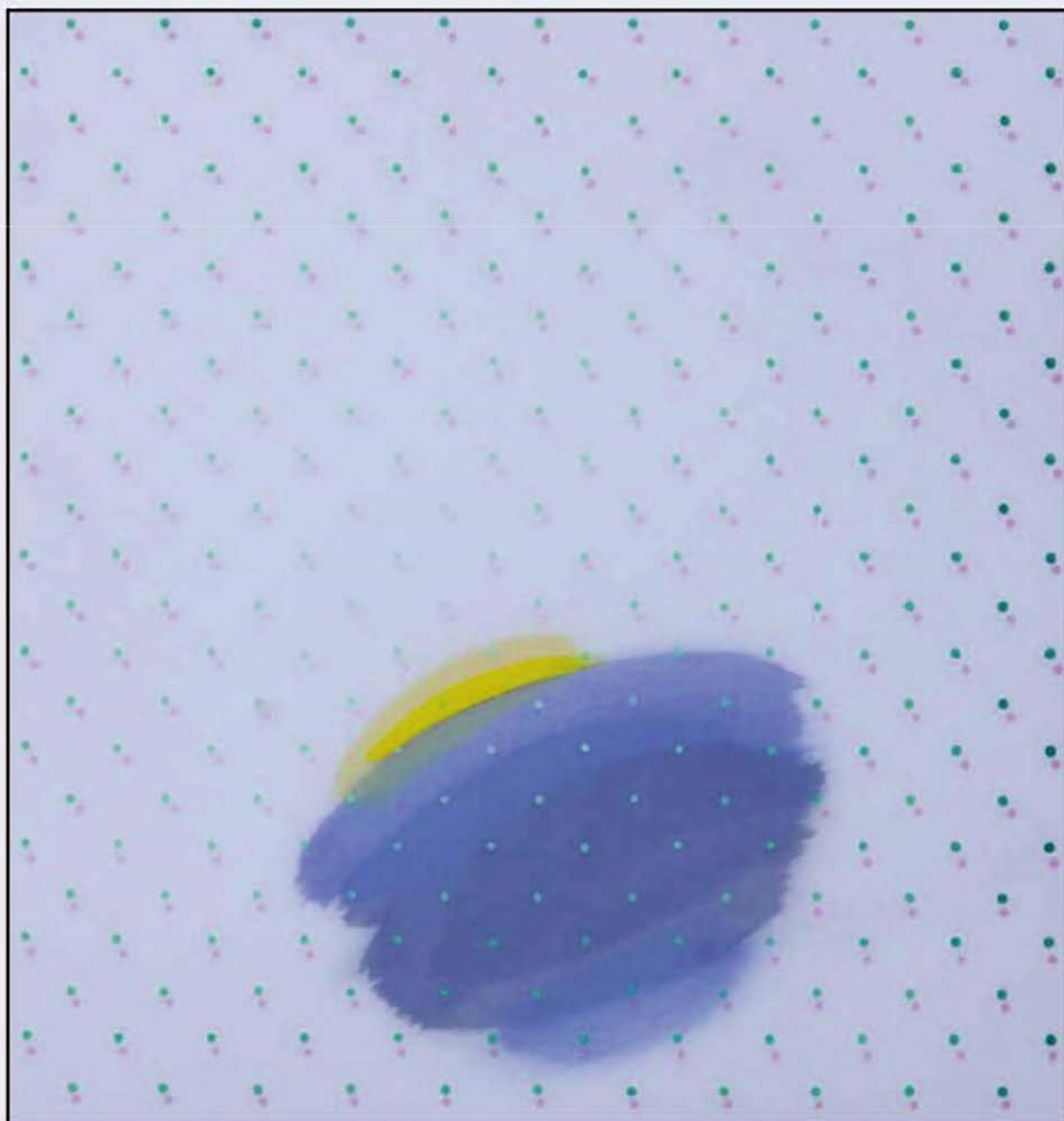


# SEEJSD

SOUTH EAST EUROPEAN JOURNAL OF SUSTAINABLE DEVELOPMENT

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Vol. 4 (2/2020)



Skopje, North Macedonia



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# Contents

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<b>Analysis of Rewarding Programs and Its Impacts to the Level of Satisfaction of Employees at Food Industry Organizations</b>	<b>10</b>
Bujamin Bela	
<hr/>	
<b>Impact of ICT in Healthcare System and Implementing IT strategy In developing Countries</b>	<b>27</b>
András Gábor, Besnik Qehaja, Bekim Fetaji	
<hr/>	
<b>Integrating Education for Sustainable Development in English Language Classrooms</b>	<b>38</b>
Edita Bekteshi	
<hr/>	
<b>Influence of the Coal Quality on Abrasion of the Boiler Elements</b>	<b>45</b>
Lidija Joleska Bureska	
<hr/>	
<b>Sustainable Development of Architecture in Continuity</b>	<b>53</b>
Vangel Dunovski, Olivera Stojanovska	
<hr/>	
<b>Welding as a Technological Process and Its Impact on the Environment, Health and Safety at Work</b>	<b>61</b>
Isein Ajdari, Aleksandra Porjazoska Kujundziski	
<hr/>	
<b>Characteristic Points of a Triangle Presented through the GEOGEBRA Software</b>	<b>70</b>
Vesa Mollakuqe, Elissa Mollakuqe	
<hr/>	
<b>Some Approximations for the Euler Number and Comparing their Convergence Using Software Octave</b>	<b>76</b>
Ilir Demiri, Shpetim Rexhepi, Egzona Iseni, Samet Kera	
<hr/>	
<b>Sustainable Urban Mobility Plans For a Successful Future of Cities</b>	<b>85</b>
Jovan Hristoski, Olivera Petrovska, Andon Petrovski	
<hr/>	
<b>Application of Newton's Forward Interpolation using MATLAB</b>	<b>90</b>
Liridon Zenku, Zoran Trifunov	
<hr/>	
<b>Author Guidelines</b>	<b>98</b>

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## EDITOR'S MESSAGE

South East European Journal for Sustainable Development (SEEJSD) is an international journal of University "Mother Teresa" in Skopje, which this year enters its fifth year of publication. In the past four years, thanks to the cooperation with all of you, we managed to publish eight issues (two issues per year). Thanks to the interest of other authors and collaborators, as well as the Editorial Board, the journal has gained in terms of quality and relevance in the academic community.

Like all other social and economic activity, the academic activity, both educational and scientific, was severely affected by the Covid 19 pandemic itself and its aftermath. In these conditions we managed to organize the planned International Conferences during this year as well.

The international conferences "Towards Sustainable Development" (TSD 2020), "Pandemic-related challenges faced by migrants", as well as the one dedicated to "Interculturalism" were successfully organized on-line. At the same time the works in -exzenso after the peer review were published in our journals SEEJSD and Interculture.

The successful organization of Conferences and the publication of journals assures and encourages us that even in difficult times like this filled with uncertainty due to the pandemic, we will be able to overcome the challenges while hoping for better days, and we will witness the end of pandemic and its consequences.

Organizing all our academic activity in these conditions was a challenging test for the entire academic community which increases our confidence that universities but also our societies, with their academic capacity and innovative ideas will know how to successfully face and overcome whatever challenges the future may bring. This situation reminded all of us to provide new knowledge and competencies in our educational systems in order to prepare new generations even with the new unknowns for which we now have no experience. Predicting such a future with many unknowns and preparing a staff how to deal successfully with them will be a new task within our academic mission.

I sincerely hope that the publication of this issue of SEEJSD finds you well. I want to thank you for the cooperation and invite you for even more intensive cooperation in the future.

I would also like to thank the Editorial Board for its support as well as my collaborators at MTU, without whose help and contribution the publication of this journal would have been difficult.

Sincerely,  
*Editor in Chief,*  
Prof. Aziz Pollozhani, PhD







# **Analysis of Rewarding Programs and its Impacts to the Level of Satisfaction of Employees at Food Industry Organizations**

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## **Abstract**

The need for effective management of rewarding programs has always been the subject of discussion for both side's employees and employers. The turbulent environment is imposing companies to compete for attracting the high quality staff and providing long term retention. Satisfied employee leads the company towards growth, development and prosperity, preserving its vitality, flexibility and profitability. Therefore, the dynamics of today's business environment impose a constantly changing environment in which companies must adapt and maintain strong competitive advantage to ensure survival, growth and development. Nowadays running a business is more dynamic and complex, and is followed by many risks, constraints, pressures and various other requirements imposed by environment. That is why today's companies need to put in more effort to exploit a variety of different knowledge and experience to build fair and equity rewarding systems. The processes of hiring, motivating and maintaining a quality workforce is imperative for a competitive enterprise. Therefore, our aim in this paper, through empirical research and various theoretical and practical approaches is to consider the main dimensions of rewarding system and how it will functioning as integrated reward system for employees of food industry. Also, through the information received, we propose ideas, suggestions and criteria for successful development and implementation of an integrated reward system that will influence to improve satisfaction of employees and the success of the organizations in food industry.

**KEYWORDS:** *Reward, Payment, Food organization, motivation, integrated reward system, recognition.*

## ***1. Literature Review of the Rewarding Elements and their Importance***

In a competitive business environment, all entrepreneurs seek to improve quality and reduce costs. The reciprocal process between the employee and the employer means that employees invest their effort and energy only if they see benefits and rewards for them. That is why in every company are different reward and recognition programs available to attract, maintaining and motivate employees with commitment toward goals and success of the organization.

The key role of an organization's reward system is to adapt employee interests and strategic goals of enterprises by attracting and retaining capable people, increase commitment and encouraging employees to develop their skills, knowledge and motivation. Therefore rewarding program has been always part of human resource management (example: salaries, benefits, training, careers, etc), but also represent a significant and growing investment for any organization. Generally, before preparing rewarding programs should examine some important dimension such as<sup>1</sup>:

- [1] How can we attract and retain the right people?
- [2] How to motivate and develop employees?
- [3] Do we know what kind of skills, knowledge, experiences and behaviors we actually reward?
- [4] How do we pay for performance?
- [5] Are salaries, benefits and career investments aligned with each other and with business strategy?
- [6] How do we measure the return on our investment in people?

Rewarding system is a process by which individuals are valued for performance of their work, which includes not only their current salaries but also bonuses, benefits, opportunities for learning and career advancement, and any other programs the company can offer. When evaluating the rewards components offered by a company to its current and future employees,

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<sup>1</sup> THOMAS B. WILSON; (2003); *Innovative Reward Systems for the Changing Workplace*; Second Edition; The McGraw-Hill Companies Inc ; United States of America p.16

always should get into the consideration the relationship between importances of each rewards components. Rewarding components are these:<sup>2</sup>

$$C=(BP+AP+IP)+(WP+PP)+(OA+OG)+(PI+QL)+X$$

TC = Total compensation;

BP = Basic Payment or Salary;

AP = Incremental payment or payments received at the correct time interval such as overtime payments;

IP = Indirect Payment (Benefits);

WP = Work-related rewards, including equipment and uniforms and other elements that facilitate the performance of work;

2. = Perks pay anything from accessories to employee discounts on company products, gifts or special benefits;

OA = Possibility to promote, participate and increase responsibility;

OG = Opportunity for growth through on-the-job training or external training;

PI = Emotional Improvements and Satisfaction from the work - Physical Improvements

QL = Quality of life, expressed by working close to home, through flexible working hours and other employee benefits

X = Other unique requirements issue that employees want the company to allow (informal dressing, informal communication, custom interior design and other unique requirements, such as: "Can I bring my dog to work?")

We can see that

Basic and variable payments, short-term incentives and incentives, other lump sums and payments, cash-flow profits sharing, long-term incentives and high performance reward plans should be incorporated on the rewarding programs of the organization. Many HR professionals find that higher salaries can help attract and retain the firm's talent by reducing long term recruitment cost and turn over cycle. Organizations struggle to define the "legal equation" how to reward the right people, right amount, right reason and at the right time. Therefore we continue by showing other models of rewarding components from other authors:

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<sup>2</sup>John E. Tropman; (2001), *The Compensation Solution, How to Develop an Employee-Driven Rewards System*; John Wiley & Sons, Inc; United States., p.30

### Model of Rewarding System

		Direct material compensations	In-direct material compensations
Level	Unit	Salary, bonuses and incentives Compensation for innovation and improvement Benefits for sharing knowledge and flexibility Other incentives	Scholarships and tuition fees Study trips and Specializations Free days Company car Managerial benefits
	Company	Bonuses related to the results and performance an organizational unit or enterprise Share of profit A share in ownership	Pension insurance Health care Life insurance and other insurance Unemployment benefit Education, holidays Bonus

Source: Thomas B. Wilson, **Total Rewards Strategy**, Lance A. Berger and Dorothy R. Berger, "The Compensation Handbook" 5th Edition, McGraw Hill, 2008, s.27.

Rewarding System			
Financial		Non-financial	
Direct	Indirect	Work	Work environment
Salary	Social Fees: Pension Fund,	Interesting tasks	Business policy
Fees- honorary	Education	Challenges	Management
Travel costs	Life and health insurance	Responsibility	Stakeholders - Contributors
Representations cost	Absence, annual vacation	Self-affiliation	Status
	Loan	Education	Working conditions, Part time
		Advancement	Shortened working week
		Achievement, Contacts	Division of work, Food

Source: Ahmet C. Acar, **İşletmelerde Ücret Yapısının Oluşturulması ve Bir Uygulama**, Literatür Yayıncılık, İstanbul, Ağustos 2007, p.9 and Robert Dimitrovski, 2006, **Management**, - Skopje, p. 151

We can see that rewarding programs include two major category of compensations, financial and non financial forms. **Direct forms of compensations** include financial elements that employees

receive as a basic salary, variable payments, bonuses, other increases to maintain purchasing power, overtime pay, lump sums and performance dependent payments.

Traditionally, the amount of the **basic salary** reflects the different levels of education, experience, responsibility, abilities, skills, or reputation that the individual bring to the organization. Basic payments also vary depending on the industry. For example, as more profitable and more capital intensive industries always pay higher levels of basic payment, for example the oil, gas and pharmaceutical industries pay their employees 20 to 50% more than manufacturing, retail and social services industries.

Another element of compensation is **performance-based payments** that take into account the individual's contribution to the organizational units, team or organizational performance. Variable payment can take many forms from bonus programs, option shares, or one-off lump sum rewards for significant accomplishments. Companies that have created variable payment plans want to achieve the business success by right relationship of performance and payment.

**Bonus programs** usually reward individual accomplishments, but they are most often used to stimulate sales of companies or to encourage sales staff to generate extra revenue and high profits. Bonuses can also be used to recognize group achievements. Bonus programs to be successfully implemented should defined measurements and criteria, that will determine when, how, why, to whom and how much of bonus will be allocated.

**Profit sharing** programs mean that among employees in the organization will be sharing package of profit which every employee will take a certain percentage of the company's profits. The amount of profit awarded to employees is usually equal to the percentage of his salary and is distributed when the business year ends.

Another key component of the rewarding **system is benefits**. Benefits are an element of compensation system that are designed to provide employees and their families with safety. The benefit covers two types of programs:

- ☐ **Employee Protection Program:** Health Insurance, Pension Insurance, Social Security, Life Insurance,
- ☐ **Paid absence :** healthy problem absence, vacation, maternity and others.

**Employment - Career** is an important part of the rewarding system that includes improving skills, abilities, work habits, training and career development, promotion training, work rotation, work enrichment, stable employment, and others.

## ***2. Importance of the Paper Study***

Factors that influence employee motivation are always in the function of improving job performance. This mean that satisfy employee can be a creative person through appropriate methods and techniques can initiate more actions to achieve organizational goals. Satisfaction can be defined as an emotional and behavioral response to work, or as a general attitude to work. The need to be competitive on the labor market requires from food industry organizations to pay more attention about building an integrated rewarding system. The efficiently reward system motivates people, satisfies them and makes them feel valuable, meaningful, mutually respectful and positively oriented to create a winning family culture. Accordingly, organizations need to understand the different needs of employees resulting from theirs diversity. Due to the fact that people are not coming only with their qualifications and skills but also with different attitudes, fears, uncertainties, arrogance, complexity, prejudice that can quickly turn into destructive energy for realizing organizations objectives. The level of job satisfaction is influenced by human beliefs and expectations as well as other factors, like job characteristics, superiors' behavior, work atmosphere, culture and others. Therefore companies to have employees' motivation should take into consideration these following areas:

- ☐ Social factors;
- ☐ Relationships with superiors;
- ☐ Internal factors;
- ☐ Reward components;
- ☐ Opportunity for learning and development;
- ☐ Safety at work;

Also companies' must take into considerations a well-designed workplace that will have these motivational features:<sup>3</sup>

- ☐ Different skills; ability to use different skills;

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[1] John E. Tropman; (2001), *The Compensation Solution, How to Develop an Employee-Driven Rewards System*; John Wiley & Sons, Inc; United States, p.179

- [2]. Identifying the task; the opportunity to complete the work completely;
- [3]. Knowledge of results; an opportunity to know what happened as a result of his work;
- [4]. Significant experience; an opportunity to feel what happened as a result of his work;
- [5]. Autonomy; the opportunity to work in their own way, with few restrictions;
- [6]. Responsibility; Possibility to calculate the working actions themselves;
- [7]. Feedback; information on how current performance evolves;

Rewarding programs and systems can include many types of reward, starting with verbal/social rewards, material/ symbolic rewards, work related rewards and money related rewards. All of this kind of rewarding category will be explain in following table. Table 1. Rewarding programs and systems

Verbal/social rewards	Material / symbolic	Work-related rewards	Money related rewards
<ul style="list-style-type: none"> <li>• Specific compliments;</li> <li>• Acknowledgments;</li> <li>• Commendable letters;</li> <li>• Celebration of activities / lunch;</li> </ul>	<ul style="list-style-type: none"> <li>• Trophies - plates;</li> <li>• Special perks for accomplishment;</li> <li>• Travels, tickets and evenings;</li> <li>• Lump sum rewards;</li> </ul>	<ul style="list-style-type: none"> <li>• Promotion;</li> <li>• Special development of programs / projects;</li> <li>• Increased decision-making authority;</li> <li>• More challenging tasks;</li> </ul>	<ul style="list-style-type: none"> <li>• Salary and increased salaries;</li> <li>• Overtime and payment for special tasks;</li> <li>• Variable payment or incentive payment;</li> <li>• Optional shares / participation in equity;</li> </ul>

**Source:** THOMAS B. WILSON ; (2003); *Innovative Reward Systems for the Changing Workplace*; Second Edition; The McGraw-Hill Companies Inc ; United States of America p.31

Managers must use different strategies and techniques to reward their employees if they want to have committed labor force. Among the most popular non-monetary forms of rewarding are **empowerment and participation** on the decision making process. Empowerment and participation are important methods that managers use to enhance employee motivation. Empowerment is the process by which employees have the freedom to set their own work goals, make decisions, and solve problems that lie within their department of responsibility and authority.<sup>4</sup>

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<sup>4</sup> Ricki B. Graffin, "Management" Texas University, USA, 1996, p. 267



## ***[1] Research Methods***

Through empirical research and various theoretical approaches we aim to analyze the main dimensions of rewarding system and do it functioning as an integrated reward system for employees at food industry organizations. Through the information received, we propose ideas, suggestions and criteria for successful development and implementation of an integrated reward system that will influence to improve satisfaction of employees. This section of the paper will show the general results of a survey of 132 employees from food industry composed by 45 questions. The questions are multiple-choice and are expressed in quantitative terms, ie., the selected alternatives are calculated in percentages depending on the respondents' desired answers.

The purpose of this research is to look at the functioning of the overall reward system in food industry organizations, covering the following dimensions of research: perceptions of barriers, employee satisfaction and dissatisfaction, and the overall functionality of the reward system. But, additionally, as an important part of the research is determining employee preferences for certain elements of the rewarding system, which will be used as input to further analyze and propose a specific model, where all employees will be more motivated and more committed to their work activities and responsibilities.

An important part of the research is determining employee **preferences** for certain elements of the rewarding system, which will be used as **input** to further analyze and propose a **specific model**, where all employees will be more motivated and more committed to their work activities.

## ***4) Findings and Results***

The actual situation according to the answers of the surveyed employees of food industry will be presented on the table where the specific answers to each question will be showed. To be more clearly, the respondent data will be presented in percentages and comparable in a single employee chart.

Nr.	QUESTION	EMPLOYEE	
1	Age	25-34 year	12 %
		35-44 year	31 %
		45-55 year	28 %
		Up to 55 year.	28 %
2	Gender	Male	53 %
		Female	46 %
3	Education level	Secondary Education	65 %
		High education	26 %
		Primary education	8 %
4	Marital Status	Married	71 %
		Not married	28 %
5	Things that make me go to work	Work improves my standard of living	40 %
		I go to work because I have to survive	35 %
		I love my job	21 %
		The job gives me pleasure	8 %
		Other	2-3 %
6	Working environment is making me feel	Creatively	38 %
		Lucky	32 %
		Indifferently	14 %
		Passive	10 %
		Frustrated	5 %
7	How satisfied you are with the job	Satisfied	41 %
		Average	28 %
		Pretty Satisfied	19 %
		Very Satisfied	10 %
		I'm not satisfied at all	2 %
8	How satisfied you are with the evaluation of your knowledge, skills and effort	Satisfied	41 %
		Average	26 %
		Pretty Satisfied	11.4 %
		I'm not satisfied at all	10.6 %
		Very Satisfied	9.8 %
9	What types of benefits do you receive in your organization?	Individual insurance	33 %
		Reduce the prices of the company's products	27.3 %
		Meals, clothing accessories, credits	3 %
		Company car and gasoline	3 %
		They didn't answer	50 %

Nr.	Question	EMPLOYEE	
10	What is the attitude of your supervisor?	The relationship is friendly and open	47 %
		The relationship is pleasant and clear	44 %
		Closed	8.3%
		Arrogant	0.75 %
		Dumb	0.75 %
11	What do you feel in terms of job development?	My development goes up	51.4 %
		We stay at the same workplace	44.3 %
		We are not developing, on the contrary we are backward	0.8 %
		No comment	2.3 %
12	Is the current compensation system fair?	Yes	45 %
		No	45 %
		No answer	10 %
13	Are you satisfied with your current salary?	Yes	50.7 %
		No	44.6 %
		No answer	4.6%
14	Would you recommend a relative or friend to work for the same company?	Yes	72 %
		No	20 %
		No answer	8 %
15	I believe they treat me as a valuable member of the company?	I completely agree	39 %
		I agree somewhat	39 %
		Somewhat disagree	15.3 %
		I totally disagree	0.8 %
		They didn't answer	6 %
16	I feel free to make suggestions for improving work processes	I totally agree	41.5 %
		I agree somewhat	31.5 %
		Somewhat disagree	13 %
		I totally disagree	9 %
		They didn't answer	5 %
17	My tasks and responsibilities are quite clearly defined	I totally agree	50 %
		I agree somewhat	30 %
		Somewhat disagree	10 %
		I totally disagree	3 %
		They didn't answer	7 %
18	I receive the right training to do my job effectively	I totally agree	53.8 %
		I agree somewhat	27.7%
		Somewhat disagree	9.2 %
		I totally disagree	1.5%

		They didn't answer	7.7 %
19	If I have a question I feel free to talk to my supervisor or senior managers..	I totally agree	54.6 %
		I agree somewhat	22.3 %
		Somewhat disagree	6.1 %
		I totally disagree	10 %
		They didn't answer	6.9 %
20	I feel that this company gives me security for future in my work	I totally agree	55.4 %
		I agree somewhat	19.3 %
		Somewhat disagree	8.5 %
		I totally disagree	7 %
		They didn't answer	9.2 %
21	I am pleased with the value of my knowledge and skills	I totally agree	31.5 %
		I agree somewhat	33.8 %
		Somewhat disagree	14.6 %
		I totally disagree	10.8 %
		They didn't answer	9.2 %
22	Physical conditions are good and meet my needs	I totally agree	42.3 %
		I agree somewhat	23 %
		Somewhat disagree	17.7 %
		I totally disagree	6.2 %
		They didn't answer	10.8 %
23	The relationships with superiors and managers are excellent	I totally agree	44.6 %
		I agree somewhat	28.5 %
		Somewhat disagree	7.7 %
		I totally disagree	8.5 %
		They didn't answer	10.8 %

Rank the potential reward components according to the employees' wishes, ie., the most unimportant (**insignificant**) 1 - 5 most important (**significant**) potential reward.

Nr.	Type of award	Most insignificant 1	2	3	4	Most significant 5	No answer
1	Free one month training to improve your own skills	23,6 %	9 %	13 %	11,5 %	12,2 %	27,5 %
2	Bonuses	6,8 %	2,3 %	10 %	16 %	48,8 %	16,8 %
3	13th salary,	10,7 %	6,1 %	5,4 %	9,1 %	50 %	16,8 %
4	Working conditions (working hours	3 %	5,4 %	11,5 %	22 %	35 %	20 %
5	Promotions	9,2 %	3 %	9,2 %	20 %	40,5 %	15,3 %
6	Extended vacation,	17 %	8 %	15 %	13,4 %	23,6 %	22,8 %
7	Praise and acknowledgments	12 %	8 %	21,5 %	16,7 %	24,6 %	17,5 %

8	Bigger pay is motivation	6 %	6 %	8,5 %	10 %	61 %	7,8 %
9	Academic trips (seminars)	26 %	5,5 %	12,6 %	22 %	15 %	19 %
10	Car, phone or laptop,	20,6 %	12,6 %	11 %	4 %	18,3 %	33 %
11	Flexible working hours,	0,6 %	7 %	8,8 %	14,3 %	25,4 %	23,8 %
12	Good manager - decent and fair to the employee	4 %	4,6 %	5,5 %	18,8 %	48,5 %	18,8 %
13	Financing recreational and sporting events for employees	19 %	8%	15,8 %	9,5 %	28 %	19,8 %
14	Company products at lower prices	13,4 %	9,5 %	11 %	12,6 %	33 %	20,5 %

The profile of the employees in the food industry is dominated by employees from 35-44 aged, who have a high school education and married. Regarding the reasons why they go to work, most employees go to work to improve their living standards. In terms of that how they feel at the workplace, most of them feel creative and happy, but there are also employees who feel indifferent, passive and frustrated. In terms of what is the first word that employees get in mind when they think about workplace are: Creativity, happiness, friendship, then enthusiasm, challenge, research, a pleasant atmosphere, pleasure, coffee, career, but there are those who they think it's just survival, responsibility, commitment, traffic, physical exertion, nervousness, uncertainty.

Regarding employee dissatisfaction and obstacles that are present in front of employees are: current salary, insufficient recognition, lack of collective vision and informations, low diversity of benefits types, selective rewarding and uncomfortable physical conditions. Diverging opinions of employees in terms of career development, justice of the reward system, solving problems, complaints of employees and level of sharing information for everyone in the organization.

Employee rankings (1-5) of the proposed reward components, and like a most significant elements are: bonuses, 13th salary, working conditions, career promotion, salary and lower priced company products. Less important are training and development, extended vacation, praise and recognition, academic trips and seminars, official business car, a phone or laptop, or funding for recreational sporting events.

On the same time we saw that offering company products by at reduced prices is more valuable and preferred by employees. Low price products of the company is a desirable element

because it is directly affects to the low-paying structure of the employees and serves as a social measure to increase the effective salary and improve the living standard of the them. This shows the real situation that are facing employees in the food industry or maybe at overall labor market of the North Republic of Macedonia.

##### ***5) Conclusions and argumentation of originality and contribution about implementing rewarding system and strategy***

Reward strategy is used by companies to transforms its competitive business strategy into a series of programs and initiatives that will have a positive impact on human behavior. It shows us that reward system is a necessary part of every business system that will help for successful implementation the vision and strategies of organizations. In order to be successful, reward system should function as an integrated system, its elements need to complement each other and sometimes one of the rewarding components should be given greater advantage over another element of the reward, for example basic pay, variable pay, bonuses, recognitions, actions or other forms of compensation, should be implemented and adjusted by the firm's budget.

As a part of rewarding system, variable pay plans and bonuses, in advance should be determined by a measurements and criteria about when, how, why, to whom and how much payments will be allocated. While designing a recognition program should always be honest, timely, understandable, individual, fair and oriented towards the overall goals of the company. For recognition to have a great effect it has to be real, current and timely, and its power is even greater if publicly stated.

Food industry organizations operating in the current business environment on the North Republic of Macedonia, as the most important factor for employees and employers are: financial parameters of rewarding system. Employees are struggling for higher wages, while employers want always to keep their payments to a minimum level and as a result to providing higher profits. High unemployment, low standard of living in Macedonia, high labor supply, non-standard business processes, unstable sales, instability in fiscal policy, traditional way of running business etc., are some of the reasons that rewarding system is not at the satisfaction level. Research shows that the most important factors of motivation, productivity and effectiveness of food business organizations are: Financial aspects; social factors; relationships with superiors; award components; opportunity for learning and development; occupational safety; safety at work and others.

Therefore every organization need to find a way how to influence on the behaviors of its employees towards achieving the goals and strategies of the company. This is achieved by focusing on certain activities, explaining the objectives and defines the essential knowledge, skills, and abilities that are needed to achieve the planning goals. Also it has been proven that companies should always be reinforced by the positive consequences that give long-term success for company. Positive consequences are those expressed through a pleasant feeling, a well-done job, job satisfaction or performance-related recognition that the employee receives. On the other hand, the traditional negative consequences that causes negative reactions on the individuals' behavior, such as public criticism, freezing payments, job rotation, degradation or dismissal, should be minimized.

As general rules that should be following by companies in the food industry in terms of rewarding their employees are: justice and fair payment and treatment, designing more interesting work, providing opportunities for advancement, participating in decision-making, stimulating teamwork, respect and sincere praise, and other specific forms that will meet the needs of the human being as an employee.

According to research, employees in the food industry vary by the wishes and desires of the employees depending on the level of education, sex and age of the employees. Recognition programs tend to be more preferred by younger than older, female gender employees preferred more team rewards while the male gender employees, individual rewards. Accordingly, men are more focused on advancement and earnings, while women employees are more focused on interpersonal relationships as a major factor of job satisfaction. Female employee's show that work environment is more important to them and they are even more active when is given greater decision-making power.

At the end integrated rewarding system in food industry organizations should consist several financial and non-financial elements, including internal motivation (through education, promotion and development) and external motivation factors (salaries, benefits, work conditions, management, etc.). But the most priority for food industry employees is to determine a **fair basic** payment level that will meet the basic living needs of employees, that will be tailored to the organization's financial capacity. Food industry organizations should also place particular emphasis on the benefits of retaining the most valuable or talent- employees.

## 6) *Suggestions for successful implementation of an integrated rewarding system*

Financial parameters are one of the most important elements of rewarding system for employees and employers on the food industry organizations in the North Republic of Macedonia. This impression is current because of the low standard of living in the North Republic of Macedonia. Also in this low living standard affects higher unemployment, low wages, restricted benefits and inability to develop on career, non-standardization of business processes, practices and policies, and others. That means that organizations are "as their rewards are."

According to the results presented in the rankings awards components are found these conclusions: Regarding the issue of ranking the potential reward: 13th salary, working conditions, higher wages and promotion of staff, good manager, fair treatment, are with greater importance and influence for employees to be more committed, loyal and successfully. On other hand praise and recognition are less important to employees, because if they are not satisfied with basic financial needs, recognition will not give effect for them. Non financial awards are complementary, but not replacing financial ones. While academic trips - seminars, flexible working hours, financing of recreational sporting events are with lowest interest by employees. Manager cans successfully applying rewards to employees if they follow the following rules:

1. Employees should be treated as individuals - every worker wants to be treated as a person, not as a number or an object.
2. Making the job more interesting - many things are monotonous and annoying. As a result, interest and motivation decrease.
3. Providing opportunities for advancement - the opportunity to advance can greatly motivate employees.
4. Allowing participation in decision making - every employee wants to keep up to date with events, not only within their own sector but within the whole organization.
5. Allowing teamwork - the sense of belonging and being a vital team member contributes to meeting the need for respect and recognition.
6. Respect for Employees - The manager of the enterprise should make constructive comments on the ideas proposed by the employees.
7. Giving Honest Commendation - True appreciate for a well-done job is a strong motivator.
8. Successful Conflict Resolution - The manager of the company should evaluate, understand, and resolve conflicts that may arise



Also our suggestions about determine and implementing reward systems on the food industry organizations should following these rules:

- Financial rewards should always be related to performance outcomes that are achievable and are established by performance standards;
- There must be a clear link between performance output and effort;
- Rewarding system must be based more on the positive than on the negative consequences of working behavior;
- Increasing reward should be equivalent to increased additional effort;
- Increasing job performance and success should directly be followed by salary increases;
- The financial compensation must be adequate to the job efforts and fair compared to others;
- The pay gap between good and bad workers must be significant in order to stimulate job performance and success.

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# Impact of ICT in Healthcare System and Implementing IT strategy In developing Countries

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## Abstract

The use of ICT in medical services has made it possible for us as researchers in the field of health care to contribute to acceptable solutions to overcome this situation by using ICT as a key tool for improving health services. During the research, the Strategies of developing countries, respectively Western Balkan countries, have been reviewed, analyzing how advanced they have been towards Kosovo and how much they have adhered to the WHO recommendations. In this paper it has been identified that the main problem in developing countries, especially in Kosovo, remains high mortality, where the findings show that mortality has increased especially as a result of chronic illness due to lack of information at the time of appropriate for medical staff and patients. At the same time, there is a high lack of digitalization of processes in the management of medical services, which has directly affected the health of the population and the performance of the stakeholders, which provide health services. The research has also resulted that Kosovo has failed in many phases. The national strategy for the implementation of the eHealth system as well as the state of health services in Kosovo remains with traditional paper-based methods. Therefore, my intention is to propose a strategy for the implementation of the health system where the objective is to improve the current situation in healthcare. The paper will focus on electronic healthcare system strategy and its implementation. A system framework will enable us to understand the daily needs of people with illnesses in order to develop tailored ICT solutions, which can help them, maintain or improve their health status and well-being during the time. The proposal follows the enterprise architecture principles and tries to set up an implementation roadmap.

**KEYWORDS:** *E-health, Strategy, Technology, Security, Patients.*

# 1 Introduction

ICT has covered virtually every aspect of life, including health care. The health information system is the creation of a standardized patient data exchange platform, through network infrastructure, hardware and software solutions. Already developing countries in EU state are applying electronic health data services, and this is seen as one of the most dominant forms of communication in healthcare institutions. This service is replacing traditional medical services by transforming them into visual electronic form, which data are estimated to be more reliable in the decision-making process by medical and management staff in healthcare institutions. During the research of this paper, it has been identified that the main problem in developing countries, especially in Kosovo, remains high mortality, where the findings show that mortality has increased especially as a result of chronic illness due to lack of information at the time of appropriate for medical staff and patients. At the same time, there is a high lack of digitalization of processes in the management of medical services, which has directly impacted on the health of the population and the performance of the stakeholders, which provide health services. The research has also resulted that Kosovo has failed in many phases. The national strategy for the implementation of the eHealth system as well as the state of health services in Kosovo remains with traditional paper-based methods. In reviewing the literature, researchers argued that the implementation of information systems has provided first results in medical services, especially in patient monitoring and administrative processes. Viewed literature is also used to elaborate all technologies that include the health information system, ranging from application level, level of data, and technology level, which support information systems in their performance. At the same time, a special focus on this paper is given to standards and safety of medical records, which are a priority in a healthcare system. The Strategy Implementation Recommendation is based on the TOGAF framework, which includes all levels, from application level, Data level, and technology or hardware level, as well as describing and visualizing the steps and tasks of implementation by level Baseline architecture to target line architecture.

## 2 Problem statement

During scientific research, reports and other relevant documents related to the health system in Kosovo, it has been evidenced that although after 19 years after the war we still have serious problems regarding access to health services. The increasing scale of mortality is evident every year as a result of healthcare. At the same time, there is a lack of digitalization in work and management processes in hospitals. Besides that, many social indicators witness for a worrisome situation in this regard. The objectives of the National Health Strategy of Kosovo are almost the same as other Western Balkan countries because Kosovo and most Western Balkan countries have similar history heavily influenced by the political conflicts of the last three decades. Whereas, regarding the implementation of the National Health Strategy, Kosovo has stagnation. Compared to the developed countries of the European Union, the Western Balkan countries including Kosovo, stagnate considering implementation of eHealth strategy. The slow pace of eHealth development is due to the lack of financial funds and political support. However, the results also show there are also promising strategic projects within the Western Balkan countries, especially in Serbia and North Macedonia.

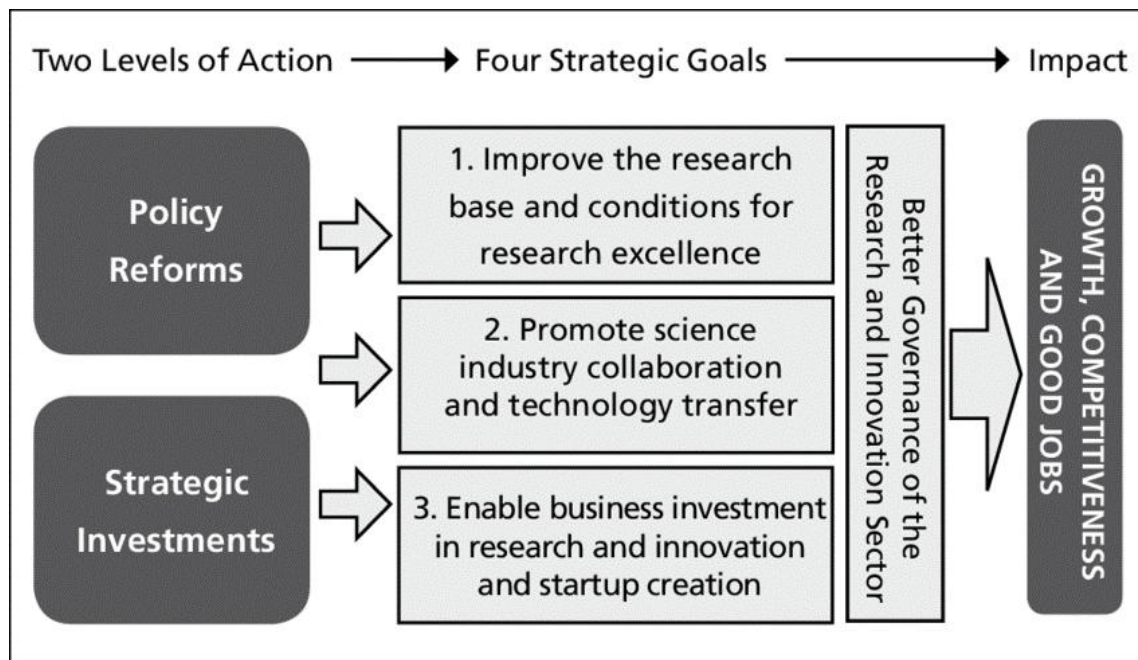
## 3 WHO strategy and digital services eHealth in western Balkan

The WHO's main goal under the 2020 Strategy is that in European countries, the national or local health management will be replaced by standardized and unified health systems so that they can be interconnected. European countries through the approval of the WHO 2020 Strategy have been endorsed for two common objectives, the need to improve health for all, and the need to strengthen leadership and participatory governance in healthcare.

Compared to the developed countries of the European Union, the Western Balkan countries including Kosovo, stagnate considering implementation of eHealth strategies (Piha, 2015). The slow pace of eHealth development is due to the lack of financial funds and political support. However, there are also promising

strategic projects within the Western Balkan countries, especially in Serbia and North Macedonia. As mentioned above through the National Health Strategy, (now) North Macedonia in 2011 started implementing (MyTermin) in order to improve clinical appointments and to reduce the long waiting times of doctors' checks and the diagnostic tests. Initially, (MyTermin) was used in three public institutions, but quickly expanded to public hospitals and primary care providers, but further development continues. The implementation of the health information system in Serbia is far more developed compared to other Western Balkan (Vučetić, Uzelac, & Gligorić, 2011) summarizing the National Strategy of Health of Serbia, conclude the implementation of the health information system has produced satisfactory results. As a result of drafting a lucid and straightforward national health strategy, Serbia has benefited from several European Union projects closely related to the WHO's Strategies for Developing Countries.

First Serbia's initial program was the development of the SIS system for Basic Health Services and Pharmaceutical Services, that same national project was extended from an initial project to a major project, which was initially tested in 4 hospitals and focused on standardizing and expanding technological infrastructure. The objectives of the National Health Strategy of Kosovo are almost the same as other Western Balkan countries because Kosovo and most Western Balkan countries have similar history heavily influenced by the political conflicts of the last three decades. Whereas, regarding the implementation of the National Health Strategy, Kosovo has stagnation.



**Figure 1: WHO strategy for Balkan country**

## 4 State of the art

A systematic review of literature I have undertaken is broadly discusses researches related to tele monitoring services, self-care and emergency treatment. The medical field needs to understand current technologies such as IT infrastructure, platforms, protocols, equipment, standards and possibilities. Benefits will be fully considered and covered by many articles, case studies, industry news and reports. The realization of ubiquitous computing requires the collaboration of many ICT areas. Its implementation depends on several factors such: specific application and devices (smaller, lower power processors), physical and semantic embedded systems, ubiquitous connectivity, interoperability (seamless networks, self-configuring), intelligent systems including sensor networks, context awareness, data handling, security and reliability (Ziefle, 2011), (Albahri, 2018). Researchers identified the eHealth infrastructure components based on demand to support the distribution of structured and meaningful health information across the geographic

and the health sector boundaries, to support improved or new ways of providing care services. via high-speed data connections (WiMAX, 5G) with health information records, authentication and authorization services.

#### **4.1 Related works case study**

Knowing that health sector is faced with expensive and complex services which have a major impact on the economy and the everyday lives of peoples, the United Kingdom is one of the first countries which has always been seeking improvements of the national healthcare system. A very important role in improving the NHS system was the technology that has been becoming more and present in these systems. One of the key goals of UK is to have a completely electronic healthcare system by 2020, leaving behind traditional forms of data retention in the paper (HMSO, 2009). Two projects, Health Gear and CodeBlue (Al Ameen & Kwak, 2011) aim to provide affordable continuous monitoring of a person's health-related issues. The major focus is given to the cost effectiveness and power consumption of devices used.

The LifeGuard project (Patel et al., 2012) which ran for astronauts in the first place, was also used to monitor the signs of the human body. The system consists of several components; the sensor interface can support different types of sensors such as ECG, breathing, pulse oximeter, and blood pressure.

The intelligent AlarmNet project was a prototype of a wireless medical network consisting of five components. The cellular network of body sensors is responsible for physiological monitoring and follow-up functions (Patel et al., 2012), (Alemdar & Ersoy, 2010). A project based on specific patient requirements, called MobiHealth was one of the earliest projects that integrate all sensor devices as body sensor, as PDA phones and the smartwatches a person carries during the day. Based on the literature review of mobile technologies we still did not find a version, which integrates the entire eHealth ecosystem, this is also a future research topic (Ziefle, 2011), (Al Ameen & Kwak, 2011).

### **[7]Recommendation of a strategy for implementation of eHealth system**

Based on the current situation and the functional requirements the proposed architecture is a solution that responds to current requirements and is in compliance with the standards in terms of technology and the compatibility recommended by WHO. For us it is very important to put the emphasis on the evolvement of different architectures and their interactions in the ecosystem. Interoperability feature of the architecture is the basis for the proposed strategy providing undeniable proofs that ICT has the potential to properly address customer requests. From an architecture design point of view the information system architecture bears decisive role, especially in the context of different types of interoperability. Interoperability requirements can be understood and interpreted with the help of typology of ICT backed decisions as prerequisites of coherent system design.

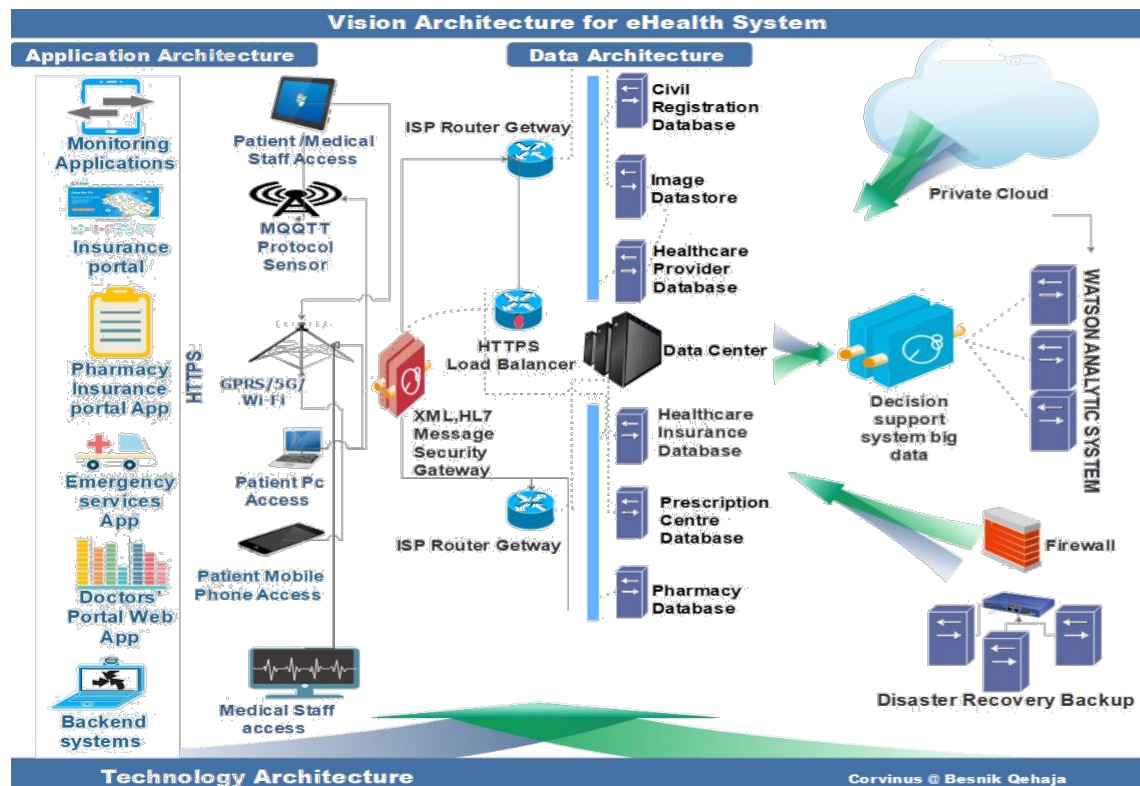


Figure 2: Vision Architecture in healthcare

## 5.1 Type standards for eHealth system

The information system is required to provide quick access to patient registration, patient's health profile and patient's medical history when and wherever a problem occurs. The patients profile data are essential in order to find and provide access to a patient's electronic health information. Electronic Health Record use a compilation of clinical practices, such as clinical data repositories, nursing documentation systems, clinical decision support systems, laboratory information systems, order entry, pharmacy management systems, physicians' documentation and diagnostic information systems. Information can be drawn from multiple sources while being managed, shared, and controlled by the individual. These standards can be classified in multiple classes including data standards, message standards, document standards, process standards. They can be syntax based, semantics-based, relationship-based, purpose-based, and classification based. International standard codes for diagnoses (ICD), (Health Level System 7) electronic health information records, IEEE 11073-20601-2008. Standard addresses needs for an openly defined, independent standard for converting the information profile of personal health devices into an interoperable transmission format, so the information can be exchanged to and from personal Telehealth devices and compute engines. Based on standards wireless communication protocols in wearable health monitoring systems use different protocol such as Bluetooth, Zigbee, and Infrared Ultra-wideband.

## 5.2 eHealth Applications access

The eHealth application architecture contains those applications, which are relevant for providing and managing healthcare services in the eHealth ecosystem. Below are some of the most important parts of the application architecture.

**Monitoring Applications** aim to collect data from the patients and from the environment in which the patient lives.

**Backend systems** will handle and manage databases, decision support actions, statistical-epidemiological reports.

**Pharmacy portal** historically allowed the patient to track purchases and insurance or social security funding of pharmaceutical products. Introducing e-receipt, medical institutions and pharmacies send and receive prescription data through the eHealth platforms, also the customer (the patient) will log in the system on the premises of the pharmacy, to get the prescribed medicaments.

**Insurance portal** This portal allows a patient to check its insurance status, the amount that the user has paid for the insurance, services the insurance covers, obtained services that insurance covered. Emergency services is a application designed to keep track of the status of the patients being in critical status, alerting medical staff in case of emergency.

**Doctors' Portal** This is similar to the Patients' Portal, but data access and information services are more detailed and customized on a professional manner.

**Patient Portal** is an application through which patient can communicate with the service providers

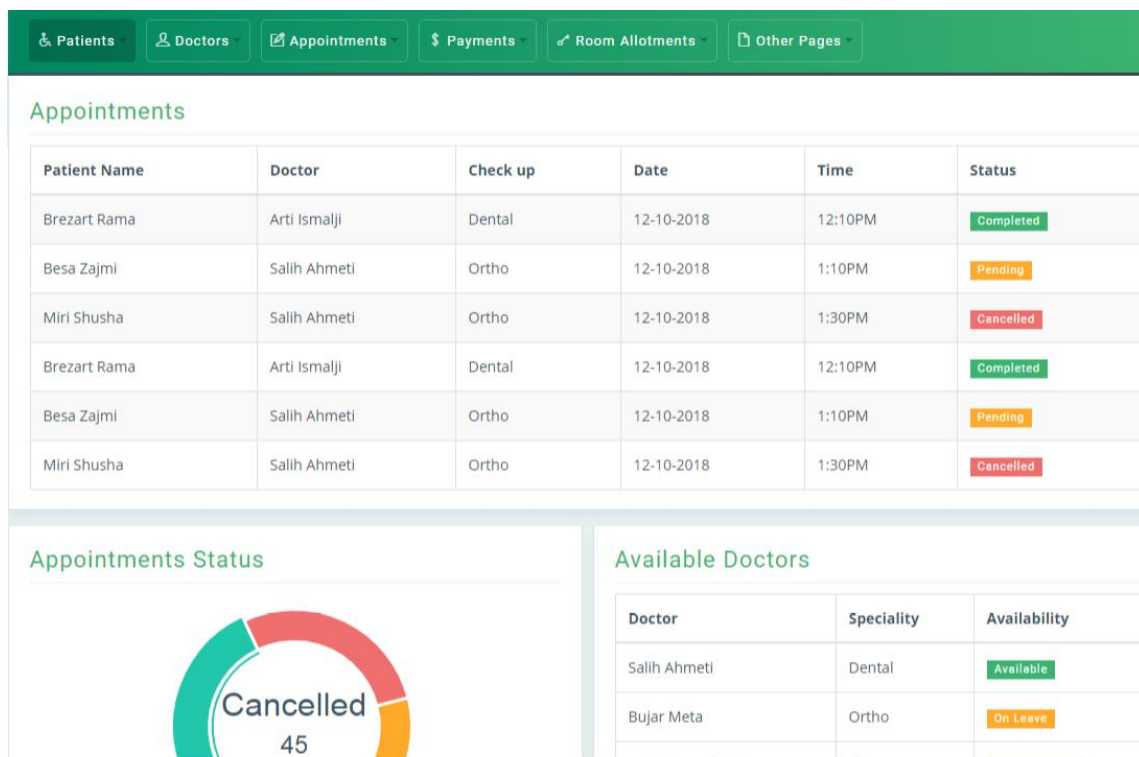


Figure 3: Application dashboard

### 5.3 Data Processing architecture

The interoperability of the eHealth system operates only when the data architecture allows to transmit information between two or more systems allowing one another to process the information in an independent manner and with a single standard. I have tried to compile flow of data where stakeholders in this architecture have unique data from different databases.

Below is the data architecture for eHealth and components are divided as follows:



Civil Registration  
 Database Image Data store  
 Healthcare Provider Database  
 Health Insurance Database  
 Hospital Resource Database  
 Prescription-Centre Database  
 Pharmacy Database  
 Medicine-center Database

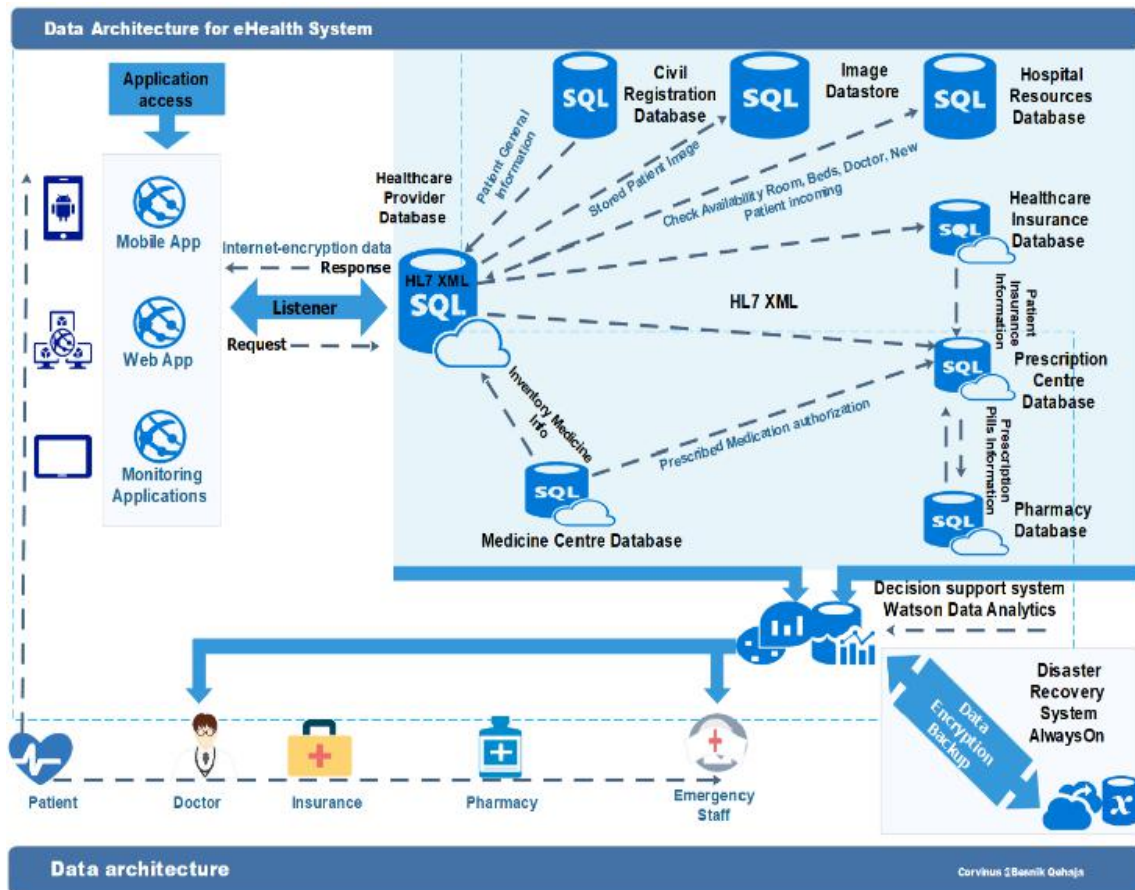


Figure 4: Data Architecture

The ultimate goal of the eHealth system is to have better information on evidence-based decision-making. Different stakeholders in the health sector have a different focus and will use the eHealth system for various purposes. The proposed solution below relates to the data that are collected, and are distributed among various databases and processed by the Statistical System through APIs to generate useful information. The number of sources of healthcare information such as EMRs, laboratory systems, diagnostic or monitoring instruments, insurance / billing requirements, pharmacies, human resources and vendor/supplier information, and real-time detection systems drives adaptation of the decision support system. The availability of as many healthcare data as possible is crucial, as stakeholders create more and more indicators for decision-making.

## 5.4 Data Security

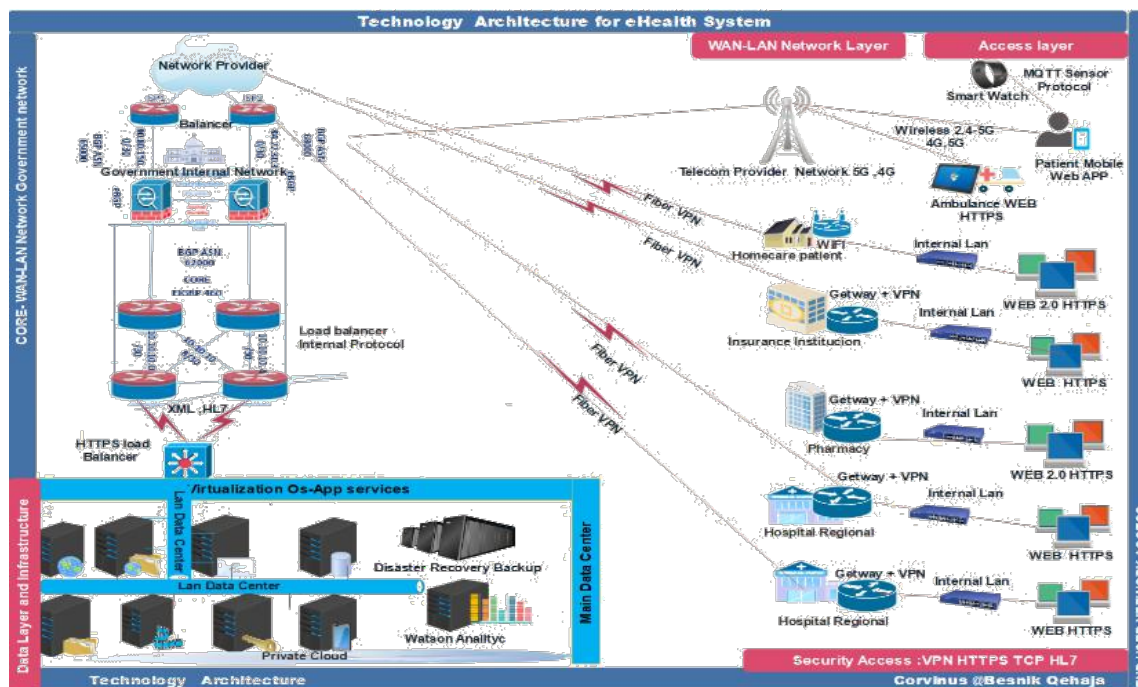
In the data architecture, the ecosystem is mirrored, where many data are stored in different databases and for eHealth system, it is vital to maintain and secure the data. Data security has the highest priority, because health records are classified and confidential, data encryption should be applied to the database. Backup copies must be also encrypted. According to EU rules, any information identifying an individual should be protected and coded against free reading and understanding (GDPR). Encryption can be done in several methods by deleting the rules and procedures that differ from which method is omitted. The minimum to be implemented is Encryption Data Transparency. Example: Encryption TDE should be created: for example certificate and database encryption key in combination with certificate. Among others, Always Encryption enables information to be generated from the database even it is transmitted over the network from the database to the client and is deciphered only in the relevant client application, which means that the data is also protected from administrators of the system. The security architecture you can find in figure 5.

## 5.5 ICT Infrastructure for eHealth Implementation

To propose a technological architecture solution for the eHealth information system, it is very important to emphasize the life cycle of different entities and their interactions in the ecosystem. The longevity of equipment and data lifetime is a critical part of the understanding the technological architecture at every level. Architecture can be analyzed in three relevant aspects that meet the requirements and objectives outlined earlier. The three aspects to be addressed during the technical architecture development are as follows: **Access Layer** the data collection and enhancer in this regard is related to how data is collected from end-user utilities. Data can be transmitted from various electronic devices and therefore we propose architecture layer for end-devices that can be used for both application and technical aspects, including communication capacity and protocol.

**Network Connection**, the focus for this aspect is related to how devices are connected to the ecosystem. There will be a review of the most advanced communication technologies inside and outside the system, by choosing adequate communication between end-devices and data storage devices, communication between mobile devices and the system using the latest technologies like 4G, 5G LAN, WAN (Oleshchuk & Fensli, 2011).

**Access Security and Privacy** treatment are one of special importance in this architecture where confidentiality will also be treated. As healthcare data will be communicated through wireless networks, efforts must be made to preserve confidentiality and privacy. Privacy includes user's right to control the collection and distribution of personal information, while security is the protection of user information from unauthorized access. To carry out the assessment of security architecture for eHealth, we will focus on the latest perspectives and assess the security challenges we have to cope with in each of the key areas, including: end-users and their access to internal networks, private cloud services, partners, internet service provider, health system data held on web platforms, and implications that may occur from standards applied to wireless devices.



**Figure 5: Infrastructure for eHealth Implementation**

In technological architecture as a primary objective, an interdependent and functional topology has been proposed in order to support / provide the necessary services for health institutions. Many factors are considered in this architectural solution, such as the definition of network topology, hardware selection and software platforms, as well as the ability to carefully configure each component. All of these elements are essential in addressing the requirements for a sustainable health system.

## 5.6 Cost Savings through Patient Monitoring in healthcare

Therefore, these are pointed out some notable indicators that investing in an eHealth information system is more than necessary and the return on investments is expected to be high. Investing in such an eHealth project justifies the cost of investing since in many aspects the architecture and the proposed system play a key role in cost reduction at all stakeholders, as well as increase the efficiency of health care services is expected. The justification for the investment costs as well as the role of each of the above proposed collection levels is provided below:

Patients and doctors through mobile and Web applications are fed with data, like registration of a meeting with a physician and payment, reduces the waiting time and helps coordinating processes and allocating resources better.

Distance communication reduces visits to hospitals, saves patient waiting time, allows having remote contact with the doctor, and enables monitoring patient's health in real time.

The doctor manages time better and decision making is more efficient, access to patient records is faster, more detailed and more reliable.

Through this medical-patient communication the system operates 24/7 and also open for emergency services.

The eHealth system also enables efficient management of drug prescriptions, enables monitoring and making sound decisions to avoid the excessive drug consumption.

## **6 CONCLUSIONS**

Taking into account all the proposals at all levels, namely Application Architecture, Data Architecture and Technology Architecture, also their standardized logical and physical connection, I believe that the proposed solution is realistic. With that being said, it is a realistic and achievable solution if the implementation involves the major stakeholders mentioned and presented above. In broad terms, the architecture meets the requirements to a certain degree and extent. But this does not affect the main architectural masterpiece and proposed solution. Furthermore, in the upcoming sections below, the implementation of the proposed solution and its architecture will be described in detail from the baseline to the target architecture; how the proposed solution can be put in practice. The implementation proposal of eHealth architecture requires a harmonized roadmap of planning activities in all types of architecture. Initially it should be analyzed the infrastructural aspect in the current situation of health institutions at state and local level. A very important aspect is the timeframe for all activities that can be carried out within the specified timeframe. From this perspective, having enough resources is of key importance to initiate with the eHealth system building, including human and technological resources, and how stakeholders are willing to be part of the development of the system. Throughout the proposed architectural recommendation, the scope starts from the current state to an adequate solution that covers the health system requirements for a stand-alone, sustainable version, in conformation with WHO standards.

## **7 FURTHER STUDY**

Though the challenges of providing high-quality healthcare in developing countries are different than those in developed countries, they share a common goal: to provide access to health monitoring and assessment technologies to people with limited or no healthcare facilities, or with geographically distant or difficult to physically access facilities.

The increasing number of mobile devices, ubiquitous internet and cloud computing will progressively emerge into a new domain called Wearable Internet of Things (IoT). This will lead to increased capability of sensing, computing and communication. Future generations of IoT promise to transform the healthcare sector, wherein wearable sensors for personalized health and wellness information seamlessly track individuals.

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# Integrating Education for Sustainable Development in English Language Classrooms

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## Abstract

This study deals with issues for Sustained Development (SD); Precisely, it deals with issues of education for sustainable development (ESD) at the University of Mitrovica "Isa Boletini" (UMIB) Kosovo. The purpose of this study is to present shortly the SD seventeen Goals (SDGs) for 2030, which are set by the United Nations General Assembly in 2015. Since these goals are broad based and dependent on each other, these 17 SDGs definitely influence the UMIB's curricula. As the fourth SDG deals with Education, the study will discuss about education, its major role in increasing students' awareness about SD, and the influence of good teaching practice by applying appropriate GloCal (Global and Local) approaches that fit to the global 21<sup>st</sup> century needs. Bearing in mind that Higher Institutions (HI) prepare students to become professionals in a specific field for the future, being aware of the need of the education for SD, and its important global and local role, this study will present few examples of SD and its current challenges, achievements observed in English language classes.

The study concludes that one of the greatest achievements in ESD is the application of active approaches to teaching, peer teaching, all-inclusive classes, collaborative, cooperative learning, creative thoughts and actions, as well as critical thinking. It also recommends HEI to introduce special topics about SD in every subject. Through the education of SDGs and education about the SDGs, the students will be able to adapt, integrate easily, embrace new opportunities, and increase their level of knowledge i.e. importance in our country and beyond.

**KEYWORDS:** *Sustainable development, global, education, integration.*

## Introduction

“Education for Sustainable Development (ESD) is commonly understood as education that encourages changes in knowledge, skills, values and attitudes to enable a more sustainable and just society for all,” ( Leicht, et al, 2018:6). Shortly, ESD enables people to become more adaptive towards changes and the 21<sup>st</sup> century social/world needs. This would make the people more effective in this complex 21<sup>st</sup> century. The 21<sup>st</sup> century education contradicts with the traditional teaching which is congruent with local, limited, dull, demotivating to educating people. Homogenous interaction should nowadays be forgotten. All what is needed is heterogeneous groups and heterogeneous interaction fostering local, and global perspectives by being more active and critical, and helping the society with creativity and innovation. When discussing about SD, that is discussing about SD through engineering, agriculture, medicine, culture, a broader perspective should include the relation of education to all other fields. i.e. progress and challenges.(Leicht, et al.2018).

SD seventeen Goals (SDGs) for 2030, which are set by the United Nations General Assembly in 2015 are as follow:

- [8] No Poverty
- [9] Zero Hunger
- [10] Good Health and Well-being
- [11] Quality Education
- [12] Gender Equality
- [13] Clean Water and Sanitation
- [14] Affordable and Clean Energy
- [15] Decent Work and Economic Growth
- [16] Industry, Innovation, and Infrastructure
- [17] Reducing Inequality
- [18] Sustainable Cities and Communities
- [19] Responsible Consumption and Production
- [20] Climate Action
- [21] Life Below Water
- [22] Life On Land
- [23] Peace, Justice, and Strong Institutions
- [24] Partnerships for the Goals

“Education for Sustainable Development (ESD) aims to develop competencies that enable and empower individuals to reflect on their own actions by taking into account their current and future social, cultural, economic and environmental impacts from both a local and a global perspective,” Rieckmann (2018:39). As such, the study focuses on the negotiation of novice curriculum that includes convergence of learning through practice for the purpose- (action oriented pedagogy) OF sustained development (SD).i.e. To create interactive, learner-centered teaching and learning settings ”(Rieckmann, 2018:40). Whereas Mohanty & Dash (2018:2) mention”... opportunity to progress towards implementing universal quality education that fosters the knowledge, skills, perspectives, values and actions that lead towards more sustainable future”. Whereas Pesanayi and Lupele (2018) consider that solutions of SD can be considered truly

sustainable only when they remain true to the environment (the planet and all its life forms), society (social justice and peace for the common good of all people) and the economy (prosperity).

They are all presented in “3Ps: People, Planet, Profit”, being aware that the recognition of the importance of these 3Ps as practices that transmit power to SD can influence the sustaining teaching/ learning methods and result in sustaining development. Although much work and understanding still needs to be done to understand and implement SD Goals, the study focuses on 3P:

**P1: People:** Keep communication functional. The focus here is in conversation by developing communicative skills quickly. “Educators are powerful change agents with the ability to deliver the educational response needed in the context of sustainable development” (Rieckman, 2018:55). The first pillar of SD, “P- People”, deals with empowering people to be more curious, rising questions and trying to change their attitudes towards surrounding, by paying attention to even slight variations occurring to the surrounding. The SD Goal allocates to provide opportunities to people to engage in updated service learning.

**P2: Planet:** The environmental issues are top issues nowadays. Greta Thunberg's (16) Speech at The U.N. Climate Action Summit on September 22, 2019, is tone of the recent examples that has moved world's decision makers about the planet and the urgent steps for its protection.

**P3: Profit.** Job opportunities, engagement of all the people and inclusive growth are characteristics of the third pillar of the SD. Rogers and Hudson (2011) point out that social and environmental impacts are important for businesses. Based on the three Pillars of SD, the study gives examples of Pesanayi and Lupele, (2018) of sustainable solutions:

- 2 The Moroccan Foundation has empowered educators with the necessary knowledge and tools. Its aim was to work with The Eco-Schools programme, in which the educators had to apply academic and practice-oriented teaching process. They had to engage, prepare and take responsibilities for preserving their living environment while being engaged with SD.
- 3 Mexico City Ministry of Environment (SEDEMA) is to strengthen environmental education via development strategy. SEDEMA created centers to promote teachers and schools, and their engagement in activities through courses, workshops, tours, campaigns and camps.

Naturally, in both cases there are needs and challenges in relation to SD. In the latter case, sustainable solutions through environmental education, such as SEDEMA centers, require high budget, whereas The Eco-School programme and sustainable solution should be introduced horizontally, i.e. in every region. (Pesanayi and Lupele, 2018)

### **Regional cooperation on ESD across the Western Balkans**

The Evaluation Report On The Implementation Of The UNECE Strategy For Education For Sustainable Development From 2005 To 2015, published in 2016 reported about “The five year programme called Education for Sustainable Development in the Western Balkans: Education for Sustainable Futures”, which was launched in 2012. It included



western Balkan countries: Kosovo, Serbia and Montenegro with €1.4 million financial support from the Rockefeller Brothers Fund, Europe Aid and the Ministry of Education, Science, and Technology of Kosovo. Its goal was to introduce and develop ESD in the European level, by integrating educational SD concepts and ideas all for the purpose of broader educational reforms shifting towards outcomes-based learning. Additionally, new teaching material was introduced and teachers were trained for the new curricula. Conferences and meeting among these countries led to educational changes as they applied all-inclusive approaches and methods. However, based on the UN report, there were also challenges: the change of the political system also effected the educational system, i.e. Ministries.

The Evaluation Report (2016) also explained the situation in Kosova: The Ministry of Education, Science and Technology in Kosova introduced ESD in every school, by adding topics such as: climate change, biodiversity, green economy, and technology, media and society, and trained teachers for the application of curriculum, for the purpose of ESD promotion. (Evaluation report on the implementation of the UNECE Strategy for Education for Sustainable Development from 2005 to 2015).

### **History of Sustainable Development in Kosovo**

Kosovo Education for Sustainable Development (KESD) was established in 2011 and has tried to reach the planned goals, although slowly. The initiative started at the Faculty of Education, University of Prishtina (Beka & Ciani, 2015), by training the future teachers.

ESD advancement is fundamentally based on higher education (HE). i.e. HE collaboration networks that include regional, transregional, and overseas cooperation among heterogeneous entities. As such, the advancement is needed to reach the desired 21<sup>st</sup> century's goals: to sustained society, environment by applying approaches where students are fully active participants in learning i.e. active approach application with sustained practices, and novice curricula. All HEI have developed their curricula based on Ministry of Education, Science and Technology (MEST) in Kosovo, by applying active approaches and pedagogical methods in which student are at the center, i.e. student-centered approaches.

As discussed above, the phenomenon of SD is new but challenges that SD arises are rather complex. Different concerns and issues generate different cooperation and collaboration. As such, a key question of the study is globalization, how and to what degree can the education effect global discourse concerning "3Ps". In this case, the paper is concerned on how English language classes effect global discourse based on the environments the people live, which is based on "ESD that promotes knowledge, skills, values and attitudes that empower learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society" (Leicht et.al. 2018).

Kosovo as a new (post war) country has evidenced social, economic difficulties, whereas the environmental issues have been neglected. Only recent years, with the promotion of ESD, the environmental issues are becoming big concerns. As such, Kosovar HEI have implemented strategic plans based on ESD and the national curricula includes topics on SD. Namely, HEIs in Kosovo comprise of different faculties and each department's

curricula is based on job market, i.e. based on the issues related to the 17 SDGs. Considering the implementation of the SDGs topics in teaching, the challenge of this study was to associate SD topics in English classes. Briefly, the overall aim of this paper is to present the benefits of English language classes for the purpose of the Education for Sustainable Development in HEI in Kosovo. Special attention will be given to challenges and benefits of introducing SD real life topics in English classes.

The study has been able to the effect of English language to promote Education for Sustainable Development which was conducted through various teaching activities at University level. The topics presented in every English class included concern and/or information about environmental issues such as air pollution, soil, water, social tolerance, cooperation, creativity, and critical thinking exercises. In all classes students were able to acquire more language i.e. foreign language input parallel with more common knowledge about world issues. In addition, it is evidenced that knowledge of SD topics dealing with SDGs contributed students' awareness of social needs, and understanding their own role in the environment, i.e. social and natural, by utilizing a foreign language, English.

## **CONCLUSION AND RECOMMENDATIONS**

The mixture of traditional teaching approaches and method, more critical thinking and innovation offered, and novice performance-based approaches, enable educators to capture nowadays' insights and less effort to develop.

The acronym **SUSTAINABLE DEVELOPMENT** will best describe the conclusion of the study:

**S-** Strategy. Teachers should plan what to teach and how to teach, i.e. Strategic

Planning **U-**Utilize all resources available for better education **S-**Synthesize knowledge and means

**T-**Timing. An important factor for acquiring knowledge. Set a time limit for every activity

**A-**Ascertain that what is being taught and what is being learned promote critical thinking

**I-**Inclusion. All inclusion and no racism

**N-**Need. Attention should be paid on the 21<sup>st</sup> century social needs.

**A-**Acquire and Add more knowledge

**B-**Benefits of being educated are vague

**L-**Learn by doing, i.e. by being active participant in every activity

**E-**Engagement is the key factor for better learning

**D-**Define the problems of the 21<sup>st</sup> century

**E-** Environmental issues should be discussed

**V**-Variety of data should be introduced and discussed

**E**-Elaborate the teaching plan based on the students' needs and wishes

**L**-Language , i.e. English language and a special topic based on SDGs should correlate

**O**-Organize teaching based on specific world/environmental issues

**P**-Prioritize no racism, no hatred in classes. Non-threatening environment to learn

**M**- Manage teaching, timing and the target language taught in EL classes

**E**-Enable yourself ( the teacher) and students to evolve

**N**-Natural approach, novice and numerous ideas

**T**-True topics trigger learning

In conclusion, ESD is the key of the 21<sup>st</sup> century development. Pre-service teacher training exists, however, it should always advance. As mentioned in the acronym, all-inclusive learning needs innovative approaches and interdisciplinary, perspective topics/subjects, whereas teacher training focus should be the cooperation with other countries' educative institution, by implementing ESD programs. These initiatives of cooperation and collaborations between various HEI should include cooperation among teachers, students, the administrative personnel, and all involved in HE system.

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# Influence Of The Coal Quality On Abrasion Of The Boiler Elements

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## Abstract

Depletion of the coal reserve in the mine Suvodol, which is the main fuel source for providing continuous operation of the Thermal Power Plant (TPP) Bitola, imposes the necessity of providing certain coal quantities from the mine Brod-Gneotino. Since the two coal deposits have different coal quality, the processes of mixing of and inter-changing between coals from both mines, influence the system for coal preparation, in particular mills and their wheels, ducts for air-mixture, convective heat surfaces, etc. Regular reports the coal technical analysis (2005 to 2018), continuously provide an insight of these changes in the coal quality.

In this paper calculated is the Abrasion Index of coals following an empirical expression developed by Raask, where influential variables are the relative weight contents of quartz, pyrites and ash found in the coal sample. In accordance with the results, classification of the coals is performed, as well as diagrams that indicate the impact of coal ash content on the coal abrasiveness and its repercussion concerning the mills, associated system components and convective heat surfaces. Further, pointed out are several recommendations regarding improving the protection of the systems from coal abrasion.

**KEYWORDS:** Ash, Abrasion, Coal, Thermal power plant

## Introduction

The Power Plant REK Bitola is designed to work with lignite from the Suvodol mine, which is close to them. As time goes on, coal reserves are reduced and Power Plant compensate for the lack of coal from the newly opened mine Brod Gneotino near the old one. The quality of coal from the Brod Gneotino mine is worse than that of Suvodol, more precisely the ash content is higher. To ensure equal quality of coal during operation at the Power Plant, both coals are mixing. In the coal mix, reducing coal from the Suvodol mine simultaneously increases the amount of coal from the Brod Gneotino mine. Changes portions of the coals cause changes operation of the boiler, especially the changes on the coal dust preparation system. Specifically, changes in coal quality caused an increase in the abrasion and wear of the mill wheels, housings, air-mix ducts, etc. By increasing part of the ash in coal, abrasion occurs on heat surfaces, especially on those installed in the convective passage of the boiler.

## Abrasion and wear

Apart from its physical characteristics, coal abrasion depends on its hardness and strength, the structure of the mineral material, the dimensions, and shape of the particles (round, square, with a sharp edge, etc.). The presence of various ingredients (pyrite, sand, clay, etc.) increase or decrease abrasion, and intensify the abrasion process on the mill's elements and other coal dust preparation equipment [2].

The abrasive of the coal is a function of mineral matter characteristics. An empirical expression was developed by Raak which allows for comparative analysis of coals and is presented by the equation [1]:

$$AI = q_c + 0,5p_c + 0,2A_c$$

Where:

$q_c$ - relative weight contents of quartz,

$p_c$ - relative weight contents of pyrite,

$A_c$ - relative weight contents of ash, found in the coal samples.

When reviewing the analysis of coals as standard industry commercial practice, it is rare to find reports defining quartz. On the other hand, pyrite is frequently identified and the reports always indicate the quantity of ash. To compensate for the lack of data, estimates for quartz and pyrites in the coal can be calculated with reasonable accuracy, employing the reports with chemical analysis for  $SiO_2$ ,  $Al_2O_3$  and sulfur S.

The quantity of quartz in coal can be determined by expression:

$$Q_c = 0,01A_c(SiO_2 - 1,5Al_2O_3)$$

Pyrite in coal is estimated by:

$$p_c = 1,3(S - 0,3)$$

These equations can be used as reasonable substitutes for laboratory data in the abrasion index equation. Raak categorized the results of the abrasion index equation into for levels of abrasion as is shown in table 1.

**Table 1. Abrasion Index Classification [2]**

<b>Abrasion Index</b>	<b>Category</b>
<b>&lt;4</b>	Slightly (Low) abrasive
<b>4-8</b>	Moderately abrasive
<b>8-12</b>	Highly abrasive
<b>&gt;12</b>	Exceptionally abrasive

## Abrasiveness of coal burned in the power plant Bitola

Classification of the coals delivered to TPP Bitola in the period from 2005 to 2018, according to their abrasiveness is shown in table 2. The Abrasion Index is calculated based on the results of the laboratory report on the annual coal samples for the relevant year.

**Table 2. Abrasion Index of coal from 2005 to 2018 and its classification.**

year	Low heat value LHV [kJ/kg]	Ash content A <sub>c</sub> [%]	Abrasion Index AI	Classification
2005	8194	12,6	5,16	Moderately abrasive
2009	7005	18,31	8,87	Highly abrasive
2010	7402	14,76	6,55	Moderately abrasive
2011	6804	17,28	9,35	Highly abrasive
2012	6645	18,27	9,88	Highly abrasive
2013*	6583	21,04	10,71	Highly abrasive
2014	5390	21,33	10,85	Highly abrasive
2015	5741	22,65	10,57	Highly abrasive
2016*	6036	24,51	11,43	Highly abrasive
2017	7435	20,98	9,40	Highly abrasive
2018*	6943	22,47	10,05	Highly abrasive

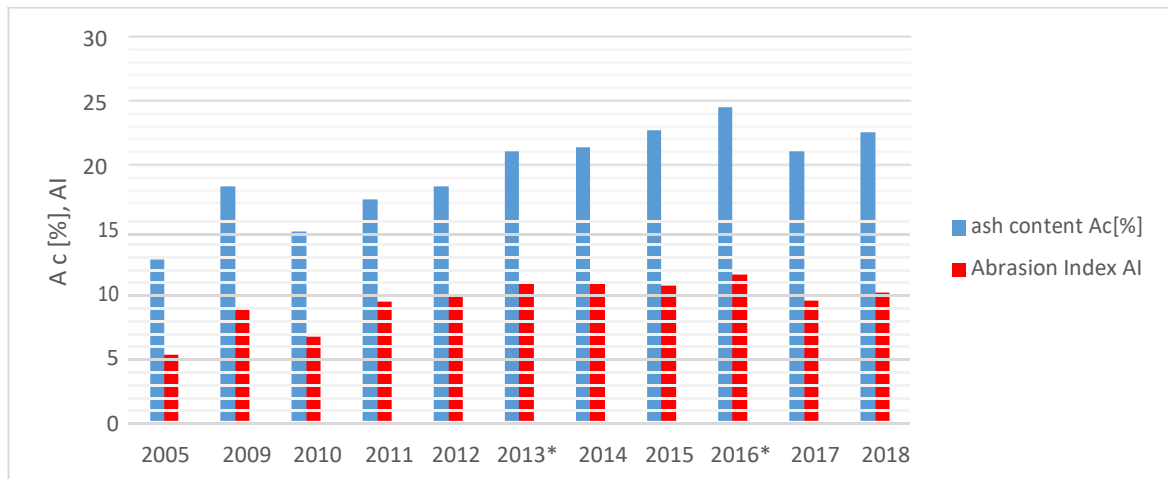
[1] for this year LHV and A<sub>c</sub> are average annual value taken from the laboratory in TPP, due to the lack an official report of the annual coal samples [4].

**Table 3. Technical characteristic of design coal [8]**

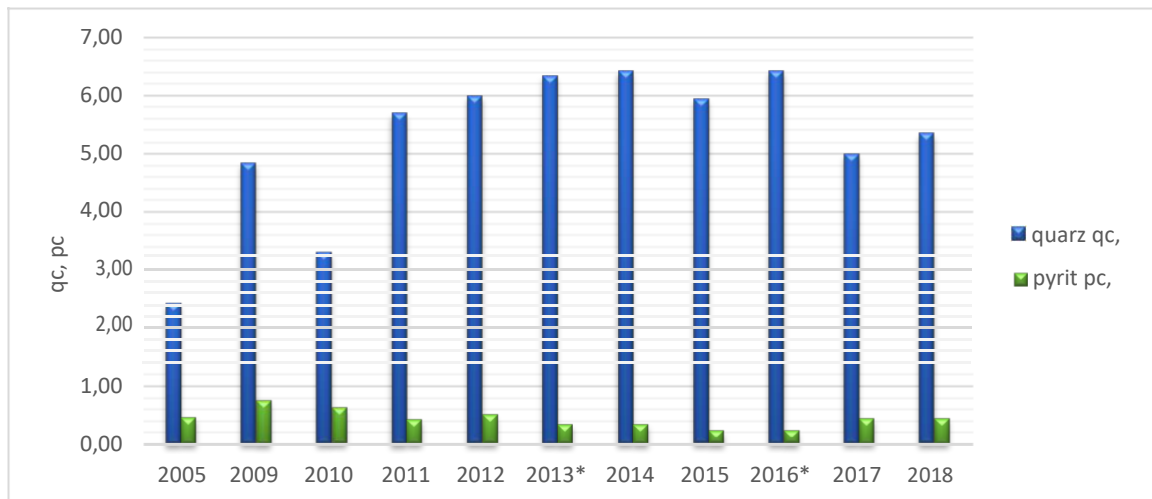
	<b>Tag</b>	<b>Design Coal</b>	<b>Best Coal</b>	<b>Worst Coal</b>
<i>Water</i>	W [%]	52,25	49,5	49
<i>Ash</i>	A [%]	13,5	12,4	20
<i>Low heat value</i>	LHV [kJ/kg]	7308	8070	6478

If we compare the technical characteristics of coal burned from 2005 to 2018 (Table 2) and designed coal (Table 3), it can be seen that in the years until 2012, the ash content of coal and its Low Heat Value correspond or are in the range on designed coal (Table 3). Whereas in the years after 2012, they have a significant increase in ash content and decrease in LHV. This increase in ash content increases the value of the Abrasion Index. The change in coal characteristics is the result of more intensive exploitation of the new Brod Gneotino mine, as the old Suvodol mine was depleted.

The data in table 2 show that by 2012 coal was more abrasive than before. The main reason for more intense abrasion is increasing the ash and quartz content. The same can be concluded from the diagrams in figure 1 and 2. where are very striking changes in the ash and quartz content.



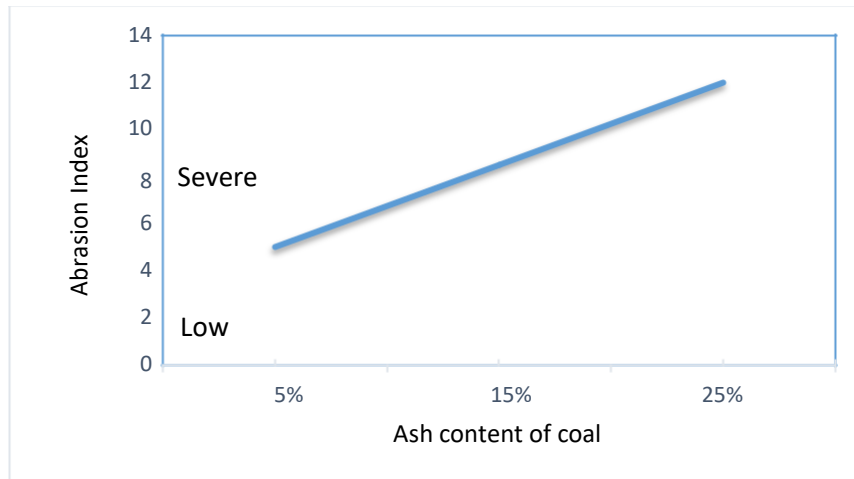
**Figure 1. Changing of the ash content and Abrasion Index on coal from 2015 to 2018**



**Figure 2. Changes the quartz and pyrite content**

The ash content of the coal, due to the quartz therein, has a linearly increasing relationship with abrasion as the ash content of the coal rises. Figure 3 shows how the ash content impacts the abrasiveness of coal [2].





**Figure 3. Increase in coal Abrasion Index with increasing ash content [2]**

### **Influence of the coal abrasion on the system for coal dust preparing**

From the above expressions and diagrams, we can conclude that increased ash content causes an increase in the coal abrasion index. But the question is what are the consequences of the coal changing and how does it affect the elements of the boiler?

Namely, in order to maintain (reach) the heat output of the boiler operating with high ash content in coal (meaning low heat value), in the system for coal dust preparing (coal feeders and conveyor, mills and ducts for air-mixture) needs to pass more coal and in that case system will be more loaded. This increase of coal throughout the system will cause wear and tear on the material due to the coal's abrasion. The parts which are particularly exposed to greater wear and tear and there have to increase maintenance are:



Mills –beater wheels and houses, including diffuser elements,



Classifiers for coal dust,



Distributors and ducts for coal dust, especially bends on the ducts,

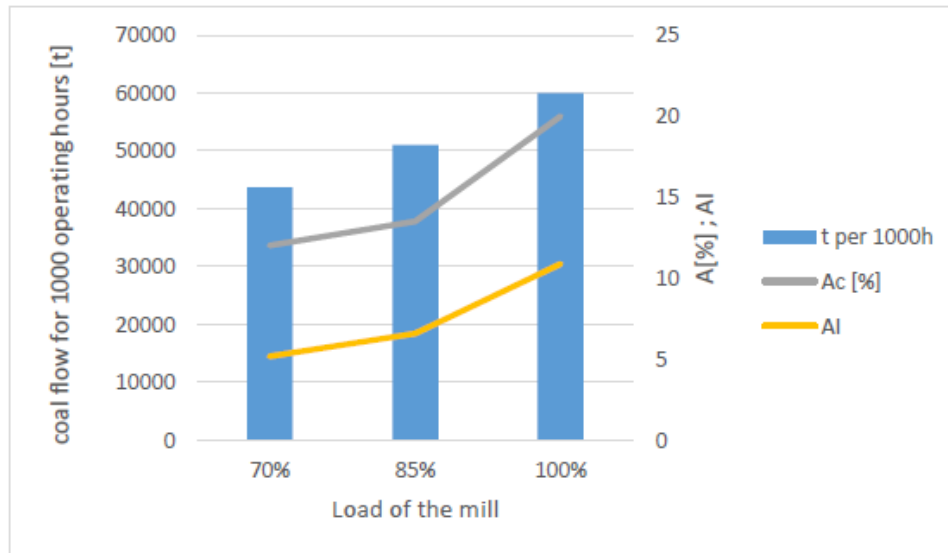


Coal burners.

If compared working of the system for coal preparing for 1000 operating hours, with the same (unchangeable) boiler heat output the following can be concluded:

When the boiler is operating with worse coal with 20% ash, through each mill passes 18 t/h coal more, than when operating with better coal with 12% ash, or through the all mills passes almost 100t/h more coal. In this case, the coal flow through the mills increases by 42%.

In other words, working with worse coal with 20% ash causes an increase in abrasion for two reasons. One is the increased coal flow to keep the same boiler heat output and the other reason is the increased percentage of ash that has a direct impact and increases the Abrasion Index. These changes are shown in figure 4.



**Figure 4. Change of mill load and coal flow through one mill over the 1000 operating hours depending on the ash content at maximum boiler load.**

The increases abrasion is the most visible in the operating hours of the mill's beater wheels. Namely, when the ash content in coal is significantly increased, the operating hours of the mill's beater wheels are reduced from 1800 to 600 hours.

### **Influence of the coal abrasion on the pressure parts in the boiler**

Wearing of the pressure parts in the boiler, particularly those elements located in the convective pass and the regions with lower gas temperatures is related to the amount of quartz in the fly ash and the velocity of the flue gas. The survival of the quartz in the combustion process directly is related to coal dust fineness, flame temperature, unburned carbon and furnace retention time. Finer grinding and classification on the pulverized coal reduces quartz survival, while staged firing, sub-stoichiometric conditions in the burner zone, for NO<sub>x</sub> control will increase the survival factor for quartz [1].

It is known, that the intensity of abrasion is directly proportional to the concentration of solid particles and their velocity in the third degree [3]. Since data for flue gas velocity are lacking, if assume that the flue gas velocity does not change and the ash content of the coal varies with the quality of the coal while boiler load is constant, then increasing the ash concentration will cause an increase of the heat surfaces abrasion. Wearing the heat surfaces is visible on the primary and secondary superheaters and economizers, located into the convective pass of the boiler. Confirmation of this situation is the multiple increases the number of replaced bends and tubes due to the abrasion during boiler overhauls in the last 3 or 4 years.

## Conclusions and recommendations

From the analysis of boiler conditions from the view of coal abrasion, while operating with coal with ash content of 12% and 20% we conclude the following:

- increasing the ash content of the coal causes an increase in the coal Abrasion Index,
- the coal from Brod Gneotino mine is classified into high abrasion coal, according to Raak calculations.
- to achieve maximum boiler heat output with 20% ash in coal it is necessary to increase coal flow by 43% than for coal with 12% ash.
- operation of the boiler with worse coal with 20% ash causes an increase in abrasion for two reasons. One is the increased coal flow to keep the required boiler heat output and the other reason is the increased percentage of ash that has a direct impact and increases the Abrasion Index.
- due to coal abrasion from the Brod Gneotino mine, the operation hours of the mill's beater wheels have been reduced by more than twice.
- the abrasion is visible and increased on pressure parts installed in the convective pass of the boiler.

Increased coal abrasion increases the cost of the Power Plant for the procurement and replacement of wear and tear materials for the system for coal preparing, for pressure parts and their maintenance.

The recommendation for the system for coal dust preparing is to use elements made of hard materials resistant to coal abrasion, welding of the side exposed to abrasion with hard electrodes, and for pressure parts to put protection sheets on the parts exposed to abrasion or metalize them.

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# Sustainable Development of Architecture In Continuity

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## Abstract

Generally speaking, the task of architecture is to create suitable atmosphere for performing a certain function of the human being.

Though today the interior and exterior space are shaped with equal responsibility and seriousness, the interior ambient is the one in which a man spends most of his time. The building as a closed space provides protection from outside climate and weather changes and provides necessary conditions for working and living no matter the outside weather and climate conditions, sounds and noises. The outside walls with windows are the vital shell under whose protection many useful human activities take place.

Analyzing the inherited values and the relation of contemporary architecture towards them through concrete examples, many important messages on architecture development and urbanism can be drawn. These messages serve the purpose of finding the basic principles on which a continuity made with positive contacts between the contemporary and the heritage can be built. Finding those basic principles is a prerequisite for creating the culture of space whose most important part is the architecture. It can be created only in cultural ground where healthy architectonic critics exist and the criteria for evaluating the architecture are clear.

**KEYWORDS:** *Architecture, Contemporary architecture, Sustainability*

## **1. Introduction**

In that process of finding, the social conditions play an important role as a firm basis for developing the architectonic thought through pointing out the most positive tendencies. In that way, the architecture can model space to fit the ground features and the characteristics of the folk tradition. From these created forms we can see the main features of the region and the nation and we can promote the specific features, origins and the future of the nation.

The goal that we have put in front of us has big demands and engagements of the greatest minds in the creation of strong theoretical scientific basis. That is why we can say that culture of space as a point of convergence towards which the modern civilization should gravitate is a complex and a structural task.

Establishing the continuity is an important condition for pointing out of the values of contemporary architecture. Mainly it is the role of the cultural space as an opposition to the irresponsible behavior towards the cultural heritage which has very often been the case in the short development of the contemporary architecture. The part of the individual in creating that space is of essential meaning since the individual is an important part of the critical careful spectator.

## **2. The good architecture and architectonic space**

The problem with the evaluation of architecture is very complex and very difficult to solve. Alongside other factors, the non-existence of any clear criteria for evaluation also contributes to this. The criteria for the complete evaluation of the architecture are not yet created, and there are no signs that this is going to happen soon. The problem is getting bigger, because architecture is on the line between art and science and it cannot be evaluated neither as art nor as science but as a specific mixture of both. Talking about nice architecture generally means that its aesthetic characteristics are expressed through the theory of the architectonic composition.

Architecture cannot be studied as a form or a content since it contains a number of other components: biological, psychological, social etc.

### **a. About the good architecture**

It is clearly noticed that the link between the aesthetic categories of the object and its emotional evaluation is not proved yet. It is not proved yet through which proportional relations the idea of spiritual harmony and peace or moral perfection could be expressed. /21/ And those are the main goals of the good architecture.

Today in the world, the role of the region and the architectonic school is important only in few countries so the modern architecture has many disproportions and other negative features.

W. Gropius talks with full right about the good architecture and says that "good architecture is a projection of life itself and includes intimate knowledge of the biological, social, technical and artistic problems. /1/

The complexity of the architecture demands wide knowledge starting from the social to the technological processes, since it shows dubiousity in meaning in almost all of its fields. In the same time it is:

- Technics and art
- Function and form
- Tradition and future

From all that we can conclude that although the evaluation of the architecture is a hard problem-through respective analysis it can clearly be seen what is an honest expression of the inner relationship and feelings and what is formalism in a sense of decoration and cold construction.

### **b. About the architectonic space**

The interest for the specificity of the architectonic space is becoming more important so there are many analyses about it. The space schemes obviously become with mutual work in the existing architectonic space and when they do not satisfy it e. r. when the image becomes confused or “too unstable”, the architectonic space has to be changed. According to that the architectonic space can be defined as concretization of the humans' existential space."/2/

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/1/Sythesis in the arcitecture pg.24 ; /2/K.N.Sulc,ibid pg.12

The conclusion comes by itself that leaping the architectonic continuity and establishing of positive contact with the inherited values cannot be achieved without creating regional architectonic identity in the frames of the mutual general expression. It could be achieved not with formal approach towards the heritage, but with interpretation of its interior meaning-its philosophy of space composition.

### **3. ARCHITECTURE IN THE CONDITIONS OF THE HIGH TECHNOLOGY**

"The architect has a duty to establish the primary role of the plastic expression as a specific element without whom the architecture cannot exist./3/"

The human being in the course of its long development made efforts to make the production of its products easier, and to not lose their beauty during the process. The Producers of every element for the needs of the human have always been torn apart between the functional and the aesthetic. Depending on the period of development stage, the sort of the product and the buyers' needs the first or the second component prevailed. Generally spoken the utilitarian products gained the functional component as a stronger part while the products for spiritual needs gained the aesthetic and artistic component. However, one is certain: the utilitarian products have not lost the second component. On the contrary, consciously or not, it has been included in the process of production. Mostly it was made on purpose.

In building its homes, man applied the whole knowledge and skills. Even when it was necessary the problem "a roof over the head" to be solved, man made it in a remarkably practical way, but in the end the object still had some aesthetic characteristics.

#### **3.1. Aesthetics and ornaments in the contemporary architecture**

Going through the different movements in the modern architecture which have given a character to the principles of building, we come to the conclusion that from the struggle of these movements results the quality of today which is called Modern architecture or architecture of the industrial and atomic era. Talking about the aesthetic of an object many people think of its external look since the number of people who entered or stayed in it is very small.

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(3) Pierre Vago, L'Architecture d'Aujourd'hui, no. 3-4 Paris, 1964





**The Guggenheim museum in New York, USA**



**Villa Savoy in Poissy, France**

Even among the historians of art and architecture, at least a small part of them have the same approach. That is why many gaps concerning the documentation for detailed principles in the building and shape of a concrete object and the details about architecture and materials occur. That leads to generalization of the conclusions, a fact which cannot be avoided even in this discussion. "Art nouveau", as one of the first signs of the modern architecture, draws inspiration from the past and nature, concerning the ornamentation of the objects. The group "Manufactures and arts" as a representative of this branch based on the principles of philosopher Ruskin will proclaim the motto through its member, the architect W. Morris: "The richness of an object consists in the richness of ornaments not in the solid construction." The "Secession" and the "Jugend" style appear with an entirely new conception and oppose academism very successfully. They talk about functionality and clean facades, with certain groups of sculptures and applications.

In the struggle between the academism and the secession an architect A. Loos with his principles will contribute in throwing out the meaningless ornaments of the facades of the buildings.

In his brochure "Ornament and crime" he comes out with original ideas but also has ideas which are considered as unreasonable today. A. Loos is not mad at aesthetics but with economic damage which comes from using the ornaments as he says: "...soon the streets of the towns will shine as huge white walls" by which he announces himself as a beginner of the Purism. Claiming that everything practical is beautiful he adds that economical materials are always modern. He himself in some objects uses precious african onyx in which we can see his contradictory personality.

L. Sullivan an architect as a functionalist has the following idea about the aesthetic of the object " ....extremely beautiful proportioning of the objects does not require additional ornamenting ".



**Villa Moller in Vienna, Austria**



**The Auditorium building in Chicago, USA**

In the course of its development the aesthetic form and ornamenting of the objects has been moving at the curves of the sinusoid. It has achieved its lowest point in the time of the Purism as one of the branches of the contemporary architecture. But that does not mean that aesthetic has been neglected during that period. It is searched for in the forms and proportions and also in the relations of the elements between themselves and toward the whole. In 1943 in the A+R magazine, the famous Kenneth Clark will write: ..."the functionalism meant revolution in the architecture. Modern style does not require ornaments and architecture is better without them. By adding colour and texture the ornaments loses its place. "In 1961 in the same magazine P. Collins writes: .... today it is a shame to thank to A. Loos", and talks in favour of using the ornaments with abstract forms. These two examples are enough to illustrate the sinusoidal movement in the development of the aesthetic and the decorative works of the facades and their elements.

### **3.2. Contemporary architecture and refabricated elements**

"The new should be interweaved with exactness, rationality, repetition, strict rhythm - characteristic features of the mechanized society."/4/

No matter how real they sound, these words by Russian authors are not completely convincing as the only and the right ones. In their sense we can find the hidden basis for creation

of a machine society in which humans can be only a part of the mechanism. It is more dangerous when man can become a part of a cybernetic society where his role would not be bigger than the role of an electronic cell. Knowing the eventual negative consequences from the mechanization and the cybernetic, during their application, in parallel with the technical people should work the Socio-Psychologists. We conclude that the usage of the refabrication in today's conditions is imposed as a need.

But today in certain circles there is resistance to that need and in some places that resistance is with a good reason which is due to the bad examples of the short era of refabrication which again is dependable on the relation of the function of the objects and their aesthetics.

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(4) A.Ikonnikov,G.Stepanov: Socialistic aesthetic, Moscow 1963, p.72

#### **4. Conclusion**

How can we start talking about any subject concerning ecology? All the problems with the environment and its potential solutions? Sustainable architecture and green buildings? Organic architecture and eco - friendly designs? Sustainable design, cost-efficient buildings?

Alternative materials. Naming all the alternatives can go on forever, although there are significant differences between the concepts of all the solutions we have mentioned here.

Ecological or sustainable architecture is a part of a wider concept that has been talked about a lot in the last couple of decades, and for which a lot of intensive actions have been undertaken.

When it comes to architecture, the question of using new materials and recycling the old, conserving energy and space, using alternative ways to create space, positioning of civil engineering, as well as recycling old used spaces, has become the main path for all designers and architects working in this field.

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# **Welding as a Technological Process and Its Impact on the Environment, Health and Safety at Work**

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## **Abstract**

Welding as a process of permanent joining metal parts is a practice in many industries. Application of the heat of an electric arc or flame to the metals results in appearance of fumes, very small metallic particles, usually in the range between 0.4 and 1.0  $\mu\text{m}$ . If inhaled, they can cause illnesses and/or permanent lungs damage. In addition, welding carries many other direct and indirect harm not only to the health and safety of the workers, but to the environment, as well. The most common hazards accompanying operations in welding are: fires and explosions, burns, fumes, electric shocks, compressed gases, hazardous substances, toxic gasses, suffocation, radiation, heat stress, dust, noise and vibration, manual handling, etc. Different welding processes need diverse arrangements of equipment, operations, workers' skills and thus, different safety and environmental requirements. Taking into consideration the importance of the environmental protection and the safety and health at work, the application of an appropriate code of practice and measures of precautions, leads to the increase of employee awareness of the health and safety at work, reduced number of injuries, but also, to the decrease of the adverse effects on the production. Moreover, the responsibility of any employer is to make clean, safe and comfortable working environment through the assessment of the safety hazards and the application of the hierarchy of control, employees' training and communication. This study will be focused on summarizing the most frequent hazards occurring in welding processes, their environmental impact, the effects on human health, as well as identification of potential measures of protection.

**KEYWORDS:** *Welding, Occupational Health and Safety, Personal Protective Equipment, Environmental Protection*

## 1 INTRODUCTION

Welding is the most common process used in permanent assembling of two or more parts with the application of energy in a form of heat and / or pressure. Commercial and technological benefits of welding rely on the following facts: The parts being coalesced become a single unit and no disassembling is possible; joining materials by welding is more economically justified than the mechanical assembling in terms of material utilization; Welding is not restricted to the plant surroundings. On the other hand, welding processes have been associated to some drawbacks, as follows: health and safety issues regarding the application of a high energy in the form of heat and/or pressure, emission of fumes and toxic gasses, and the musculoskeletal disorders related to the manual work; increased process cost due to the requirements of skilled and trained workers, etc [1].

Welding is one of the most used operations in many industries, e.g., in automobile production, manufacturing of home appliances, production of different equipment, in construction industry, at the shipyards, in mining, oil, aerospace, petrochemical industries, etc., but it can be also part of the maintenance and repair operations [2].

The aim of this study is to emphasize the existence of the hazards and associated risks toward the environment, as well as the occupational safety and health during performance of the welding activities. In addition, an attempt was made to highlight the importance of the need of the risk reduction measures that include engineered measures (such as the provision of safety protection - e.g. guarding and warning systems), operational measures (training, safe work practices, operating procedures, method statements), along with management supervision [3].

Although 50 different types of welding processes can be recognized depending on the type of energy and the equipment used, the basic classification can be summarized into two groups: fusion welding and solid-state welding. The basic subgroups of these processes are given in the Table 1.

Table 1. Common Welding Processes and Their Characteristics [4]

<b>Fusion welding</b> (Applies heat for melting the metals being assembled, and very frequently includes filler for joint strengthening)		<b>Solid-state welding</b> (Assembling accomplished by pressure alone and/or application of heat avoiding metal melting, and no filler applied)	
<b>Process</b>	<b>Description</b>	<b>Process</b>	<b>Description</b>
Arc welding	Uses electric arc to heat metals and/or application of pressure and filler.	Diffusion welding	Applies pressure at increased temperature, where joining of the parts is done by solid-state fusion.
Resistance welding	The resistance to the current flow through the metals produces heat, and a pressure might be applied too.	Friction welding	Heat is produced by friction between the parts being assembled.
Oxyfuel gas welding	A mixture of oxygen and acetylene produces a hot flame, used in metals and filler melting.	Ultrasonic welding	Bonding achieved as a result of shear stresses present due to the normal and vibratory forces
Electron beam welding	Heat is achieved by high-intensity beam of electrons.		
Laser beam welding	Energy for welding is produced by coherent light beam.		

Source: Mikell P. Groover. 2013. Welding processes In Fundamentals of Modern Manufacturing: Materials, Processes, and Systems (5th. ed.), John Wiley & Sons, Inc. Hoboken, NJ, USA, 748-806

Over 50 welding technologies have been recognized [5], among which, the simplest and the most common arc welding processes is the Shielded Metal Arc Welding, also known as Manual Metal Arc Welding or stick electrode

welding. The type of the arc welding processes, Figs. 1 and 2 [6], usually used for the most metals is the Gas Tungsten Arc Welding, applied mostly for light metals (e.g. aluminum and magnesium alloys), copper alloys and carbon steels, while the Submerged Arc Welding is suitable for carbon steel and low alloy steels [4].

To accomplish the joining, resistance welding (RW) applies both heat and pressure. The process includes the following components: workparts to be welded, electrodes, part of the equipment responsible for the pressure, and the AC power supply that controls the current. Electrical resistance to the flow of current at the junction points produces heat, and in contrast to arc welding processes, the resistance welding does not apply shielding gases, flux or filler metal, and uses nonconsumable electrodes. The most common resistance welding processes are spot, seam and projection welding [4].

Oxyfuel gas welding (OFW) is based on the burning of the mixtures of fuels and oxygen. Usually the gases used in this type of welding are propylene, propane, hydrogen, methylacetylene-propadiene, natural gas (consisting of methane and ethane), but the mostly used is acetylene gas. Combustion between acetylene and oxygen in oxyacetylene welding (OAW) produces high-temperature flame that is directed toward two parts being welded by the welding torch, accompanied by the application of filler material and pressure on the parts [4].

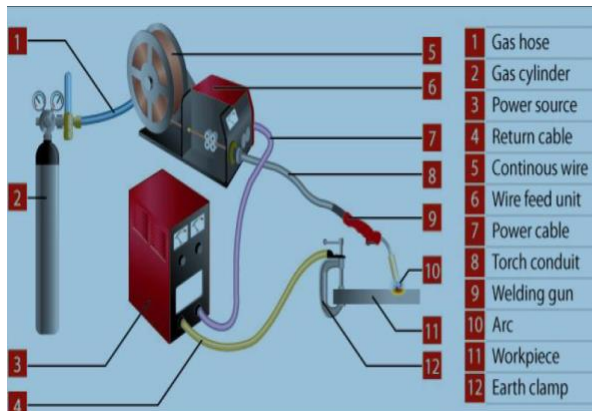


Fig. 1. Gas metal arc welding (GMAW) [6].

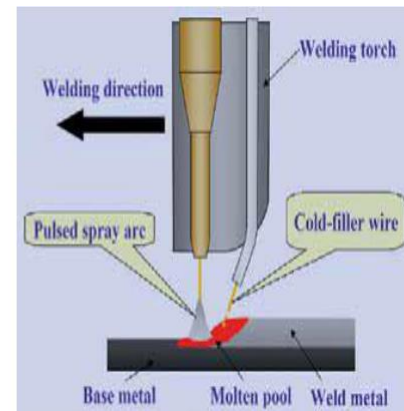


Fig. 2. Principle of the cold tandem pulsed GMA welding process [6].

*Source:* The influence of copper coating on the fume formation rate of carbon steel welding wire during the gas metal arc welding process, Nicolaas Christian Bothma, University of Wollongong, 2012

The heat of welding in electron-beam welding (EBW) is obtained by a streamed beam of electrons of a high intensity focused toward work materials. EB welding is used for refractory metals and metals having difficulties to be joined by arc welding, but it can be used also for any metal that can be welded by arc welding [4].

Similarly, like EBW, laser beam welding (LBW) uses the high-energy beam of light against work parts. Although LBW has many advantages over EBW, like absence of vacuum chambers and no X-rays emission, EBW is more suitable than LBW for deep-to-width welding. Yet, the new technologies of EBW do not apply vacuum [4].

Solid state welding accomplishes bonding of the work surfaces by application of pressure alone, or heat and pressure, where the melting of the metal does not occur at all, or ensures only localized melting.

Diffusion welding (DFW) belongs to the group of solid-state welding that involves both, temperature (maximum 0.5 of its melting point) and pressure where coalescence of the faying surfaces occurs as a result of the diffusion. Sometimes, application of the filler facilitates the diffusion process. DFW is characteristic for high strength and refractory metals [4].

Friction welding (FRW) includes movement of the two metal surfaces in contact relative to one another, i.e., friction, which produces increased temperature at the contact, and in addition to applied pressure leads to better coalescence [4].



In ultrasonic welding (USW), the permanent joining of two parts is done by the oscillatory shear stresses caused by application of ultrasonic frequency.

There are other joining processes that belong to the group of solid-state welding, like forge welding, cold welding, roll welding, hot pressure welding and explosion welding [4].

Regarding the fact that the melting of the metal surfaces is not needed in the solid-state welding, the advantage of these processes over the group of fusion welding is the absence of the heat-affected zone, and thus the properties of the material around the welded zone remain the same [4]. Due to the possibility of automatization, low equipment cost, high flexibility, and high level of productivity, the most common welding processes are: Gas metal arc welding (GMAW), Manual metal arc welding (MMAW), and Laser arc hybrid welding (LAHW) [4].

In accordance with the literature data [7], there are up to 2% of the working population in the developed countries that are involved in the welding processes. Due to the fact that most of the welding processes involve toxic gases, fumes, work in closed spaces, manual work, etc., there is a need of environmental assessment of inputs and outputs of many welding processes through life cycle assessment (LCA), as well as estimation of the social and socio-economic impacts to people, i.e., Social Life Cycle assessment (SLCA) [8].

## 2 ENVIRONMENTAL IMPACT OF WELDING PROCESSES

Air pollution is a potential risk not only to people, but to the entire eco system as well. Welding is included in almost all industrial processes that include metals, so the effects of the side-products of this operation toward people and/or environment can be very significant. The level of the pollution from welding operations depends on the type of the welding process and the equipment used.

The life cycle evaluation of one welding product includes all the phases of the life cycle of the materials used in welding processes, starting from the processes involved in production of consumables (that can include manganese, barium, thorium, etc.) [9], production of the materials for welding, the process of welding itself, and at the end the controlled disposal of the materials in the landfill after their deterioration, i.e., waste management. In addition to the outputs, such as slags, gases, fumes, remaining of the electrodes, etc., one needs to encompass all the inputs for the welding processes such as electrical energy, filler material, need of the shield gases, etc., including here the energy required and different emissions during extraction of the metals from the ores [5].

Two types of gases are included in the welding processes: shielding gases and the gases generated during the process itself. Inert or semi-inert gases such as carbon dioxide (CO<sub>2</sub>), argon (Ar), helium (He), are used as shielding gases. They are unreactive, and they are considered as nontoxic for the environment, although they are known as suffocators. If the welding process is performed in a confined space, substitution of air by the shielding gases can cause deficiency in oxygen, and thus, some health problems to the welders, like dizziness, decreased cognitive processes, asphyxiation and even death.

Gases produced by welding are generally toxic, they have adverse effect on people, and typically comprise of carbon monoxide (CO), ozone (O<sub>3</sub>) and nitrogen oxides. The common types of the gases formed by welding processes, their source and the impact they have on human health is given in Table 1. The type and amount of gases produced depends on factors like the type of welding and materials used (metal surfaces, type of filler, electrodes, etc) [5, 10, 11].

Table 1. Common gases produced in welding with the effects on humans [10; 11].

Gas	Origin	Effect to humans
Carbon monoxide (CO)	Formed as a result of incomplete burning of the electrode coating and when CO <sub>2</sub> is used as shielding gas.	The excess of CO will prevent the transport of oxygen to the organs and tissues, leading to the headache muscle weakness and asphyxiation.
Ozone	Produced by the use of the welding arc, when ultraviolet light reacts with surrounding air.	Irritant in small concentrations, while the prolonged contacts lead to respiratory deceases.
Nitrogen oxides		
Phosgene		Irritant in small concentrations, while



Hydrogen chloride	Formed with the decomposition of the electrode coatings	the continuous contacts cause deceases to the lungs, bones and kidneys.
Hydrogen fluoride		

### 3 HEALTH EFFECT FROM WELDING

As it was previously mentioned, the fumes and gases formed during welding processes are potential hazards that will most probably cause health problems to the workers. Also, the composition and the characteristics of the gases and fumes depend on the process itself and the material (metal) welded. Workers' exposure to the fumes and gases depends on the place the welding is performed (outside, plant, confined place, etc.), the welding processes, the type of used metal and filler, the experience of the worker, and the air ventilation [12]. Thus, Occupational Health and Safety Agencies have established the recommended limits of exposure to fumes and gases. Tables 2 and 3 show the recommended, i.e., threshold limit value (TLV) and the regulatory limits of the exposure to some metal fumes and gases. Threshold limit value is the maximum level of the exposure of the workers, every day within 8 working hours without harmful effects to their health [5].

Table 2. Regulatory and recommended limits of exposure to some metal fumes and their cancerogenicity [5, 10, 11, 13].

Substance	Regulatory Limits (mg/m <sup>3</sup> )	Recommended Limits (TLV) (mg/m <sup>3</sup> )	Cancerogenicity
Aluminum metal, insoluble compounds	15 (Total dust) 5 (Respirable fraction)	1 mg/m <sup>3</sup> (Respirable fraction)	
Arsenic, inorganic compounds, as As		0.01	A1
Antimony and compounds, as Sb	0.5	0.5	
Barium, soluble compounds, as Ba	0.5	0.5	
Cadmium, as Cd		0.002 (resp.)	A2
Chromium (VI)		0.0002 (short-term exposure) 0.0005 (inhalable)	A1
Chromium metal and insoluble compounds	1	0.5 (inhalable, metallic chromium)	A4
Cobalt metal, dust, and fume, as Co	0.1	0.02 (inhalable)	A3
Copper Fume, as Cu	0.1	0.2	

Iron oxide	10 (fume)	5 (resp.)	A4
Lead inorganic, as Pb		0.05	A3
Magnesium oxide fume	15	10 (inhalable)	
Manganese fume, metal and inorganic compounds, as Mn	5	0.02 (resp.); 0.1 (inhalable)	
Molybdenum, soluble compounds, as Mo	5	0.5 (resp.)	
Molybdenum, insoluble Compounds, as Mo	15	10 (inhalable); 3 (resp.)	
Nickel, metal, insoluble and soluble compounds, as Ni	1	1.5 (inhalable); 0.2 (inhalable) (insoluble inorganic compounds) 0.1 (soluble inorganic compounds)	A5 (elemental) A1 (insoluble, inorganic)
Platinum metal and soluble compounds, as Pt	0.002 (soluble compounds)	1 (metal); 0.002 (soluble compounds)	
Rhodium metal fume, insoluble and soluble compounds, as Rh	0.1 0.001 (soluble compounds)	1 0.01 (soluble compounds)	
Silver, metal and soluble compounds, as Ag	0.01	0.1 (metal); 0.01 (soluble compounds)	
Tellurium and compounds, as Te	0.1	0.1	
Tin, organic compounds, as Sn	0.1	0.1	
Titanium dioxide, total dust	15	10	
Vanadium respirable dust, as V <sub>2</sub> O <sub>5</sub>	0.1	0.05	
Zinc compounds fume, dust	1 (zinc chloride fume) 5 (zinc oxide fume) 15 (total dust); 5 (resp.)	1 (zinc chloride fume) 2 (zinc oxide fume, resp. dust)	
Zirconium compounds, as Zr	5	5	

A1 – Confirmed human carcinogen

A2 - Suspected human carcinogen

A3 – Confirmed Animal Carcinogen and unknown influence to humans

A4 – Not classifiable as a human carcinogen

A5 – Not suspected as a human carcinogen

Table 3. Regulatory and recommended limits of exposure to some gases [5, 10, 11, 13].

Substance	Regulatory Limits (ppm)	Recommended Limits (ppm)
Carbon dioxide	5000	5000
Carbon monoxide	50	25
Nitrogen dioxide	9	0.2
Ozone	0.1	0.05-0.2
Phosgene	0.1	0.1
Hydrogen chloride	5	2

Exposure of welders to the gases and metal fumes may result in development of many acute, or chronic and adverse illnesses, including cancer.

Irritations, allergic reactions, and skin cancer melanoma are effects of the exposure to the UV, infrared radiations or exposure to some metals, such as cobalt, chromium or beryllium. If the metal particles are very small, they can penetrate through the skin and can cause lung deceases.

Snow blindness and welder's flash are eye disorders associated to the exposures to the UV or infrared radiations. Occupational exposure to heavy metals like nickel and chromium (VI), or gases, e.g. phosgene, hydrogen chloride, hydrogen fluoride, may result in abnormality in kidney functions.

It was shown that welding, particularly in the cases of stainless steel, due to the exposure to nickel and chromium, results in impairment in the reproductive system.

Contact to ozone in low concentrations evokes respiratory problems, such as irritations, tightness in the chests, shortness of the breath, or edema when ozone is present in increased concentrations. Respiratory dysfunctions can be a result of a contact to the nitrogen oxide.

Composition and increased concentration of the particles, their size, shape, and the length of exposure influence the appearance of many respiratory diseases, asthma or lung cancer.

Exposures to metal fumes initiate damage of the peripheral and central nervous system. Thus, harm of the central nervous system can be triggered by high concentrations of manganese and lead, while Alzheimer and Parkinsonian diseases, may be a result of the accumulation of aluminum in the brain. Carbon monoxide causes lack of attention, memory and visual difficulties.

Some other health problems, like sprains, strains, musculoskeletal disorders resulting from repetitive motions and lifting heavy objects, can be associated to the welding processes, too. Welders suffer from carpal tunnel syndrome, white finger, shoulder pain, back injuries, tendonitis, etc. Burns can be related to the application of sparks and heat in welding, while eye injuries are evoked by the side effects of welding, such as hot slags and metal chips.

The proper control measures applied to welding processes reduce the number of injuries and health adverse effects to workers. In addition to the abovementioned hazards, it is worth indicating the likely hazards accompanying welding processes, like fire, noise, and vibrations [5, 12].

#### 4 RISK ASSESMENT AND CONTROL MEASURES

Identification of potential hazards and the level of their risk to the environment and human health in one organization is done with a process of risk assessment, as a part of a planning phase of the health and safety management system.

Table 4. Risk assessment steps [3]

<b>STEP 1: Look for the hazard</b>
<b>STEP 2: Who might be harmed, and how</b>
<b>STEP 3: Evaluate the risks and decide if current precautions are adequate or more should be done</b>
<b>STEP 4: Record the findings</b>
<b>STEP 5: Review the assessment</b>

*Source:* Phil Hughes and Ed Ferrett. 2009. Introduction to Health and Safety at Work (4th. ed.). Butterworth-Heinemann, Elsevier, Burlington, MA, USA

Appropriate risk assessment identifies the significant hazards, which, with application of the suitable control measures are kept at low level of risk. General steps included in the risk assessment include five basic steps, as given in Table 4 [3]. First, the important hazards are identified, and the minor ones are disregarded. In addition, the people with the potential to be harmed are recognized. Quantitative and qualitative risk evaluation and the confirmation of the suitability of the existing precautions is done. Keeping records of the results of the risk

assessment is important for the decisions in the actions to be taken for the future improvements, as comparison data or as historical records.

Review and modification of the risk assessment process, as well as review of the control measures applied is necessary at the moment of some changes, like installment of new equipment, new materials used, different methods of work applied, new worker, changes in the law, after some incidents / accidents appeared or simply, if longer time passed since the last revision.

Table 5. Hierarchy of control [3].

Avoidance of risks	Elimination of the risk by substitution of the more
Elimination or substitution for something less hazardous	hazardous substances, processes, equipment, people, etc., with less hazardous.
Reducing or limiting the duration of exposure to the hazard	If the previous is not possible, then using the engineering controls fights the risks at the source.
Isolation/segregation	Engineering control gives the collective protective measures priority. Examples of the engineering controls are placing guards to the dangerous parts of the machines, thus separating the worker; Limited exposure of the worker to the harmful hazards; design of the equipment for decreased emission of the dangerous matter, etc.
Engineering controls	
Safe systems of work	Administrative control measures, i.e., safe system of work, encompass methods of doing the tasks in a safe manner, including the procedures, precautions, information and training, personal protective equipment (PPE), welfare...
Training and information	
PPE (Personal Protective Equipment)	Training and information increase the awareness of health and safety among workers, and thus reduce the number of occupational injuries and illnesses.
Welfare	PPE are used as a final option when the other control measures are not enough.
Monitoring and supervision	The effectiveness of the control measures and their application as planned, are assessed by the process of monitoring and review.

Source: Phil Hughes and Ed Ferrett. 2009. Introduction to Health and Safety at Work (4th. ed.). Butterworth-Heinemann, Elsevier, Burlington, MA, USA

Monitoring of the air helps in determination of the level of the gases and fumes present in the working environment and comparing it with the recommended exposure level of the specific substances. If appropriate control measures are not in place, it may result in different health problems to those being exposed. In addition, health monitoring of workers and / or those being exposed, enables detection of the potential alterations in their health [14].

The suitable hierarchy of the control measures, given in Table 5 [3], is essential in controlling the hazards and keeping them at the lowest possible level of risk.

In this regard, as far as control measures of the welding processes is concerned, the things needed to be done are [6]:

- [1] As far as it is a reasonable practice, elimination of the exposure to welding fumes;
- [2] Substitution with less hazardous if the elimination can't be implemented;

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- 1 Removal of the impurities from the surfaces being welded decreases the production of the fumes;
- 2 Isolation of the compartments where the welding is performed;
- 3 Application of engineering control measures, like ventilation systems, which can remove the hazardous gases and fumes, but also to supply fresh air to the working environment;
- 4 Working procedures reducing the risk of injuries and adverse health effects, i.e., safe system of work;
- 5 And as a last resort, when all the measures are applied, the use of the PPE, e.g., respiratory protective equipment.

## 5 CONCLUSIONS

Welding is a potentially hazardous process that can cause adverse effects to humans and the environment, related to the type and process of welding, the working environment (indoors or outdoors), preventive measures taken and Personal Protective Equipment (PPE) used. The presence of gases and airborne contaminants and their inhalation or penetration through the skin, may result in dysfunctions in living organisms, like disorders in the respiratory system, kidneys, reproductive organs, visual system, etc. Additionally, welding processes might be associated to hazards related to physical injuries, e.g., fire, burns, electric shock, noise, vibrations, musculoskeletal disorders, etc.

Application of an appropriate code of practice and control measures, and by that, increasing the employee awareness for the need of suitable system of health and safety at work, leads to better control of the hazards and reduction of the risk level toward illnesses and injuries among welders, and environment as well.

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# Characteristic points of a triangle presented through the GEOGEBRA software

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## ABSTRACT

Geometry is a branch of mathematics that deals with the shapes, sizes, position of the figure. The word geometry comes from the Greek language "geo - earth" and "meter - measurement". The first beginnings of geometry are in Egypt and Mesopotamia. The Greek mathematician Tales of Miletus used geometry to solve problems such as the distance of ships from shore, the height of the pyramids, etc. The most influential books on geometry are those of Euclid called "Elements".

In our century, in addition to classical learning, various interactive software is used in learning geometry. Among them, we can mention Geogebra.

Geogebra was created in 2001/2002 by Markus Hohenwarten. GeoGebra is interactive mathematical software consisting of teaching and learning from elementary to university level. This software is provided as a pedagogical and mathematical auxiliary tool. GeoGebra helps teach math because using this software, students see different mathematical formulas, algebraic and geometric presentations. GeoGebra is software that can be downloaded free of charge and can be easily installed on computers or other smart devices. In this paper, using the GeoGebra software, some characteristic points of a triangle are presented such as center of an inscribed circle, center of an outer circle, triangle median intersection (center of gravity), triangle intersection height (orthocenter) then addressing their pedagogical aspect. The research involved 112 students. Of them 40% excellent, 35% average, 25% below average. The purpose of the research is to prepare children aged 12-15, from grades 6, 7, 8, 9 in learning, working and explaining geometry through Geogebra software. Special emphasis is placed on the characteristic points of the triangles.

This content includes medians, intersection of heights - orthocenter, inscribed circle in triangle, circumcircle of triangle.

**KEYWORDS:** GeoGebra, Software, geometry, triangle, pedagogical aspect.

# 1 Mathematical Background

A convex polygon having three sides is called a triangle, represented in figure 1. Elements of triangles are: vertices  $A, B, C$  angles  $\alpha, \beta, \gamma$ , edges  $a, b, c$ . Triangles are separated by sides and by angles. Triangles by sides: Equilateral Triangle, Isosceles Triangle, Scalene Triangle. Triangles by angles: Acute Triangle, Right Triangle, Obtuse Triangle.

1

Perimeter of Triangle:  $P = a + b + c$ . Area of Triangle:  $\text{Area} = \frac{1}{2} \times \text{base} \times \text{perpendicular height}$ .

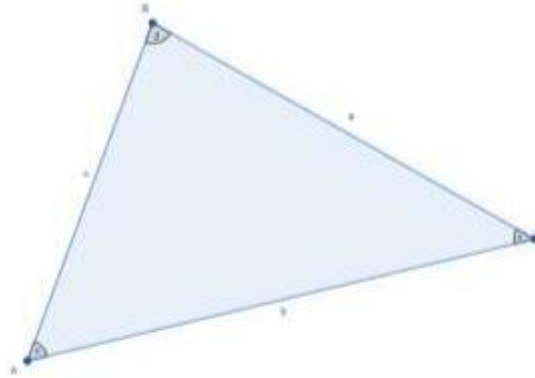


Figure 1. Triangle

The intersection of the heights of the triangles it is called the orthocenter.

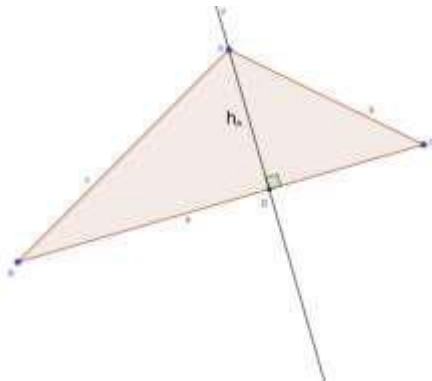


Figure 2. Altitude of triangle

$$f \perp BC$$

D – foot of altitude AD

$$AD = h_A$$

The segment that joins a vertex of the triangle with foot of its normal is called the altitude of the triangle, represented on figure 2.

The segment that joins the vertex of the triangle with the midpoint of the front side it is called the median. The three medians meet at one point. That point is called the center of gravity in triangle [1].

The three symmetries of the interior angles of the triangles meet at one point, which is the center of the inscribed circle on the triangle [1].

The three symmetries of the sides of the triangle meet at one point, which represents the center of the circumscribed of the triangle [1].

## 2 Characteristic points of a triangle

A triangle is a polygon with three sides. A triangle consists of three line segments and three angles. Basic properties of triangles are: The sum of the angles in a triangle is  $180^\circ$  called the angle-sum property [2]. The sum of the lengths of any two sides of a triangle is greater than the length of the third side [2]. Similarly, the difference between the lengths of any two sides of a triangle is less than the length of the third side [2]. The side opposite to the largest angle is the longest side of the triangle and the side opposite to the smallest angle is the shortest side of the triangle [2]. Characteristic points of a triangle are mediana, othocenter, Inscribed circle in a triangle and Circumscribed circle of a triangle.

### 2.1 Medians

In the Geogebra startup software via the Polygon option, we present the triangle. Then, we talk about what the median is. Once all students are clear, the media begins to be constructed. The beginning is the middle of the sides through the Midpoint or Center option. The media is then constructed using the Segment option. Thus, by designing with software, there is no need to talk about accuracy as GeoGebra does.

What is noticeable is the fact that students find fun while learning the lesson. Learning is no torture through software at all. Based on the research, it is noted that the participation of students in teaching is 100%. Each student gives their best to understand and contribute to learning and above all everyone is very curious and enthusiastic about the form of work, the construction of median is represented on figure 3, where: A, B, C are vertices of triangle, a, b, c are edges of triangle, ma, mb, mc are medians and G is Center of gravity.

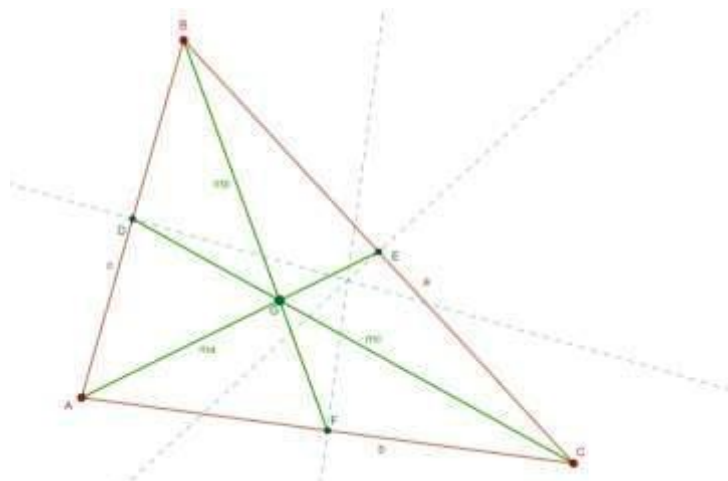


Figure 3. Medians in GeoGebra

If we go back to the classic, students should definitely be provided with geometric work tools. Also, the teacher should definitely be provided with tools.

In explaining the teacher all the time he speaks, explains, constructs, and demands attention from everyone.

In the end, when controlling the students work, the students' mistakes are numerous, starting with the way of drawing triangles where often the sides are not joined, the triangle does not appear triangles and there is no medians intersection.

Such mistakes are made in 25% of below average students (in most cases) and up to 35% of average students (in a few cases). While 40% of students with maximum achievement do not make such mistakes.

In the classical form, we have less desirable participation in learning. Errors and inaccuracies with geometric tools make them easy to overlook. With Geogebra, students become more curious about learning, ask endless questions, and the desire to learn is unquestionable.

### 2.2 Orthocenter

In Geogebra software through the Polygon option, we present the triangle. Students are explained what the altitude of the triangle is. With the Perpendicular Line option, we construct the altitudes. This is how we obtain the altitudes of the triangles constructed through software. Students appear surprised and curious about the outcome of the work. From there they start to play with colors and move the triangle in different positions.



Research shows that students are 100% involved in learning. Questions from students are many. A high percentage of students ask questions like:

- [1] If the triangle was bigger, would the altitudes meet?
- [2] Can altitudes not meet??
- [3] Is it possible that the altitude and the side in front, do not form angle  $90^\circ$ ?

The most positive part was that the students then managed to answer the questions by moving the triangle.

In classical explanation, tools are needed.

From the beginning, the teacher speaks, demonstrates and constructs, together with the students.

Finally, the check is done. The most common mistake was altitude meeting. Research shows that 75% of students fail to accurately construct altitude meeting, 25% succeed.

From the classical form, the students fail to perceive the altitudes of the triangle, as they cannot move the triangle at different positions. Also, the pace of work is not the same. Some students are on time but many others are left behind, the construction of orthocenter is represented on figure 4 where: A, B, C are vertices of triangle, a, b, c are edges of triangle and f, g, h are altitudes of triangle.

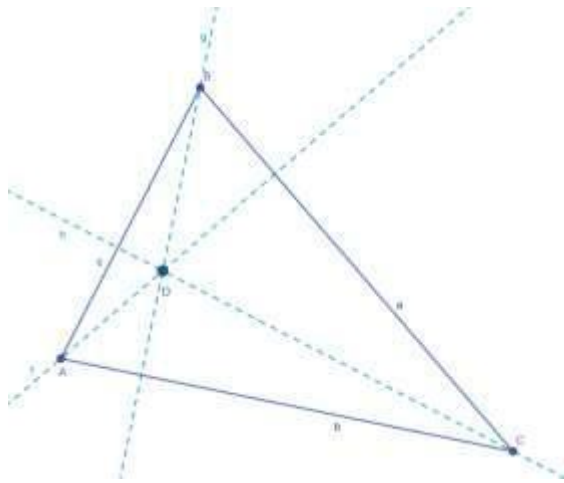


Figure 4. Orthocenter in GeoGebra

## 2.3 Inscribed circle in a triangle

In Geogebra software we first draw a triangle through the Polygon option. The students are then explained how the center of the inscribed circle is located. Then with the Angle Bisector command, we find the symmetries of the three angles. At the point of intersection of these three symmetries lies the center of the inscribed circle in the triangles. Then, through the Perpendicular Line command, we present the normal line in AC through point D. Then create the center circle in D to point E. After creating the circle, the students understand what they are creating. They start and move the triangle in different positions. Ask questions. What distinguishes the intersecting circle in triangles from other points is the fact that students now seek to construct themselves the construction of Inscribed circle in a triangle is represented on figure 5.

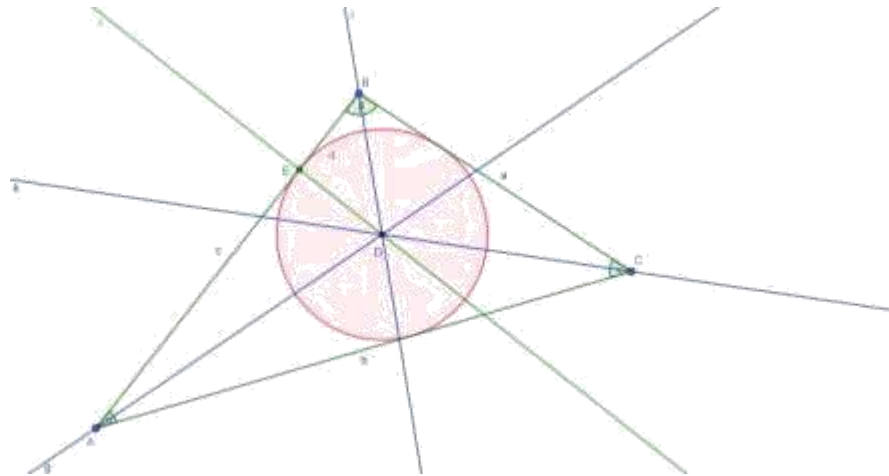


Figure 5. Inscribed circle in a triangle

In the classical form, the tools of geometry are obtained. First, it is shown that the main element of construction is the meeting of symmetries at one point. During the work up to the end of the construction, error is observed. According to the research, 88% of the students do not reach the center of the inscribed circle. So the symmetries do not meet at one point. While 12% of students construct correctly.

In Geogebra these problems did not occur. Looking at the notebook work and the Geogebra work, the students come to understand how they have been constructed and how they should have been constructed.

## 2.4 Circumscribed circle of a triangle

Perpendicular Bisector option we find the middle of the sides. At their meeting at point D lies the center of the circumscribed circle of triangle. Using the Circle with Center through Point option, click on D then point A. So we have the circle.

This is how students see their job. They know what they did, but they have many questions. Among them were:

- 1 If the symmetries did not meet, what happens?
- 2 How do symmetries meet?
- 3 Can we randomly find the center of the circumscribed circle of triangle? To give an answer, they must do all the work themselves.

We return to classical construction. Using geometric tools, we construct the triangle. All three questions were answered.

The students' mistake was the answer to their questions.

Unless the symmetries met, we had no center of circumscribed circle of triangle, represented on figure 6.

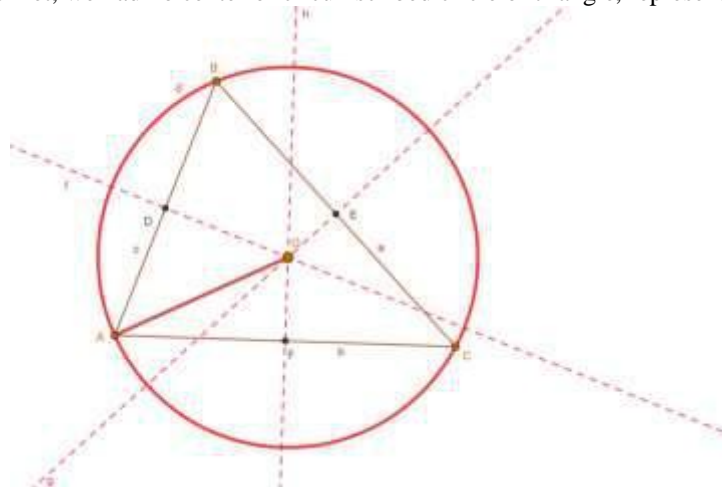


Figure 6. Circumscribed circle of triangle

Then, how do the symmetrical symmetries meet through construction? We were finally convinced that the center of the circumscribed circle of triangle is not randomly found. The survey also found that 76% of students with geometric means had many problems. 24% had no problems. In Geogebra, no pupils had any problems with the construction.

## CONCLUSION

In general, research shows that students are very ready to learn geometry through Geogebra software. They are much more curious and the attendance at school is much greater. Thought, understanding, and interest are much greater when working through this software.

Classical form, geometric tools are very suitable for teaching. But the probability of error is very high. Uncertainty, lagging behind in construction steps, relinquishing instruction, with the idea that teaching is difficult, are some of the characteristics of learners, especially in average and below average students.

Students above average do not encounter problems in any of the forms explained. Research shows that explaining Geogebra attracts more students to math learning. The characteristic points of the triangle, through Geogebra, turn out to be clearer when students construct on their own in the software.

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# Some approximations for the Euler number and comparing their convergence using software Octave

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## Abstract

There are used some known facts and inequalities in order to find new relations and equalities which approximate Euler number. Also comparisons and visualizing between existing approximations and new ones, which are given as infinitely series, are given by software Octave by testing their rate of convergence to Euler number for some terms.

**KEYWORDS:** Carleman's Inequality; Polya's inequality; Euler number.

## 1 Introduction

Euler number first appeared in 1618 in contributions to the logarithms of the Scottish mathematician John Napier, not as a constant, but as the basis of logarithms. The discovery is attributed to Swiss mathematician Jakob Bernuli who tried to find  $\lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$ , which is in fact number  $e$ , and its value taken first 20 decimals, is  $e = 2,71828182845904523536 \dots$

The note for this number was given by mathematician Leonhard Euler in 1727.

The Euler number can be presented in different ways, as an endless series of endless productions, a continuous ratio or a sequence limit, which is also taken as a definition in mathematical analysis courses, ie:  $e = \lim_{n \rightarrow \infty} \left(1 + \frac{1}{n}\right)^n$ .

But for its calculation with the highest precision it is most appropriate to appear in infinite series, ie.  $e = \sum_{n=0}^{\infty} \frac{1}{n!}$  which converges very quickly.

The idea of finding these constant approximations, and others like this, is nothing new, but it has attracted the attention of many mathematicians, and even today it continues to make efforts to find the fastest and most accurate approximations.

The importance of finding these approximations lies in the fact that the number  $e$  is an irrational number, rather than transcendental, and that it appears in many important formulas, not only in mathematics but also in other branches, so it is important to find series which in as few terms as summ will obtain more digits of this constant.

In this paper we will give some inequalities(restrictions), including the Euler number, for achievement of which we use some known inequalities, in particular Carleman's inequality, namely the generalization of Polya's inequality, than the obtained series, which approximate Euler number, will be compared with the well-known approximation(series)  $\sum_{n=0}^{\infty} \frac{1}{n!}$ .

## 2 Auxiliary facts

**Lemma 1.1** ([1])  $\frac{1}{(n+1)!} \leq e - \sum_{n=0}^{\infty} \frac{1}{n!} < \frac{3}{(n+1)!}$ ,  $n = 1, 2, \dots$

**Lemma 1.2** ([2])  $\frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{2n} < 1$ ,  $n = 1, 2, \dots$

**Lemma 1.3**  $\left(1 + \frac{1}{n}\right)^n < e$ ,  $n = 1, 2, \dots$

**Lemma 1.4 (Carleman's inequality)** ([3])  $\sum_{n=1}^{\infty} (a_1 a_2 \dots a_n)^{\frac{1}{n}} < e \sum_{n=1}^{\infty} a_n$ , where  $a_n \geq 0$  ( $n = 1, 2, \dots$ ) and  $\sum_{n=1}^{\infty} a_n < \infty$ .

The generalisation of this inequality is given by Polya in the following form:

$$\sum_{n=1}^{\infty} \lambda_n (a_1^{\lambda_1} a_2^{\lambda_2} \dots a_n^{\lambda_n})^{\frac{1}{\sigma_n}} < e \sum_{n=1}^{\infty} \lambda_n a_n$$

Where  $\lambda_n > 0$ ,  $\sigma_n = \sum_{k=1}^n \lambda_k$ ,  $a_n \geq 0$  ( $n = 1, 2, \dots$ ) and  $0 < \sum_{n=1}^{\infty} \lambda_n a_n < \infty$ .

**Lemma 1.5** :  $\sum_{k=1}^{\infty} \frac{1}{\alpha^2 + k^2} = \frac{e^{\alpha\pi} \alpha\pi - sh\alpha\pi}{2\alpha^2 sh\alpha\pi}$ .

**Proof:** From complex form of Fourier series  $f(x) = \sum_{k=-\infty}^{\infty} c_k e^{ikx}$ , where

$c_k = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{-ikx} f(x) dx$ . For  $(x) = e^{\alpha x}$ ,  $\alpha$ - real number we take:

$$\begin{aligned} c_k &= \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{-ikx} e^{\alpha x} dx = \frac{1}{2\pi} \int_{-\pi}^{\pi} e^{(\alpha - ik)x} dx = \\ &= \frac{1}{2\pi(\alpha - ik)} (e^{(\alpha - ik)\pi} - e^{-(\alpha - ik)\pi}) = (-1)^k \frac{\alpha + ik}{\pi(\alpha^2 + k^2)} sh\alpha\pi. \end{aligned}$$

Since  $c_k = \frac{a_k - ib_k}{2}$  from last equality we get:

$$\begin{aligned} a_k &= (-1)^k \frac{2\alpha sh\alpha\pi}{\pi(\alpha^2 + k^2)} \text{ and } b_k = -(-1)^k \frac{2k sh\alpha\pi}{\pi(\alpha^2 + k^2)}, \text{ so} \\ e^{\alpha x} &= \frac{sh\alpha\pi}{\alpha\pi} + \frac{2}{\pi} sh\alpha\pi \left( \sum_{k=1}^{\infty} \frac{(-1)^k \alpha}{\alpha^2 + k^2} coskx + \sum_{k=1}^{\infty} \frac{(-1)^{k-1} k}{\alpha^2 + k^2} sinkx \right) \end{aligned}$$

For  $x = \pi$  we get:  $e^{\alpha\pi} = \frac{sh\alpha\pi}{\alpha\pi} + \frac{2}{\pi} \alpha sh\alpha\pi \sum_{k=1}^{\infty} \frac{1}{\alpha^2 + k^2}$

respectively  $\sum_{k=1}^{\infty} \frac{1}{\alpha^2 + k^2} = \frac{e^{\alpha\pi} \alpha\pi - sh\alpha\pi}{2\alpha^2 sh\alpha\pi}$

**Lemma 1.6:**  $sgn\sin x = \frac{4}{\pi} \sum_{n=1}^{\infty} \frac{\sin(2n-1)x}{2n-1}$

## 3 Main results, numerical illustrations and graphical presentations

**Proposition 1.1.**  $e = \sum_{k=1}^{\infty} \frac{2k-1}{3(k-1)!}$

**Proof:** Using Taylor expansion we have:

$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!}$ ,  $\Rightarrow e^{x^2} = \sum_{n=0}^{\infty} \frac{x^{2n}}{n!}$ , since this series is convergent than the following relations hold:

$$2xe^{x^2} = \sum_{n=0}^{\infty} \frac{2nx^{2n-1}}{n!} = \sum_{n=1}^{\infty} \frac{2nx^{2n-1}}{n!} = \sum_{n=1}^{\infty} \frac{2x^{2n-1}}{(n-1)!} \Rightarrow$$

$$xe^{x^2} = \sum_{n=1}^{\infty} \frac{x^{2n-1}}{(n-1)!} \Rightarrow 2x^2e^{x^2} + e^{x^2} = \sum_{n=1}^{\infty} \frac{(2n-1)x^{2n-2}}{(n-1)!} \Rightarrow (1 + 2x^2)e^{x^2} = \sum_{n=1}^{\infty} \frac{(2n-1)x^{2n-2}}{(n-1)!}.$$

Since it is convergent  $\forall x \in \mathbb{R}$ , than for  $x = 1$  we get:

$$3e = \sum_{n=1}^{\infty} \frac{2n-1}{(n-1)!} \Rightarrow e = \sum_{n=1}^{\infty} \frac{2n-1}{3(n-1)!}$$

The Octave code to generate the partial sums of the above series is :

```
function e_sum = e_sum(n)
s = 0;
for i = 1:n
s = s + (2*i-1)/(3*factorial(i-1));
endfor
e_sum = s;
endfunction
```

Now we give some approximations obtained in Octave:

```

Command Window
>> e_sum(2)
ans = 1.3333
>> e_sum(3)
ans = 2.1667
>> e_sum(5)
ans = 2.6806
>> e_sum(7)
ans = 2.7171
>> e_sum(10)
ans = 2.7183
>>

```

Fig.1 Some partial sums of series  $\sum_{n=1}^k \frac{2n-1}{3(n-1)!}$  using Octave for k=2, 3, 5, 7 and 10 respectively

**Proposition 1.2.**  $\frac{(2e-1)(n+1)!-6}{(n+1)!} < \sum_{k=1}^n \frac{2k^2-k+3}{3k!} \leq \frac{2e-3}{(n+1)!}$ ,  $\forall n \in \mathbb{N}$ .

Proof: Obviously that  $0 < e - \sum_{k=0}^n \frac{1}{k!} < \frac{3}{(n+1)!}$ ,  $n = 1, 2, \dots$ , and

$0 < e - \sum_{k=1}^n \frac{2k-1}{3(k-1)!} < \frac{3}{(n+1)!}$ ,  $\forall n \in \mathbb{N}$ . Adding these inequalities side by side we get:

$$2e - \left( \sum_{k=0}^n \frac{1}{k!} + \sum_{k=1}^n \frac{2k-1}{3(k-1)!} \right) < \frac{6}{(n+1)!}$$

$$2e - 1 - \left( \sum_{k=1}^n \left( \frac{1}{k!} + \frac{2k-1}{3(k-1)!} \right) \right) < \frac{6}{(n+1)!}$$

$$2e - 1 - \frac{6}{(n+1)!} < \sum_{k=1}^n \frac{3+k(2k-1)}{3k!}$$

$$\frac{(2e-1)(n+1)!-6}{(n+1)!} < \sum_{k=1}^n \frac{2k^2-k+3}{3k!}, \forall n \in \mathbb{N}$$

Also the following inequalities are valid:

$$e - \sum_{k=0}^n \frac{1}{k!} \geq \frac{1}{(n+1)!}, \forall n \in \mathbb{N}$$

$$e - \sum_{k=1}^n \frac{2k-1}{3(k-1)!} \geq \frac{1}{(n+1)!}, \forall n \in \mathbb{N}$$

Adding these inequalities side by side we get:

$$2e - 1 - \left( \sum_{k=1}^n \frac{1}{k!} + \frac{2k-1}{3(k-1)!} \right) \geq \frac{2}{(n+1)!}$$

$$2e - 1 - \frac{2}{(n+1)!} \geq \sum_{k=1}^n \frac{2k^2-k+3}{3k!}$$

So finally we get the  $\frac{(2e-1)(n+1)!-6}{(n+1)!} < \sum_{k=1}^n \frac{2k^2-k+3}{3k!} \leq \frac{2e-3}{(n+1)!}$

**Proposition 1.3.**  $\frac{n+1}{n} < \sqrt[n]{\frac{e}{\frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{2n}}}$

**Proof:** Using lemma1.2 and lemma1.3 we get  $\frac{e}{\left(1+\frac{1}{n}\right)^n} > 1 > \frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{2n}$ , consequently

$$\left(1 + \frac{1}{n}\right)^n < \frac{e}{\frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{2n}}$$

$$\frac{n+1}{n} < \sqrt[n]{\frac{e}{\frac{1}{n+1} + \frac{1}{n+2} + \dots + \frac{1}{2n}}}$$

**Proposition 1.4.**  $e^\pi > \pi^e$  (proved in a new way)

**Proof .** According to Taylor expansion of series we get:

$$e^a > 1 + a + \frac{a^2}{2!} + \frac{a^3}{3!}, a > e$$

$$a^e > 1 + e \ln a + \frac{e^2 \ln^2 a}{2!} + \frac{e^3 \ln^3 a}{3!}$$

$$e^a - a^e > a - e \ln a + \frac{a^2 - e^2 \ln^2 a}{2!} + \frac{a^3 - e^3 \ln^3 a}{3!}$$

Let us consider the function  $f(x) = x - e \ln x$ , for  $x > e$

$$f'(x) = \frac{x-e}{x}$$

$f'(x) = 0 \Rightarrow x - e = 0 \Rightarrow x = e$ . For  $x \in (0, e)$ ,  $f'(x) < 0$ , and for  $x \in (e, +\infty)$ ,  $f'(x) > 0$ , so for  $x \in (e, +\infty)$ , function is increasing, consequently for  $a > e \Rightarrow$

$f(a) > f(e) \Rightarrow a - e \ln a > e - e \ln e = 0 \Rightarrow a > e \ln a$ ;  $\frac{a^2}{2!} > \frac{e^2 \ln^2 a}{2!}$ ;  $\frac{a^3}{3!} > \frac{e^3 \ln^3 a}{3!}$  respectively

$$a - e \ln a + \frac{a^2 - e^2 \ln^2 a}{2!} + \frac{a^3 - e^3 \ln^3 a}{3!} > 0$$

So  $e^a - a^e > 0 \Rightarrow e^a > a^e$  and for  $a = \pi$  we get  $e^\pi > \pi^e$ .

**Proposition 1.5.** The following relation is true

$$\sum_{n=1}^{\infty} \left( \frac{q^{-n}}{\sqrt[q^2]{2!} \sqrt[q^3]{3!} \sqrt[q^4]{4!} \dots \sqrt[q^n]{n!}} \right)^{\left( \frac{(1-q)}{q(1-q)^n} \right)} < e^{1+\frac{1}{q}}$$

Where  $0 < q < 1$ .

**Proof**

Using Polya's inequality and putting  $a_n = \frac{1}{n!}$ ,  $\lambda_n = q^n$ ,  $0 < q < 1$ , then

$\sigma_n = q + q^2 + \dots + q^n = q \frac{1-q^n}{1-q}$ , so we get the inequality:

$$\sum_{n=1}^{\infty} \left( \frac{q^{-n}}{q^2 \sqrt{2!} q^3 \sqrt{3!} q^4 \sqrt{4!} \dots q^n \sqrt{n!}} \right)^{\left( \frac{(1-q)}{q(1-q)^n} \right)} < e \sum_{n=1}^{\infty} \frac{q^{-n}}{n!} = e e^{\frac{1}{q}} = e^{1+\frac{1}{q}}$$

**Proposition 1.6.**  $e = \sqrt{\sum_{n=0}^{\infty} \frac{(2n+3)2^{2n}}{(2n+1)!}}$

**Proof :** It is known that:

$\cosh x = \sum_{n=0}^{\infty} \frac{x^{2n}}{(2n)!}$  and  $\sinh x = \sum_{n=0}^{\infty} \frac{x^{2n+1}}{(2n+1)!}$  hold for every  $x \in \mathbb{R}$ .

For  $x = 2$  we get:  $\cosh 2 = \sum_{n=0}^{\infty} \frac{2^{2n}}{(2n)!}$  and  $\sinh 2 = \sum_{n=0}^{\infty} \frac{2^{2n+1}}{(2n+1)!} \Rightarrow \frac{e^2 + e^{-2}}{2} = \sum_{n=0}^{\infty} \frac{2^{2n}}{(2n)!}$  so  $\frac{e^2 - e^{-2}}{2} = \sum_{n=0}^{\infty} \frac{2^{2n+1}}{(2n+1)!}$ .

Adding these equalities we obtain :

$$\begin{aligned} e^2 &= \sum_{n=0}^{\infty} \left( \frac{2^{2n}}{(2n)!} + \frac{2^{2n+1}}{(2n+1)!} \right) \\ e^2 &= \sum_{n=0}^{\infty} \frac{2^{2n}(2n+1) + 2 \cdot 2^{2n}}{(2n+1)!} \\ e^2 &= \sum_{n=0}^{\infty} \frac{(2n+1+2)2^{2n}}{(2n+1)!} \Rightarrow e^2 = \sum_{n=0}^{\infty} \frac{(2n+3)2^{2n}}{(2n+1)!} \Rightarrow e = \sqrt{\sum_{n=0}^{\infty} \frac{(2n+3)2^{2n}}{(2n+1)!}} \end{aligned}$$

The code in the Octave to generate the partial sums of the above series is :

```
function e_sq = e_sqrt(n)
s = 0;
for i = 0:n
s = s + ((2*i+3)*2^(2*i))/factorial(2*i+1);
endfor
e_sq = sqrt(s);
endfunction
```

**Command Window**

```
>> e_sqrt(2)
ans = 2.6957
>> e_sqrt(3)
ans = 2.7168
>> e_sqrt(5)
ans = 2.7183
>> e_sqrt(7)
ans = 2.7183
>> e_sqrt(10)
ans = 2.7183
>> |
```

Fig.2 Some partial sums of series  $\sqrt{\sum_{n=0}^k \frac{(2n+3)2^{2n}}{(2n+1)!}}$  using Octave for  $k=2, 3, 5, 7$  and  $10$  respectively



Now we consider the well-known series  $e = \sum_{n=0}^{\infty} \frac{1}{n!}$ , which in Octave has the following code::

```
function [e_fact] = e_factorial(n)
s = 0;
for i = 0:n
s = s + 1/factorial(i);
endfor
e_fact = s;
endfunction
```

```
Command Window
>> e_factorial(2)
ans = 2.5000
>> e_factorial(3)
ans = 2.6667
>> e_factorial(5)
ans = 2.7167
>> e_factorial(7)
ans = 2.7183
>> e_factorial(10)
ans = 2.7183
>> |
```

Fig.3 Some partial summs of series  $\sqrt{\sum_{n=0}^{\infty} \frac{1}{n!}}$  using Octave for n=2, 3, 5, 7 and 10 respectively

Let us present the Octave code for graphical representation of the series  $e = \sqrt{\sum_{n=0}^{\infty} \frac{(2n+3)2^{2n}}{(2n+1)!}}$  and  $e = \sum_{n=0}^{\infty} \frac{1}{n!}$ , and according to these presentations we will compare these series:

```
function plot_e = plot_e(n)
M = zeros(4,n);
for i = 1:n
M(1,i) = i;
M(2,i) = e_factorial(i);
M(3,i) = e_sqrt(i);
M(4,i) = e_sum(i);
endfor
plot(M(1,:),M(2,:),M(1,:),M(3,:),M(1,:),M(4,:))
endfunction
```

The graphs of these series are shown below:

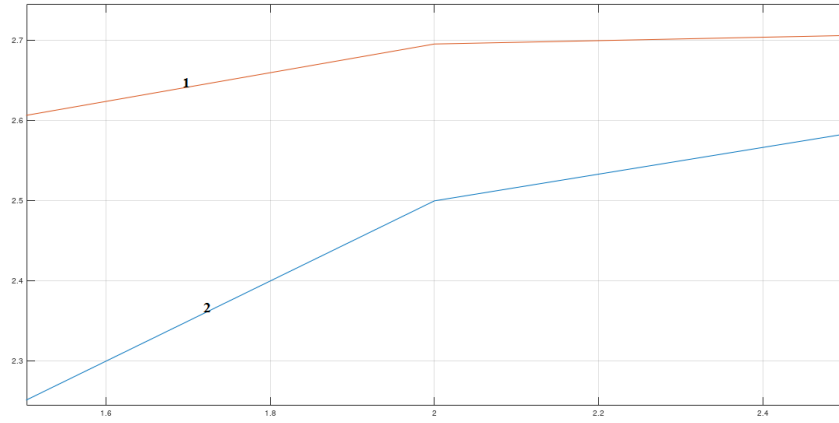


Fig. 4 (1-brown colour)-graph presentation of series  $e = \sqrt{\sum_{n=0}^{\infty} \frac{(2n+3)2^{2n}}{(2n+1)!}}$

(2-blue colour)- graph presentation of series  $e = \sum_{n=0}^{\infty} \frac{1}{n!}$

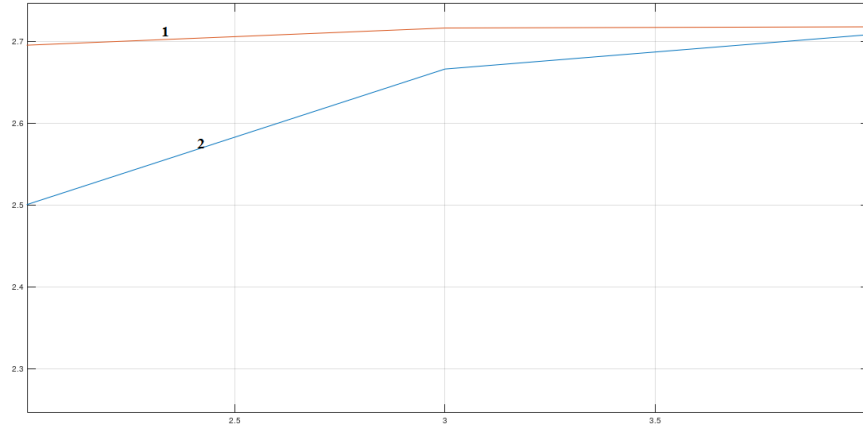


Fig.5 Graphical presentation of the sums of the first three terms

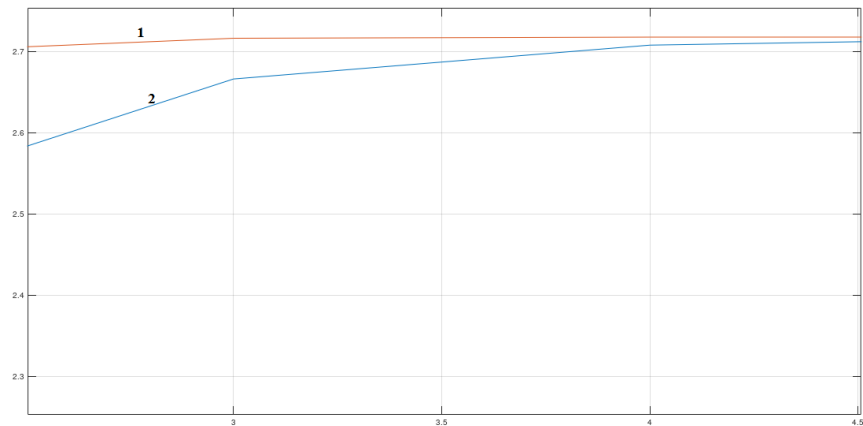


Fig.6 Graphical presentation of the sums of the first four terms

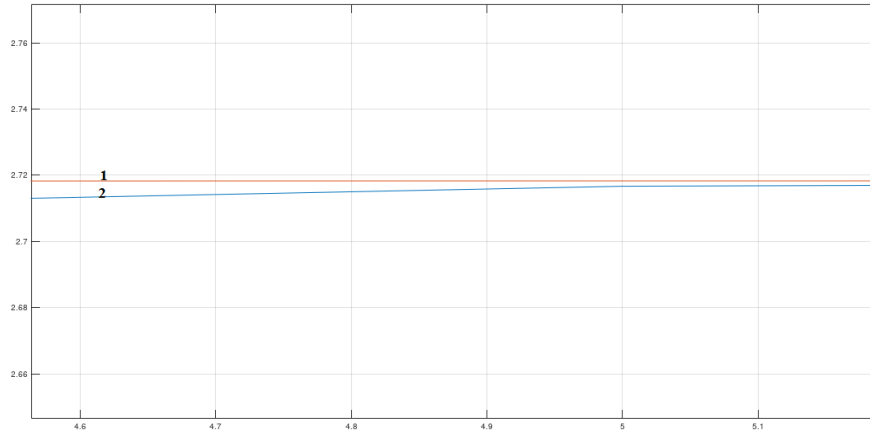


Fig. 7 Graphical presentation of the sums of the first five terms

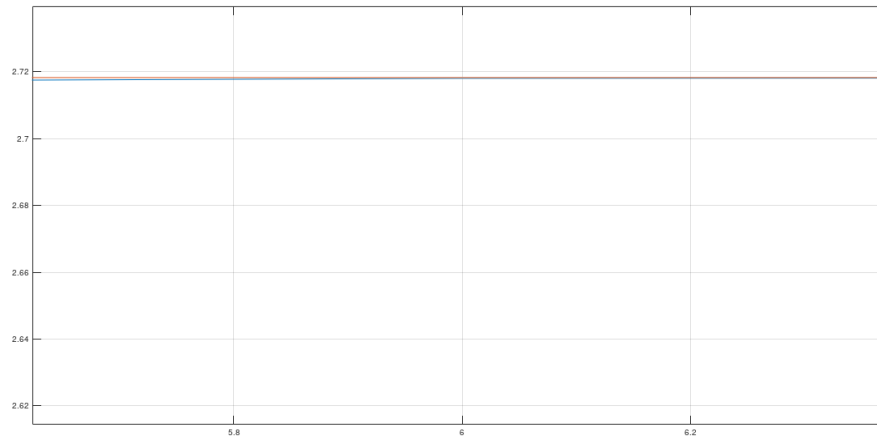


Fig.8 Graphical presentation of the sums of the first six terms

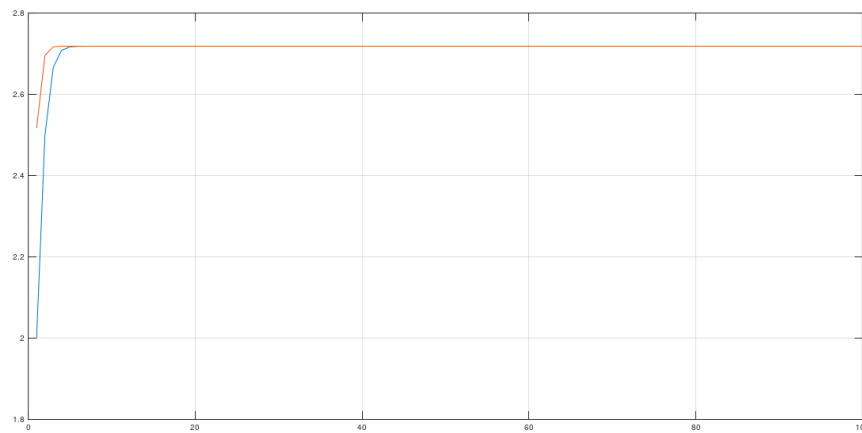


Fig.9 Graphical presentation of the sums of the first a hundred terms

**Proposition 1.7.** The relation

$$e^\pi = \left( \frac{\sum_{k=1}^{\infty} \frac{k^2 + 1 + 2^{k+2}}{2^{k+2}(1 + k^2)}}{\sum_{k=1}^{\infty} \left( \frac{k^2 + 1 + 2^{k+2}}{2^{k+2}(1 + k^2)} + \frac{4(-1)^{k-2}}{2k-1} \right)} \right)^{\frac{1}{2}}$$

is valid.

**Note 1.** The number  $e^\pi$  is known as Gelfond's constant.

**Proof.** Using lemma 1.5, for  $\alpha = 1$  we get

$$\begin{aligned} \sum_{k=1}^{\infty} \frac{1}{1+k^2} &= \frac{e^\pi \pi - sh\pi}{2sh\pi} = \frac{e^\pi \pi}{2sh\pi} - \frac{1}{2} \\ \sum_{k=1}^{\infty} \frac{1}{1+k^2} + \frac{1}{2} &= \frac{\pi e^\pi}{e^\pi - e^{-\pi}} \\ \sum_{k=1}^{\infty} \frac{1}{1+k^2} + \frac{1}{4} \sum_{k=1}^{\infty} \frac{1}{2^k} &= \frac{\pi e^{2\pi}}{e^{2\pi} - 1} \\ \sum_{k=1}^{\infty} \left( \frac{1}{1+k^2} + \frac{1}{2^{k+2}} \right) &= \frac{\pi e^{2\pi}}{e^{2\pi} - 1} \\ 1 - e^{-2\pi} &= \pi \left( \sum_{k=1}^{\infty} \left( \frac{1}{1+k^2} + \frac{1}{2^{k+2}} \right) \right)^{-1} \\ e^{2\pi} &= \frac{\sum_{k=1}^{\infty} \left( \frac{1}{1+k^2} + \frac{1}{2^{k+2}} \right)}{\sum_{k=1}^{\infty} \left( \frac{1}{1+k^2} + \frac{1}{2^{k+2}} \right) - \pi} \end{aligned}$$

Taking natyral logarithm in both sides and using lemma 1.6, for  $x = \frac{\pi}{2}$ , respectively

$$\pi = 4 \sum_{k=1}^{\infty} \frac{(-1)^{k-1}}{2k-1}, \text{ we get}$$

$$\pi = \ln \sqrt{\frac{\sum_{k=1}^{\infty} \frac{k^2 + 1 + 2^{k+2}}{2^{k+2}(1 + k^2)}}{\sum_{k=1}^{\infty} \left( \frac{k^2 + 1 + 2^{k+2}}{2^{k+2}(1 + k^2)} + \frac{4(-1)^{k-2}}{2k-1} \right)}}$$

Which yields to our result.

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# Sustainable Urban Mobility Plans For A Successful Future Of Cities

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## Abstract

Integrated traffic planning is a new way of planning that derives from the experiences and good practices of many European cities and regions that have worked on its successful implementation. Its main purpose is to reduce the environmental burden caused by the transport system and to contribute to the establishment of a sustainable, attractive, accessible and healthy environment.

A key element of integrated traffic planning is the Sustainable urban mobility plan (SUMP). This Plan is based on European Union documents as well as guidelines set by the European Commission. The Sustainable urban mobility plan is a document with a set of measures to help cities to achieve a shift towards more sustainable modes of transport and higher quality of life. The key to change is moving towards integrated traffic planning. The SUMP offers the opportunity to transition from classic to modern, comprehensive traffic planning. Integrated traffic planning does not override, but on the contrary, builds on existing planning practices and has a long-term and strategic vision for sustainable mobility.

The Sustainable urban mobility plan is a document that incorporates and updates the existing strategic documents of the city itself. It is a new way of thinking and planning that represents a step towards more sustainable traffic planning in the region - in line with modern European Commission guidelines and recommendations.

**KEYWORDS:** Sustainable urban mobility plan, mobility, strategy, traffic planning, urban plans

## 1. INTRODUCTION

Integrative traffic planning is a new way of planning that originates from experiences and good practices of many European cities and regions that have been working on successfully implementing its key principles. Its main objective is to reduce environment related burden caused by transport system and contributing to establishment of a sustainable, livable, attractive, accessible and healthy environment.

The process was designed to use tested planning methods that balance economic development, social justice and quality of the environment while taking into account existing practices and policies of different sectors and levels of authority. Public involvement in all stages of the planning process allows setting a clear vision and goals whose achievement is measurable and that are accepted by relevant stakeholders and general public.

The central element of the integrative traffic planning is Sustainable urban mobility plan - SUMP. It is based on EU documents and guidelines set by European commission. A sustainable urban mobility plan is a document in which the municipality drafted a set of measures which will help achieve a shift toward more sustainable transport modes and higher quality of living. The key to the change is a shift towards integrative traffic planning. Sustainable urban mobility plan offers possibility for transition from classic to modern and comprehensive traffic planning. Integrated traffic planning does not reject, but upgrades current planning practices and it has a long-term and strategic vision striving towards sustainable mobility.

The Plan is aiming towards an attractive public passenger transport, branched network of safe cycling routes and good conditions for pedestrians. It focuses on city center as a regulated, attractive, accessible and safe urban space.

## 2. INTEGRATIVE TRAFFIC PLANNING

A principal shortcoming of urban transport planning today is the lack of coordination between policies and organizations. Addressing this deficit represents a major challenge for sustainable urban mobility planning, but is also a main source for innovation and improvement.

Existing planning practices in the municipality included some sustainable mobility ideas and proposals but they still lacked complex analysis and ranking of the projects. Planning should provide quality services that meet demands of the public as well as constant renewal of existing transport system that fits the needs of its users. A strategic planning practice is aimed at satisfying mobility need of population while improving the quality of living in urban areas.

Traditional Transport Planning	Sustainable Urban Mobility Planning
Focus on traffic	→ Focus on people
Primary objectives: Traffic flow capacity and speed	→ Primary objectives: Accessibility and quality of life, as well as sustainability, economic viability, social equity, health and environmental quality
Modal-focussed	→ Balanced development of all relevant transport modes and shift towards cleaner and more sustainable transport modes
Infrastructure focus	→ Integrated set of actions to achieve cost-effective solutions
Sectorial planning document	→ Sectorial planning document that is consistent and complementary to related policy areas (such as land use and spatial planning; social services; health; enforcement and policing; etc.)
Short- and medium-term delivery plan	→ Short- and medium-term delivery plan embedded in a long-term vision and strategy
Related to an administrative area	→ Related to a functioning area based on travel-to-work patterns
Domain of traffic engineers	→ Interdisciplinary planning teams
Planning by experts	→ Planning with the involvement of stakeholders using a transparent and participatory approach
Limited impact assessment	→ Regular monitoring and evaluation of impacts to inform a structured learning and improvement process

**Table 1: Difference between planning processes,**  
Source: Guidelines, 2014, <https://www.eltis.org/guidelines/sump-guidelines>

According to The Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan [4], with implementation of integrated transport planning the municipality is choosing:

**All-inclusive planning:** We want take advantage of knowledge from different professions, planning practices and strategies and experiences of different decision-making sectors, public institutions and enterprises and all levels of government.

**Sustainable Development:** By practicing sustainable transport planning we want to achieve a balance between social equality, healthy environment and economic development.

**Effective measure packages:** By interconnecting and complementing proposed measures we want to increase the ability and efficiency of the municipality in overcoming development challenges.

**Measurable strategic objectives:** Proposed measure packages are derived from strategic goals which are in line with the set vision of the municipality. This kind of hierarchy allows us to evaluate implemented measures and their contribution to set strategic goals.

**Real cost assessment:** Future transport planning will include wider social costs and benefits to all sectors. Strategic planning allows control over and rational use of public funds.

With integrated traffic planning the municipality can obtain many benefits:

**Better quality of living, environment and health:** There is strong evidence that sustainable urban mobility planning raises the quality of life in urban areas. Well-coordinated policies result in a wide range of benefits, such as more attractive public spaces, improved road safety, better health, and less air and noise pollution.

**Improved mobility and accessibility:** Integrated traffic planning ensures better mobility of all inhabitants and facilitates accessibility to individual areas and service.

**Decisions supported by the public:** Planning for people includes responding to needs of different user groups. By involving the public in decision making and assessment of proposed measures, planning sector acquires a significant degree of "public legitimacy".

**New and comprehensive political visions:** Integrated traffic planning offers long-term and strategic a vision for mobility. It encourages effective and integrated planning, which seeks to integrate the sectorial policies as well as achieving other objectives of the municipality (economic, social, and environmental).

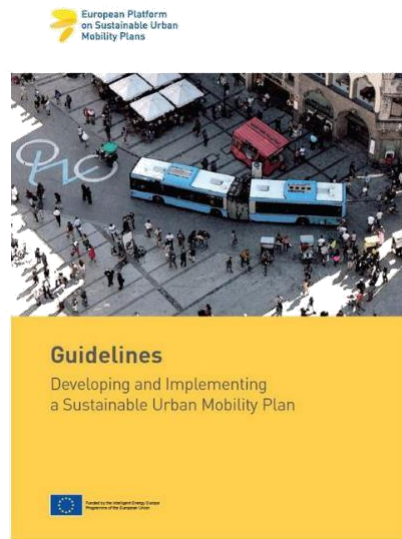
**Improve access to funds:** An integrated transport strategy can provide access to resources, which are available for innovative solutions, and increase competitiveness municipalities to apply for calls for national and international funding.

### 3. SUSTAINABLE URBAN MOBILITY PLAN

A Sustainable urban mobility plan is a document that incorporates and upgrades existing strategic documents of municipality. It is a new way of thinking and planning that represents a step towards more sustainable traffic planning in the region - in line with modern guidelines and recommendations of the European commission.

SUMP is comprehensive integrated traffic planning that upgrades current planning practices and it has a long-term and strategic vision striving towards sustainable mobility. Sustainable urban mobility plan is a result of the participation of an expert group on transport planning, local authorities and affected social groups. Local institutions and citizens played an important role in the creation of the document as their values and proposals serve as a basis for proposed measure packages.

Sustainable urban mobility plan is a result of the participation of an expert group on transport planning, local authorities and affected social groups. Local institutions and citizens played an important role in the creation of the document as their values and proposals serve as a basis for proposed measure packages.



**Figure 1. Guidelines for developing and implementing a Sustainable Urban Mobility Plan,**  
**source: Guidelines, 2014, <https://www.eltis.org/guidelines/sump-guidelines>**

The document reflects the planned development of municipality and is prepared in line with existing spatial and urban planning documents. Individual measures can be implemented and coordinated with existing and incorporated in future planning documents. Infrastructural projects will be implemented in connection with soft measures, aimed at reducing demand for private motorized transport and incentivizing other more sustainable modes of transport, strengthening each other's impacts.

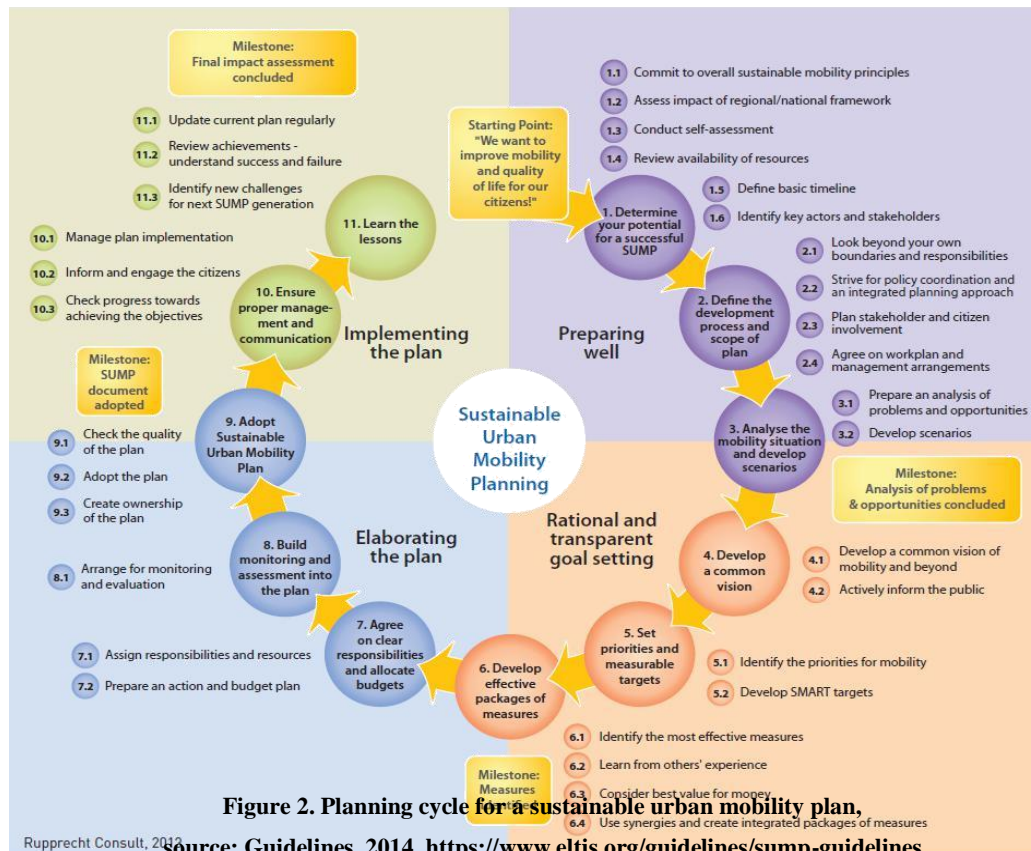
In course of preparation of the document public consultations regarding challenges and opportunities that municipality faces were held with local authorities and interest groups. The participants presented their aspects and views on the existing situation in the municipality while their comments were evaluated and utilized in preparation of proposed vision and measures.

Measures and projects that have impact on the city and its inhabitants will be planned and implemented in line with the framework proposed in this document. Strategic transport development practices are in synergy with urban development of the area and give priority to increasing quality of life by promotion and implementation of sustainable measures. The planning process consists of eleven main steps made up of 32 activities. They should be taken as part of a regular planning cycle in the sense of a continuous improvement process.

The planning process will not come to an end with adoption of Sustainable urban mobility plan. The process will continue with gradual preparation and implementation of proposed measures. The monitoring system is set to evaluate implemented measures and their contribution to set strategic goals. Integrated traffic planning is a cyclic process and should be considered as a continuous improvement process with regular reassessments and renewals.

Good communication is essential for the success of planning decisions. It encourages citizens and stakeholders to take ownership of sustainable mobility ideas while it allows the city administration to incorporate local feedback into their work. The local administration will set up a communication plan which will enable comprehensive implementation and monitoring of the strategy. The promotion of sustainable values should be done with the cooperation of the public and private sector.





#### 4. CONCLUSION

Measures and projects that have impact on municipality and its inhabitants are planned and will be implemented in line with the framework proposed in Sustainable urban mobility plan. Strategic transport development practices are in synergy with urban development of the area and give priority to increasing quality of life by promotion and implementation of sustainable measures.

***Adoption of the SUMP of Municipality does not mean its conclusion, but a transition to its implementation.***

The planning process will not come to an end with adoption of Sustainable urban mobility plan of Municipality. The process will continue with gradual preparation and implementation of proposed measures. The monitoring system is set to evaluate implemented measures and their contribution to set strategic goals. Integrated traffic planning is a cyclic process and should be considered as a continuous improvement process with regular reassessments and renewals.

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# Application of Newton's Forward Interpolation using MATLAB

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## Abstract

Interpolation is the estimation of values between data points. The problem of polynomial interpolation is useful and important because of its applications to numerical derivation and integration. To construct an interpolation polynomial, exist many techniques, including linear interpolation, Lagrange's interpolation, Divided differences, Spline interpolating, Newton's Forward and Backward interpolation, Stirling interpolation, Bessel's interpolation etc. The Newton's Forward interpolation as one of most important numerical techniques have huge application in mathematics, computer science and technical science. The development of many software packages has enabled the numerical methods to be solved quickly and accurately. Such is the Matlab software packages. MATLAB is a numerical analysis environment and a programming language. MATLAB enables easy function plotting, data visualization, algorithm implementation, and creating user interfaces.

This paper provides an analytical description of Newton's Forward interpolation. Also, in this paper, in addition to the analytical approach of the Newton's Forward interpolation, MATLAB software will be applied, which will provide algorithm and then solve specific problems with the application of these software.

**KEYWORDS:** Interpolation, Newton's Forward interpolation, MATLAB.

# 1 Introduction

Interpolation is a very important and very useful technique in numerical analysis. If a function whose analytic form is either completely unknown or inconvenient for calculation, then it is desirable to replace it with another function, convenient and simple to calculate, and "close enough" to the given. That operation of replacing one function to another, simpler, is the main task of interpolation [1].

To construct a polynomial of interpolation, there are many techniques, including linear interpolation, Lagrange's interpolation formula, Divided differences, Spline interpolating, Newton's Forward and Backward interpolation, Stirling interpolation, Bessel's interpolation etc. [3].

This paper describes the analytic form of solving problems with Newton's forward interpolation formula and solving the same problem with use of MATLAB (matrix laboratory) software. We decided to use this method because it is simpler to evaluate and we can write code in MATLAB, Wolfram Mathematica and other software to determine the required value, unlike some other methods that are appropriate only in theoretical studies. This paper is organized as follows. Section 2 provides an analytical description of Newton's Forward interpolation formula. Section 3 provides an application of this interpolation and how it can be solved with MATLAB. Finally, Section 4 concludes the paper and provides future work directions.

## 2 Newton's Forward Interpolation formula

Let be given the points  $x_0, x_1, x_2, \dots, x_n$  and the function  $f$  on  $[x_0, x_n]$ .

Suppose now that the points  $x_0, x_1, x_2, \dots, x_n$  are equidistant, i.e.  $x_{i+1} - x_i = t$  for  $i = 0, 1, 2, \dots, n-1$ .

**Definition:** The finite first order forward difference for the function  $f$  in relation to  $x$  (or  $x_i$ ) is called the expression

$$\Delta f(x) = f(x+t) - f(x) \text{ or } \Delta f(x_i) = f(x_{i+1}) - f(x_i)$$

and the  $k^{th}$  order forward difference is defined as

$$\Delta^k f(x) = \Delta(\Delta^{k-1} f(x)) \text{ or } \Delta^k f(x_i) = \Delta(\Delta^{k-1} f(x_i)).$$

These differences are often presented in a tabular format as in Table 1.

**Table 1:** The finite forward difference [2].

$x_i$	$f(x_i)$	$\Delta f(x_i)$	$\Delta^2 f(x_i)$	$\dots$	$\Delta^n f(x_i)$
$x_0$	$f(x_0)$	$\Delta f(x_0)$	$\Delta^2 f(x_0)$	$\dots$	$\Delta^n f(x_0)$
$x_1$	$f(x_1)$	$\Delta f(x_1)$	$\Delta^2 f(x_1)$		
$\vdots$	$\vdots$	$\vdots$			
$x_{n-1}$	$f(x_{n-1})$	$\Delta f(x_{n-1})$			
$x_n$	$f(x_n)$				

Newton's Forward interpolation formula for interpolation is obtained from the Definition given above.

For  $s = \frac{x_p - x_0}{t}$  we get the polynomial:

$$P_n(x_p) = f(x_0) + \Delta f(x_0)s + \frac{\Delta^2 f(x_0)}{2!}s(s-1) + \dots + \frac{\Delta^n f(x_0)}{n!}s(s-1)\dots(s-n+1)$$

This formula is useful when the value of  $f$  is required at point  $x_p$  near the end of the segment.

The error in this case is

$$E_n(x) = t^{n+1} s(s-1)\dots(s-n) \frac{f^{(n+1)}(\xi)}{(n+1)!} \approx s(s-1)\dots(s-n) \frac{\Delta^{n+1} f(x_0)}{(n+1)!}.$$

### 3 Application of Newton's Forward Interpolation

Now let's apply the Newton's Forward difference by analytically solving a concrete example to find the value of the function  $\cosh(2,94)$ . Below is given the table of values of the function  $y = \cosh x$ .

**Table 2:** Values of  $\cosh x$ , [6].

$x$	$f(x_i)$
2,7	7,4735
2,8	8,2527
2,9	9,1146
3,0	10,0677
3,1	11,1215
3,2	12,2866
3,3	13,5748
3,4	14,9987
3,5	16,5728

*Solution of the Problem:*

First, it is necessary to create the Forward difference table. This is given in Table 3.

**Table 3:** Forward difference table for the concrete problem.

$x$	$f(x_i)$	$\Delta f(x_i)$	$\Delta^2 f(x_i)$	$\Delta^3 f(x_i)$	$\Delta^4 f(x_i)$
2,7	7,4735	0,7792	0,0827	0,0085	0,001
2,8	8,2527	0,8619	0,0912	0,0095	0,0011
2,9	9,1146	0,9531	0,1007	0,0106	0,0012
3,0	10,0677	1,0538	0,1113	0,0118	0,0008
3,1	11,1215	1,1651	0,1231	0,0126	0,0019
3,2	12,2866	1,2882	0,1357	0,0145	
3,3	13,5748	1,4239	0,1502		
3,4	14,9987	1,5741			
3,5	16,5728				

Next, for  $t = 0,1$ , and for  $x = 2,94$ , for  $s$  the following value is obtained:

$$s = \frac{2,94 - 2,9}{0,1} = 0,4.$$

From Table 3 and Newton's Forward formula, we get

$$\begin{aligned}
f(2,94) &\approx f(x_0) + \Delta f(x_0)s + \Delta^2 f(x_0)\frac{s(s-1)}{2!} + \Delta^3 f(x_0)\frac{s(s-1)(s-2)}{3!} + \Delta^4 f(x_0)\frac{s(s-1)(s-2)(s-3)}{4!} = \\
&= 9,1146 + 0,4 \cdot 0,9531 + \frac{0,4 \cdot (0,4-1)}{2!} \cdot 0,1007 + \frac{0,4 \cdot (0,4-1) \cdot (0,4-2)}{3!} \cdot 0,0106 + \\
&+ \frac{0,4 \cdot (0,4-1) \cdot (0,4-2) \cdot (0,4-3)}{4!} \cdot 0,0012 = \\
&= 9,1146 + 0,38124 - 0,012084 + 0,0006784 - 0,00004992 = 9,48438448
\end{aligned}$$

The error will be

$$E(x) = s(s-1)(s-2)(s-3) \frac{\Delta^4 f(x_0)}{4!} = 0,4 \cdot (0,4-1) \cdot (0,4-2) \cdot (0,4-3) \cdot \frac{0,0012}{4!} = -0,00004992$$

Using the MATLAB code from [4], we have calculated the value of the function  $\cosh(2,94)$ , which is given in Figure 1. The code is written and adapted according to the definitions used in this paper.

```

>> x=[2.7 2.8 2.9 3.0 3.1 3.2 3.3 3.4 3.5];
fx=[7.4735 8.2527 9.1146 10.0677 11.1215 12.2866 13.5748 14.9987 16.5728];
dt=zeros(9,6);
for i=1:9 dt(i,1)=x(i);
dt(i,2)=fx(i);
end
n=8;
for j=3:10
for i=1:n
dt(i,j)=dt(i+1,j-1)-dt(i,j-1)
end
n=n-1;
end
h=x(2)-x(1)
xp=2.94;
for i=1:8
q=(xp-x(i))/h;
if (q>0&&q<1)
p=q;
end
end
p
l=xp-(p*h)
for i=1:8
if(l==x(i))
r=i;
end
end
f0=fx(r);
f01=dt(r,3);
f02=dt(r,(3+1));
f03=dt(r,(3+2));
f04=dt(r,(3+3));
% using the forward interpolation formula

fp=(f0)+((p*f01)+(p*(p-1)*f02)/(2)) + ((p*(p-1)*(p-2)*f03)/(6))+((p*(p-1)*(p-2)*(p-3)*f04)/(24))
E=(p*(p-1)*(p-2)*(p-3)*f04)/(24)

```

**Figure 1:** MATLAB Code for Newton's Forward interpolation formula.

The output of the program is given in Figure 2.

```

dt =

    2.7000    7.4735    0.7792    0.0827    0.0085    0.0010
    2.8000    8.2527    0.8619    0.0912    0.0095    0.0011
    2.9000    9.1146    0.9531    0.1007    0.0106    0.0012
    3.0000   10.0677    1.0538    0.1113    0.0118    0.0008
    3.1000   11.1215    1.1651    0.1231    0.0126    0.0019
    3.2000   12.2866    1.2882    0.1357    0.0145         0
    3.3000   13.5748    1.4239    0.1502         0         0
    3.4000   14.9987    1.5741         0         0         0
    3.5000   16.5728         0         0         0         0

h =

    0.1000

p =

    0.4000

l =

    2.9000

fp =

    9.4844

E =

   -4.9920e-05

```

**Figure 2:** Output of the Results.

Next, let's apply the Newton's Forward difference by analytically solving a concrete example to find the number of graduated students in 2013 in the Republic of North Macedonia. The available data for the number of graduated students for different years from 2012 to 2018 at higher school and faculties – first cycle of studies (undergraduate studies) is taken from the State Statistical Office. This data is given in Table 4.

**Table 4:** Number of graduated students at higher schools and faculties - first cycle of studies, [6].

Year ( $x_i$ )	2012	2014	2016	2018
Number of graduated students	10392	9863	8247	7698
$(f(x_i))$				

*Solution of the second Problem:*

First, we will create the Forward difference table. This is given in Table 5.

**Table 5:** Forward difference table for the concrete problem.

$x_i$	$f(x_i)$	$\Delta f(x_i)$	$\Delta^2 f(x_i)$	$\Delta^3 f(x_i)$
2012	10392	-529	-1087	2154
2014	9863	-1616	1067	
2016	8247	-549		
2018	7698			

Next, for  $t = 2$ , and for  $x = 2013$ , for  $s$  the following value is obtained:

$$s = \frac{2013 - 2012}{2} = 0.5.$$

From Table 5 and Newton's Forward formula, we get

$$\begin{aligned}
 f(2,94) &\approx f(x_0) + \Delta f(x_0)s + \Delta^2 f(x_0)\frac{s(s-1)}{2!} + \Delta^3 f(x_0)\frac{s(s-1)(s-2)}{3!} = \\
 &= 10392 + 0,5 \cdot (-529) + \frac{0,5 \cdot (0,5-1)}{2!} \cdot (-1087) + \frac{0,5 \cdot (0,5-1) \cdot (0,5-2)}{3!} \cdot 2154 = \\
 &= 10392 - 264,5 + 135,875 + 134,625 = 10398
 \end{aligned}$$

The error will be

$$E(x) = s(s-1)(s-2)\frac{\Delta^3 f(x_0)}{3!} = 0,5 \cdot (0,5-1) \cdot (0,5-2) \cdot \frac{2154}{3!} = 134,625.$$

Using the MATLAB code from [4], we have calculated the number of graduated students in 2013, which is given in Figure 3.

```

>> x=[2012 2014 2016 2018];
fx=[10392 9863 8247 7698];
dt=zeros(4,5);
for i=1:4 dt(i,1)=x(i);
dt(i,2)=fx(i);
end
n=3;
for j=3:10
for i=1:n
dt(i,j)=dt(i+1,j-1)-dt(i,j-1)
end
n=n-1;
end
h=x(2)-x(1)
xp=2013;
for i=1:4
q=(xp-x(i))/h;
if (q>0&&q<1)
p=q;
end
end
p
l=xp-(p*h)
for i=1:4
if (l==x(i))
r=i; ...
end
end
f0=fx(r);
f01=dt(r,3);
f02=dt(r,(3+1));
f03=dt(r,(3+2));
fp=(f0)+((p*f01)+(p*(p-1)*f02)/(2)) + ((p*(p-1)*(p-2)*f03)/(6))

```

**Figure 3:** MATLAB Code for Newton's Forward interpolation formula.

The output of the program is given in Figure 4.

```

dt =

    2012    10392    -529    -1087    2154
    2014     9863   -1616     1067         0
    2016     8247    -549         0         0
    2018     7698         0         0         0

```



```

h =

    2

p =

    0.5000

l =

    2012

fp =

    10398

```

**Figure 4:** Output of the Results.

## Conclusion

From the above calculations and the outputs of the codes, the same values for the tables, error and for the polynomials are obtained. However, the main advantage of using MATLAB is that it calculates much more quickly and much more correctly both, the Forward difference table and Newton's Forward interpolation polynomial. This code is convenient and easy to use. Therefore, it is very used by our students of the Faculty of Technical Sciences within the subject Numerical methods. Also, it can be used code generated in other software's.

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### Author Guidelines – SEEJSD

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