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Recovery of sulfur dioxide from flue gas for sulphuric acid production

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Abstract: The paper presents a review of the literature relative to the flue gas desulfurization methods for sulphuric acid (H_2SO_4) manufacturing. The covered topics include wet and dry methods. Particular attention has been paid to the desulfurization of the flue gas from the copper smelting industry that can lead to a generation of SO_x rich streams resulting in high profitability of H_2SO_4 production.

Keywords: SO_2 , H_2SO_4 , DESULFURIZATION, COPPER, SMELTING INDUSTRY

1. Introduction

Economic activity, especially production, affects the environment by introducing substances into the air, water, soil or ground. These emissions cannot always be avoided, but a special care has to be taken to minimize them in accordance with the law. This means that an appropriate permit must be obtained for the introduction of substances or energy into the environment, and sometimes appropriate methods of preventing or reducing emissions must be applied.

Desulfurization is mostly associated with the treatment of boiler flue gases and waste gases from crude oil processing, sulfuric acid production and smelting/ metal processing. It is aimed at converting SO_2 into a substance easy to remove both from the gas and from the treatment system. These operations result in the recovery of sulfur in the form of commercial products or the generation of sulfur waste. In the literature may be found different techniques of desulfurization, however, due to techno-economic problems and difficulties in scaling-up from laboratory to industry level, only a few of them have found wide appliances.

The aim of this paper is to review the methods of gas desulphurization, with particular emphasis on technologically mature methods enabling sulphuric acid production from boiler flue gases and waste gases from crude oil processing, smelting and metal processing or sulphuric acid production.

2. Overview of available wet methods

These methods are implemented using a scrubber located in the flue gas duct (upstream of the chimney). As a result of contact with water or a solution, the purified gases are cooled to a temperature of about 365 K, since the stack temperature is about 420 K. The most important issue in these methods is the concentration of SO_2 , since sulphur recovery in the form of H_2SO_4 can be carried out when $SO_2 + SO_3 > 0.3\%$ v/v. Several important facts should be taken into consideration, namely:

- purified gases must be heated before being directed to the chimney,
- few methods are able to provide the required degree of desulfurization in a given range of concentrations,
- removing water from a product is expensive.

The choice of method is determined by the degree of desulfurization.

The lime method

The method is based on absorption and chemical reaction of SO_2 in a suspension of lime or limestone. The $CaSO_3$ and $CaSO_4$ in the form of sludge or wet solid in most cases is waste. According to [2] it is believed that once the lime methods have been properly adapted to the conditions in metallurgy and optimized, they may prove to be crucial for this industry. The conditions in the stack are favorable for the formation of SO_3 and sulfuric acid from flue gases. When the concentration of SO_3 drops below the dew point temperature, a reaction occurs with the vapor H_2O and forms H_2SO_4 in the form of droplets. These droplets are diluted to an equilibrium concentration. An important aspect in any project is the costs incurred, thus in this case the best solution is to mix the purified gases with a corresponding volume of hot, untreated flue gas stream taken from the boiler or precipitator. Also important is the amount of heat that must be applied to heat the purified gases to prevent condensation prior to emission from the stack and to ensure

adequate lift and dispersion in the atmosphere. This property is due to the physicochemical characteristics of the flue gases and the design of the chimney and the conditions of dissipation.

Magnesium regeneration method

This is one of the desulfurization methods, in which hydrated (IV) and (VI) magnesium sulfates and unreacted MgO are obtained. The separated solid products are dried and then calcined at temperature 1080-1300 K. As a result of this operation, MgO is regenerated and SO_2 is recovered. The dry waste gas from calcination contains about 5-15% v/v of SO_2 which is used to produce H_2SO_4 . Despite the many different details of this method, such as the use of activators, blocking the interior of the apparatus with a deposit of solid or regeneration of the absorbent, it has found many applications in metallurgical processes. Like many technological processes, it has certain limitations, e.g. high corrosion and erosion risks or the necessity of proper dedusting. Nowadays, this method is most popular in the Czech Republic and the USA [4].

The Cat-OX method

In metallurgy, there are many methods to desulfurize flue gases that have been developed by industry companies. The Cat-OX method, developed by Monsanto, involves oxidising SO_2 to SO_3 using a catalyst V_2O_5 catalyst at a temperature of 700-750 K, followed by cooling of the gases and absorption of H_2SO_4 . The resulting H_2SO_4 is already an 80% product. Unfortunately, the Cat-OX method, has proved to be another method that poses great corrosion problems. At the very beginning of the operation it requires a thorough preliminary purification of the gas, generating huge economic costs.

Lurgi-Sulfacid method

The next company to implement a desulfurization method is Lurgi-Sulfacid, which uses a layer of activated carbon sprinkled with water. The end product is only 10-20% H_2SO_4 . The method is used in the removal of SO_2 of waste gases from chemical and metallurgical processes when the concentration of SO_2 is $\geq 2\%$ v/v [2].

Degussa absorption method

According to the method developed by Degussa, SO_2 is sprinkled with an oxidized water in a separate column. The process makes possible to reduce the concentration of SO_2 in the flue gas to about 20 mg/Nm³. In this method it is obtained 70% H_2SO_4 .

Solinox method

Solinox regenerative desulfurization is based on absorption of SO_2 in liquid ethylene glycol esters, followed by desorption of SO_2 by means of elevated temperature, pressure reduction or gas stream desorption. The aim of the method is to reduce sulphur dioxide emissions by means of a waste-free and highly efficient installation. The sulfur dioxide-treated inlet gases leave the absorption zone through a stack bottom isolating the liquid circuits and enter the sorbent residue backwash zone. Although the sorbent vapours have a very low vapour pressure at this point, due to the large amount of gases and the entrainment of the liquid droplets by the gases, sorbent losses cannot be neglected. The low temperature of the water for leaching the sorbent residue caused by the low gas inlet

temperature and the water evaporation is compensated in the heat exchanger. The treated inlet gases are discharged to the atmosphere via a chimney [1]. Solinox installation works i.a. KGHM Legnica Copper Smelter.

Microbiological reduction of SO_2

One of the most interesting methods is microbiological reduction of SO_2 developed by the Paques-Hoogovens company from the Netherlands. The whole process is carried out in three cycles, consisting of absorption of SO_2 , bioreaction with SO_2 and separation of elementary sulphur. Absorption SO_2 is characterized by the production of H_2S , which is oxidized to sulphur in a biologically controlled environment. The whole operation takes place in a settling tank where the sulfur suspension is concentrated. This suspension is subjected to dehydration in a vacuum filter. In order to obtain high quality sulphur, it is subjected to thermal refining. The desulphurization degree of this method is up to 98% [3].

BIPOLAR electrolytic process

Stuffer Technology has implemented the BIPOLAR electrolytic process, which proceeds in two stages. In the first stage, a column filled with rings or saddles made of a material with good electrical conductivity, e.g. phosphosilicon alloy with 12% Si content, is used for absorption of SO_2 in an aqueous solution of sulphuric acid. In the second stage, by electrolysis of sulphuric acid (IV) at a potential of about 0.6 V, it is oxidized to acid (VI) with release of hydrogen. As a result, 40-48% sulfuric acid is obtained, depending on the conditions of the process.

3. Overview of available dry methods

As the name suggests, dry desulphurization methods proceed in dry state i.e. in gas-solid system/ waste products/ utility desulphurization products. They are characterized by adsorption on solid sorbents - metal oxides or activated carbon and absorption with chemical reaction with simultaneous drying of desulfurization products. Dry methods in comparison to wet methods allow to avoid problems connected with pH control, settling of solids in the apparatus, accumulation of liquid waste or heating of purified gases.

Sorption of SO_2 on solid sorbents

In the FW-BF (Foster Wheeler Bergbau, Forschung) method, SO_2 is adsorbed in a mobile layer of active coke, at 400 K, from a dusted flue gas. In this case, if the plant contains a so-called RESOX node, in which the reducer SO_2 anthracite or coke oven gas is the reducer, the desulphurisation product is a concentrated stream of SO_2 or elementary sulphur. As a result, the formed sulphuric acid diffuses from the pores to the liquid layer on the particle surface, from where it is washed out with demineralised water to obtain sulphuric acid (VI) of 10-20% concentration. This method has found recognition in metallurgical processes, because it enables the removal of SO_2 from waste gases. Sorbents in this method are oxides of Mn, Fe, Cu, Co, Zn and others. Due to the significant rate of the reaction with SO_2 , the method provides satisfactory economic results. It should be remembered, however, that this method requires the use of adsorption units of large dimensions [2]. Recently there were developed methods that allow the use of activated carbons produced from unburned carbon for the purpose of FW-BF [4-5].

Another oxide that deserves attention is CuO, because due to the its catalytic action, SO_2 oxidises to SO_3 . An important element during adsorption is the decrease in efficiency with time and the decrease in mechanical strength of the granules. At higher temperatures Cu i SO_2 is regenerated by means of H_2 , CO or light hydrocarbons. This operation takes place at temperatures not exceeding 680 K due to minimization of hydrogen consumption and better copper activity. Desulphurisation efficiency based on sorption SO_2 on CuO is over 95%. Despite the high investment cost, this process has great potential for practical applications.

Desulphurisation by spray drying

Absorption with chemical reaction SO_2 in droplets of alkaline solution occurs simultaneously with spray drying. Unreacted reactants, or desulfurization products, are released as powder. The reactants in this process are solutions of soda or $Ca(OH)_2$. $Ca(OH)_2$ is the most applicable due to insolubility of desulphurization products in water. SO_2 contained in the gas, is absorbed on the surface of droplets, penetrates into the interior, undergoes oxidation and reacts with $Ca(OH)_2$ to form calcium sulfite and sulfate. As a result of water evaporation, the flue gas temperature drops to 10-20 K above the dew point temperature of 333-344 K. Physical changes in the droplets of the suspension have a great influence on the desulfurization rate, through oxidation SO_2 in the liquid phase of the droplets [6].

A similar phenomenon can be observed in smog formation and "acid rain" processes. Therefore, in order to achieve a high desulphurization rate with low sorbent consumption, the process should be carried out at a temperature close to the adiabatic saturation temperature of the waste gases. Better efficiency is also ensured by recirculation of part of the separated solids due to increased contact surface area of the reactant phases in the dryer and faster formation of solid phase nuclei, increasing the utilization rate of $Ca(OH)_2$. This is a very expensive process and any by-product is not economically viable.

4. Summary

A comparative analysis between the methods requires taking into account many aspects, such as the demand for reagents and energy, operation and maintenance, waste collection and neutralization, as well as the costs incurred, which to a large extent determine the realization of the process. Process efficiency is an indicator thanks to which it is possible to visualize the effectiveness of the actions taken. When this value is compared in dry methods, in which a higher stoichiometric sorbent ratio is required to achieve the same levels SO_2 and at the same time are considerably more expensive, it can be concluded that the process is not very cost-effective [7].

However, due to the many times higher cost of the reagent $Ca(OH)_2$ than $CaCO_3$, dry methods are preferred for desulfurization of flue gases from combustion of low-sulfur coals. In addition, due to the elimination of large volumes of slurry streams and the heating of treated gases, the energy requirement is significantly lower. From the practical point of view, in the industry, the key is the facilitated operation with reduced maintenance, due to the elimination of many nodes and apparatuses or blocking of the interior of the apparatus with deposits or reduced corrosion, this method is mainly preferred in the processes of gas purification from smaller emission sources. However, the role of environmental protection development is crucial in today's investments, metallurgical and chemical processes and, above all, in industry. Constantly changing environmental laws and EU standards regulate the level of emissions without regard to both investment and economic costs. Therefore, each branch of the economy uses the tools that are the most necessary for it and at the same time duly effective.

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High energy formation of active elements: processes of creation and methods of improvement

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Abstract: The paper examines the processes associated with the high-energy formation of active elements. A model of the processes is created and certain relations are derived, which are suitable for practical calculations of the parameters of high-energy systems with directional motion. The processes of movement, deformation and penetration of the active element are studied. Methods and means for influencing the processes of creation and improvement of the active elements are proposed.

KEYWORDS: ACTIVE ELEMENTS, HIGH-ENERGY FORMATION

1. Introduction

The present study is motivated by the fact that there is no theory allowing the study of the phenomenon of impact interaction of an active element with a barrier, and the main method for studying the dynamics of impact and penetration therefore is an experimental one. This makes it necessary to conduct an optimization study of the processes of creating and improving the active elements, based on the verification of various methods and tools that affect the processes of both the formation of active elements and the most effective breaching of the integrity of the barrier [6, 7, 8].

2. Solving the problems of breaching a barrier with an active element

The main factors influencing the processes of both the proper formation of an active element and the maximally effective breaching of the integrity of the barrier are as follows: the shape of the high-energy module and of the cumulative recess of the lining, the geometrical dimensions of the high-energy module and the metal lining, the properties of the lining metal, the distance from the high energy module to the barrier, and the place of initiation of the high energy module.

The solution of the problems for penetrating a barrier with an active element is done using a minimum number of determining parameters – those that have the strongest influence on the process of impact between the bodies [1].

Impact velocity always plays a fundamental role in body-to-body impacts. Therefore, it is natural to try to classify the processes of penetration according to the value of the normal component of the velocity of the active element on the surface of the barrier. If the mechanical stresses occurring at high velocity impact are greater by several orders of magnitude than the tensile strength of the materials of the active element and of the barrier, the initial stage of the interaction process can be described based on models of compressible and incompressible liquid. It is assumed that the impact velocity V_0 in the so-called “hydrodynamic mode” varies within the following limits:

$$\sqrt{\frac{\sigma_s}{\rho}} \leq V_0 \leq \sqrt{\frac{K}{\rho}}, \quad (1)$$

where:

σ_s is yield strength;

K is bulk modulus;

ρ is material density.

For velocities V_0 close to the lower limit, the compressibility of the liquid can be neglected. At impact velocities close to the upper limit, melting and evaporation of the material may occur. The value of the speed V_0 , at which the strength of the active element and the barrier may not be taken into account, varies in a wide range

depending on their materials. It can be assumed that this is the value between 2 and 10 km/s. At impact speeds above 10 km/s, the nature of the impact process is explosive.

Many studies published in the literature have addressed the issue of determining the criteria for the occurrence of destruction in materials. To date, no reliable criteria have been obtained in a form convenient for solving practical tasks. But there is an experimental result which shows that at large values of the rates of deformation, which are characteristic of the processes of penetration, the destruction does not depend on impact velocity. This fact is used to solve practical problems.

3. High-energy formation of active elements

3.1 Model of a cumulative unit forming an active element

The cumulative unit consists of four elements: lining, explosive substance, case, and fuse. The principle of operation includes creating a speed gradient in the lining under the impact of the pressure generated by the energy of the explosion [2]. The speed gradient value:

- varies in the lining from initial values in the central zone to final ones in the peripheral zone;
- is high enough to ensure complete deformation of the lining;
- is low enough not to cause the active element to tear apart.

The shapes of the explosive and of the explosive charge chamber, as well as the type of materials used, must be such that at constant volume the speed gradient in the lining can be calculated, resulting in different preset shapes of the active element:

- front bending by pulling the central area of the lining towards the front of the active element;
- rear bending by pulling the central area of the lining towards the back of the active element.

3.2 Study of the processes occurring during high-energy formation of active elements

The transformation of the metal lining into an active element requires huge pressures of the order of several tens of thousands of megapascals. They are generated by the energy of the explosion and act on the lining for a very short time when the blast wave reaches it [3]. Because the lining does not completely envelop the explosive substance, all of which is housed in a metal case, the lining does not shatter under the action of the high pressure. Instead, it swells and deforms depending on the direction of the blast wave. At such high pressures, the individual elements of the lining move independently of each other at different velocities.

These velocities depend directly on the ratio between the mass of the element (segment) of the lining and the mass of the elementary charge column located behind this element.

The thinner the lining, the greater the velocity at which it accelerates.

For a lining several millimeters thick, as is standard for cumulative units, the velocity is about $2 \div 3$ km/s at a physico-chemical conversion front velocity of about $8 \div 9$ km/s, depending on the type of explosive.

If the front of the elementary charge column is covered with a smooth disk, and the explosive charge is initiated in such a way that the blast wave strikes the disk evenly over its entire surface, the disk will fly out at a certain velocity without undergoing any deformation. The final ballistic effect of the disk will be almost equal to zero, as its velocity will drop very quickly because of the high aerodynamic resistance. To reduce the resistance, the disk must be converted into an active element with a significantly smaller diameter. What can be used here is the ability of an angular detonation wave to accelerate the elements of the lining both in the direction of the wave and perpendicular to it. For example, if the disk is only touched by the wave, at the point of contact it will bend at a certain angle. This angle depends on the relationship between the velocity at the point of contact and the rate of physico-chemical transformation of the explosive. The particular element of the disk accelerates in a direction of half the angle concluded between its already bent and not yet bent parts.

If the disk must be folded by bending, it must be constructed as a hollow body placed in a corresponding cumulative recess. In such a construction, the individual elements of the lining tend to bend towards the center. For the successful implementation of this bending process, the disk, the high-energy module and the detonating mechanism must be located symmetrically. Rotational symmetry is usually used for high energy modules with high energy formed active elements.

3.2.1 Momentary state point

Momentary state point (MSP) is a term that characterizes the state of the process of deformation of the lining at a specific point in time.

MSP is associated with the process of additional deformation. Its preservation requires the flow of the elements of the lining, which have reached velocity V , to be divided into two parts that move away from each other in two opposite directions. The frontal part thus formed moves in front of the MSP, while the rear part moves behind it. For cones with smaller vertex angles, the velocity of the frontal part is much higher than the velocity of the MSP.

It is known that the lining elements which are driven first move at a velocity higher than that of those which are driven afterwards. This is explained by the increase in the mass of the lining from the top to the base.

The reduction of the MSP speed leads to a corresponding reduction of the speed of the material flow outside it, as a result of which the speed gradient increases along the axis frontal part – rear part, which leads to an elongation of the two parts of the lining. As a rule, the speed gradient reaches large values and it is possible that as a result of this, the stress may exceed several times the tensile strength of the lining material, whereby the active element is torn into pieces. For the formation of a coherent active element, the speed of the MSP must vary within very narrow limits, in order to prevent maximum stretching of the transformed body. This can be achieved with vertex cone angles between 120° and 160° .

The difference in the velocities of the frontal and rear part decreases very rapidly with the increase of the vertex angle and disappears completely for very flat cones. For angles greater than 140° , the velocity difference becomes practically zero and the lining is transformed into a monolithic impact mass with high kinetic energy.

The residual speed gradient disappears in the process of stretching. The use of linings with large cone vertex angles eliminates the possibility of the formation of active elements that have higher velocities than that of the MSP.

The velocity component acting along the axis is not sufficient to completely move the points from the peripheral zone to the center so that the hollow shape of the cone is closed. It is necessary to use linings of degressive thickness, i.e. with cones the thickness of whose walls decreases from the top to the base. For such linings the velocity of the MSP of the peripheral zone is better coordinated with that of the central zone.

It is also advisable to place the high-energy module in a massive case in order to delay a subsequent expansion of the front of the physico-chemical conversion wave.

3.3 Optimization of the processes taking place during high-energy formation of active elements

The process of high-energy formation of active elements can be optimized only by using linings that have defined and different in value angles of their three zones (central, intermediate and peripheral). With them, the front of the physico-chemical conversion moves perpendicularly and accelerates the central zone directly along the longitudinal axis, which enables the axial and radial components of the velocity to be better coordinated in the process of deformation of the lining elements. The active element is formed when the lining reverses.

The propagation of the physico-chemical conversion front inside the high-energy material takes place from the detonator towards the lining [4, 5]. The surface of the physico-chemical conversion front in the high energy module is a sphere with a radius equal to the distance from the initiation center to the physico-chemical conversion front. At a considerable distance from the center, the surface of the front can be considered as flat. When the blast wave moves, the products of the physico-chemical transformation act on the lining.

The velocity of the products of the physico-chemical transformation Q_n is determined by the velocity Q of their movement behind the front of the physico-chemical conversion and by the scattering velocity Q_p , which reaches its maximum value at a small distance from the scattering surface. Since the velocity of the products of the physico-chemical conversion is much lower than the scattering velocity, the angle of rotation β behind the front of the physico-chemical conversion of the resulting velocity Q_n is small - $\beta = 5^\circ - 7^\circ$. Therefore, it can be assumed that the products of the physico-chemical conversion act on the lining in a direction perpendicular to its surface. As a result, the lining is deformed, forming an active element out of the metal.

4. Conclusions

The shape and the thickness of the lining, the material from which it is made, the locally exceeded force and the direction of the front of the physico-chemical conversion have a significant influence on the final shape of the high-energy-formed active element. Therefore, the amount and the power of the high-energy material, as well as the point of initiation, are among the parameters determining the shape of the high-energy-formed active element most appropriate for a given lining.

The average velocity of the lining is lower than the velocity of scattering of the products of the physico-chemical conversion and depends on the thickness and density of the metal of the lining, the properties of the high-energy material and the quantity of the products of the physico-chemical conversion which scatter in direction of the cumulative recess. The part of the high-energy module whose products scatter in direction of the lining and interact with it is called the active part of the high-energy module.

The main resistance of the lining is the inertial one, because the pressure of the products of physico-chemical conversion on the lining is many times greater than the strength of its metal, and therefore, the resistance to deformation of the lining can be neglected.

The results of this report are aimed at the implementation of Work Package 2 "Intelligent Security Systems" of the project

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Points for real time temperature capturing in welding process

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Abstract: It is presented experiment for temperature measurement in welding process. It is shown arc interference with measurements and temperature versus distance from arc trajectory. This study will help selecting specific points for measuring temperature in welding process..

Keywords: TEMPERATURE MEASUREMENT, WELDING PROCESS

1. Introduction

Welding process is performed under Welding procedures (WP) in which strictly are defined the welding equipment and parameters. Welding joint quality is determined by following the welding parameters by the operator of the welding process. Variations from set it the welding procedures parameters – welding current, voltage speed, initial heating of the welded elements cause lowering the quality.

Deviation from set in the welding procedure parameters may occur by various reasons – in the equipment, in the materials and in the operator of the process. Some of those lowering welded joint quality reasons may occur during the process and some may be appear and disappear periodically during the process.

For lowering the impact on welding process and welded joints quality of such occurrences in the welding process has to be inserted quality control in real time. Such control is performed by capturing welding parameters such as welding current, voltage, speed or indirect indications as capturing temperature in one or more specific points of interest.

Physical application on welding current and voltage with defined speed heats the welded elements equally in equal other conditions and welding environment. For those reasons temperature control is applicable and used. Temperature control may be contact – mostly by thermocouples placed next to the welding joint or contactless – by pyrometers capturing temperatures focused next to the welding joint.

For better results of temperature control of the welding process thermocouples of the contact measurement and focusing the pyrometer have to be as close as possible to the trajectory of the welding torch along over the welding joint.

Unfortunately, thermocouples cannot be placed too close to the welding arc because of two reasons – the arc itself will damage or destroy the thermocouple and with this will malfunction the temperature capturing system; and melting basin next to the arc will shift or move the thermocouple. This can result in welding the thermocouple into the welding joint making welded detail unusable.

Emitted infrared light will interfere with pyrometer measurement causing false temperature result. In the case of pyrometer temperature measurement, the operator of the process or the welding torch may cause shade obstructing in visibility by the pyrometer. This has to be taken in advance to prevent interruption of the measurement.[1]

2. Experimental set up

The set up has two main parts – welding equipment and measuring equipment. The welding equipment consists of welding torch, which is mounted on mechanical grip. The mechanical grip fixes the torch in one position and removes fluctuations from welder's movements. The mechanical grip is mounted on welding tractor, which moves along and over the welded elements with constant speed. Welded elements are placed on welding table. Next to the welding table are placed the power source that feeds the torch and gas bottle that protects the joint. The measuring equipment consists of capturing module Lincoln Arc Tracker. Arc tracker captures welding current and voltage. It is connected to WiFi

Router that transmits the data to laptop. On two tripods are placed pyrometers IL 92 and Trotec TP10 that measure contactless the temperature in two points next the welding joint. The pyrometers are connected via USB cables to the laptop. The pyrometers are placed on 1,5m (Trotec TP10) and 1,2m (IL 92) distance from the measured point. It is developed program with Matlab for capturing the temperature from the pyrometers. Temperature of the process is measured with 8-channel contact thermometer Spider 8. K type thermocouples are connected to the Spider 8 and set in 8 point next the welding joint. Thermocouples are welded to the welded elements. The Spider 8 is connected to the laptop with UBS cable. Temperature is captured by Spider 8 with software Catman.

The two pyrometers Trotec TP10 and IL 92 was chosen to perform the experiment, both have wide temperatures measurement range, including liquid metals, can be freely measured. The excellent distance / measured spot ratio of 75:1 (Trotec TP10) and 50:1 (IL 92) allows long-distance measurement of small objects, as well as in extreme conditions, e.g.: in the furnace. The characteristics of the device are: Trotec TP10 – measuring range: - 50 to 1850°C; accuracy of the device $\pm 2\%$; reaction time - 150ms; spectral range - 8-14 μm [1]; IL 92 – measuring range: -50 to 2200°C; accuracy of the device $\pm 2\%$; reaction time - 150ms; spectral range - 8-14 μm . [2]

The set up functionality is verified with experiment with the following parameters:

- welding current – 210A
- welding voltage – 25V;
- η of the welding source – 0,8;
- welding power – 4200J/s;
- welding speed – 50cm/min;
- welding steel plates 50x5x200mm.

Contact temperature is measured simultaneously in 8 points (from 1 to 8) placed in a row with distance of 1mm from each other starting at 1mm from the welding torch trajectory to 8mm away from it as shown on Fig.1.

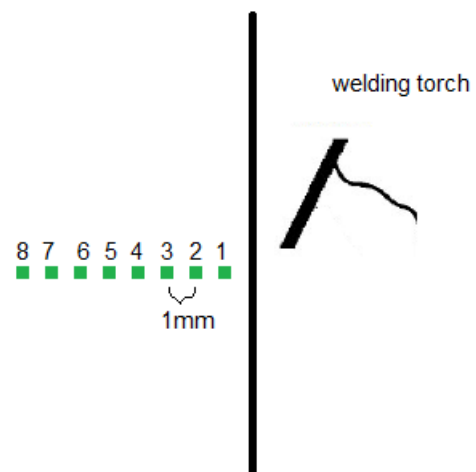


Fig. 1 Diagram of placement of the thermocouples.

Contactless temperature is measured simultaneously in 4 runs at 2 points each run placed in a row with distance of 1mm from each other starting at 1mm from the welding torch trajectory to 8mm away from it as shown repeating measurements of the thermocouples. First run is in points 1 and 2, 2nd at 3 and 4, 3rd at 5 and 6, 4th at 7 and 8. Each run is performed at the same experiment parameters.

3. Results

In the contact measurement the thermocouple in the first point is destroyed and in the second point is damaged. Result of thermocouples from point 3 (3mm) to point 8 (8mm) are shown on Fig.2.

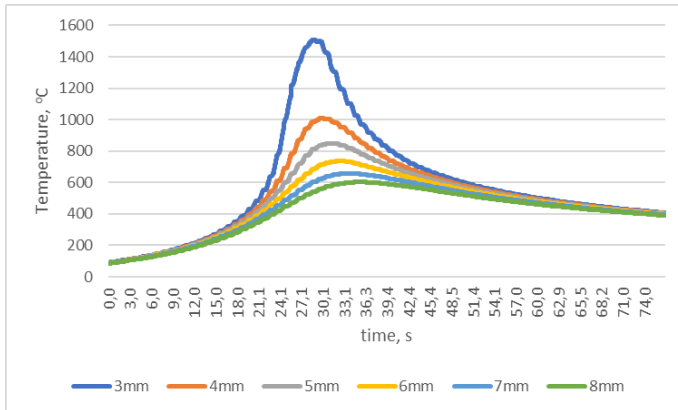


Fig. 2 Temperature curves from thermocouple 3 (3mm) to thermocouple 8 (8mm).

In the contactless measurement the first and second points have interference from the welding arc that caused data loss when the torch passed next to the measured points. Result of measured temperature from point 3 (3mm) to point 8 (8mm) are shown on Fig.3.

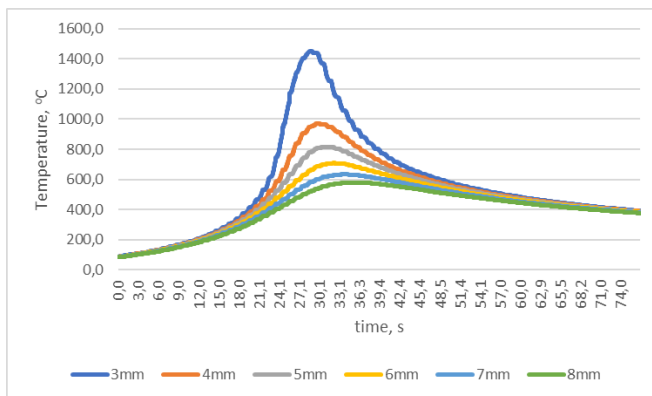


Fig. 3 Temperature curves from pyrometers from points 3 (3mm) to point 8 (8mm).

Results from contact and contactless measurements show similar results for the points from 3mm to 8 mm away from the line of welding. Contact measurement show 3-4% higher values of the temperature than contactless. At bot type of measurements point at 1mm and 2mm away of the welding line give false results at the time of welding torch passing or cause malfunction of the measurement system.

The most informative point for this experiment is at 3mm away from the welding line. At this welding parameters temperature in this point is close to the liquidus line and may cause false results if welded with more power.

The point at 4mm away of the welding line is also informative for temperature measurements. If welded with higher power this

point would be best for temperature measurement and control of the welding process.

4. Conclusions

It is measured temperature in 8 consecutive points at a line perpendicular to the welding line ate 1mm from each other starting from 1mm away of the welding line.

The point at 1mm and 2mm caused false results in the contactless measurements and measurement system malfunction in the contact measurements.

For these welding parameters the point at 3mm away of the welding line is the best for measurement temperature. Is the welding parameters are higher the point at 4mm would be the best. For further welding powers net point of the sequence would result the best.

Acknowledgments

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5. References

1. Datasheet of pyrometer Trotec TP10
2. Datasheet of pyrometer IL 92

An assessment of energy efficiency measures in a public building in Albania in the prospect of cost and emissions reduction

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Abstract: The building sector in our country has an important share of energy consumption. According to Eurostat data, final energy consumption in the residential sector was estimated about 35 % of the total consumption. On the other hand about 75% of the electricity consumption takes place in the building sector. It should be noted that currently this sector faces many challenge, as the quality of energy supply (heating) in public buildings and the residential sector remains at low rates. Nevertheless, reducing energy consumption is one of the main targets set in the National Energy Strategy 2018-2030. By 2030 this target suggests 15.5 % of the energy reduction. This study has at its core the assessment of energy consumption in a public building placed in the city of Durres. Determining the typology and thermo-physical characteristics of the building is of primary importance. The evaluation of the energy performance of the building in the dynamic regime was carried out through the Hourly Energy Analysis (HAP) software. The implementation of energy efficiency measures is carried out taking into account the energy and cost criteria. A cost analysis of EE measures was performed using the dynamic Net Present Value method.

Keywords: PUPBLIC BUILDINGS, ENERGY EFFICIENCY, COST, EMISSION

1. Introduction

Energy consumption in building represents more than 38 % of the total energy in Europe [1]. On the other hand, buildings are responsible for approximately 35 % of greenhouse gas emissions. Albania is part of this energy consumption trend. According to INSTAT (Institute of Statistics) energy consumption of non-residential building is approximately 20.6 % of the total energy consumption [2]. In the recent years a number of initiatives in the Albanian energy sector have been recorded. The Energy Efficiency Directive established a set of binding measures to achieve the 20% target in Energy Efficiency (EE) [3]. On the other hand Albania has made a significant progress in preparation of the National Energy and Climate Action Plan (NEACP). In order to maintain a high economic growth rate, Albania has to provide power supply, which is long-term, reliable and within the means to pay for it [4]. On the other hand, the country needs to use energy in an efficient way and to diversify its energy sources. Energy demand in the residential sector represents a permanent challenge. The general classification of climatic zones in Albania according to heating degree days is divided into three main categories: zone A, B and C. Most of area of public buildings, which makes up 57%, is located in climate zone A. It is followed by the area climate B with 26% of the area and finally the area climate C with 17% of the surface. Public buildings with all the sub-categories have a significant contribution on energy demand in buildings. For this reason this study is focused on the A climatic zone. In absolute values the climatic zone A results the largest percentage of energy savings. This paper discusses the energy performance of a public building situated in climatic zone A.

2. Energy consumption in buildings

Electricity is often the main energy source for space heating, especially in urban areas. Share of electricity consumption in Albanian households according to Eurostat [5] is 31.7 % for space heating, 29.8 % goes for cooking, whereas 21.4 % and 11.7 % for domestic hot water and lighting/electrical equipment respectively. Recently Albania introduced changes to the law of energy efficiency in country, in order to insert mandatory energy efficient targets for public, private and large consumers of energy. Therefore, from September 2021 the public sector is obliged to renovate a minimum of 3 % of the overall stock of public buildings [6]. This should be realized annually to meet the minimum requirements of energy performance. The law obligates municipalities to prepare local action plans for energy efficiency that includes policies and measures to save energy. In general, Albanian dwellings are partially heated, and only for a few hours a day. The continued use of old firewood stoves brings many problems to the environment and health of citizens. Findings on the final energy consumption

need for thermal energy services in the residential sector in 2015 speak of 4.9 billion kWh, of which 54% were met by electricity, 37% by wood consumption, and 9% from liquid gas. The sector emitted 96,000 tons of CO₂ associated with the consumption of liquid gas. The final consumed energy calculated on the basis of the geometric and thermal properties of buildings, as well as the features of the installed energy systems, differ substantially from the energy balance. A view of energy sources share for space heating is given below in Figure 1.

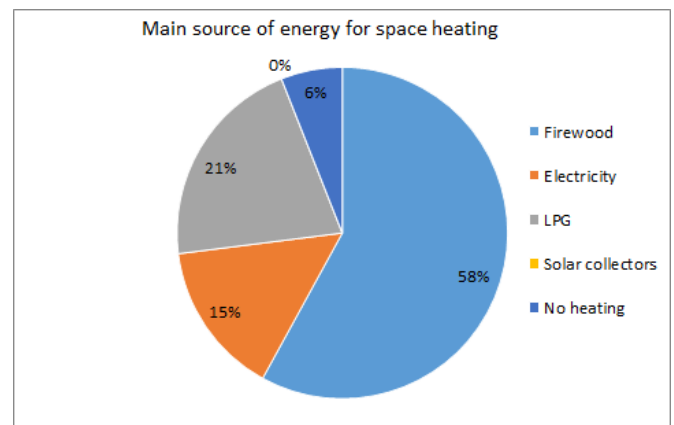


Fig. 1 Main energy sources used for space heating purposes

3. Case Study

An administrative office building was considered for this study. The building is placed in the port city of Durres. The gross floor area of the building is approximately 925.9 m² which is organized in two floors. Total window area is estimated 137 m², whereas wall transmission area results 442 m². The roof transmission area according to the plan is 438 m². The building serves as an administrative and office space running 8 hours per day and 6 days a week. The actual energy flows in the building, include lighting, office equipment, HVAC system. Electricity is the main energy source in the building. As for the time of this study no other fuel source supplied the building facilities. It is obvious that electrical equipment consists in the largest energy consumer in the investigated building. However, the first attempt was to highlight the current energy performance of the building. Overall heat transfer coefficient prior the energy efficiency measures was estimated $U=1.023 \text{ W/m}^2\text{K}$, whereas for windows this value was $U=3.147 \text{ W/(m}^2\text{k)}$. For the roof the estimated value was $U=2.05 \text{ W/(m}^2\text{K)}$. In Figure 2 is given the front view of the building studied in this paper. Before estimating the energy performance a thermal

imaging of the building was performed using infrared Testo camera. The result is shown in detail in Figure 3.



Fig. 2 Front view of the office building [8]

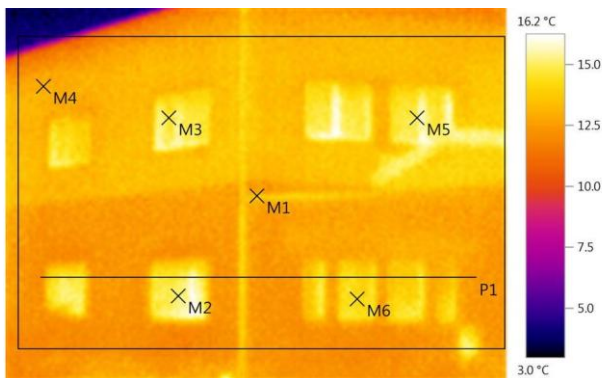


Fig. 3 Temperature distribution of the measured building side

In this case study thermal insulation was considered as the first energy efficiency measure. For this a 50 mm polystyrene XPS was predicted as an effective energy efficiency measure. It was obvious from the beginning that the share of heating and cooling in the total energy consumption is not very high due to geographic location of the city in the west part of the country. However we expect large consumption in cooling during summer season in both cases. It is a fact that in this study the no intervention on windows replacement was introduced, due to the relatively good condition observed during the investigation of the building. On the other hand, window replacement would require extra financial sources that were not predicted by the administrative staff of the building.

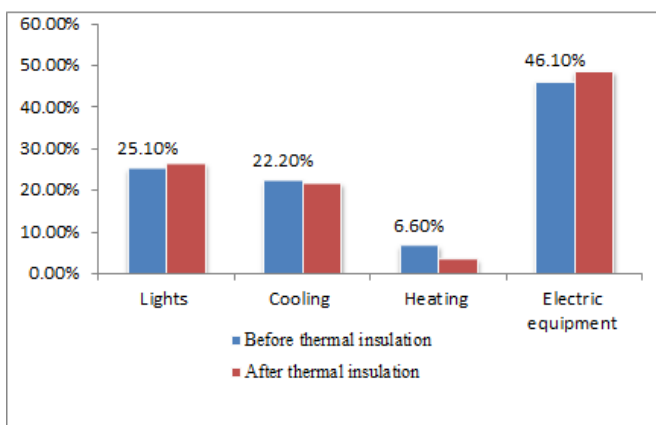


Fig. 4 Distribution of energy consumption in the building before and after EE measures

A view of energy consumption in the building is presented in Figure 4. The graph shows the real distribution of energy flows in building before and after thermal insulation assumed. The results suggest

that introduction of such an EE measure could have a considerable impact on heating, by a reduction by half. On the contrary, a slight impact is observed in cooling where this reduction is less than in heating. In Hourly Analysis Programme (HAP) is performed the monthly energy consumption by each consumer in the building inserting all the input data, such as lighting load, HVAC load, equipment load, working hours, technical description of energy consumers, employees etc. The results are presented in the Figure 5 to Figure 7.

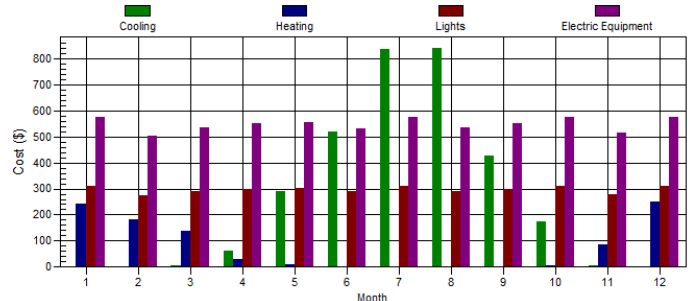


Fig.5 Monthly component cost estimated in USD in HAP software.

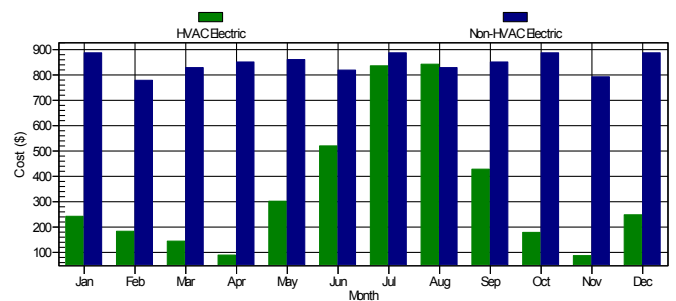


Fig.6 Monthly energy cost for HVAC and non-HVAC components prior introducing thermal insulation

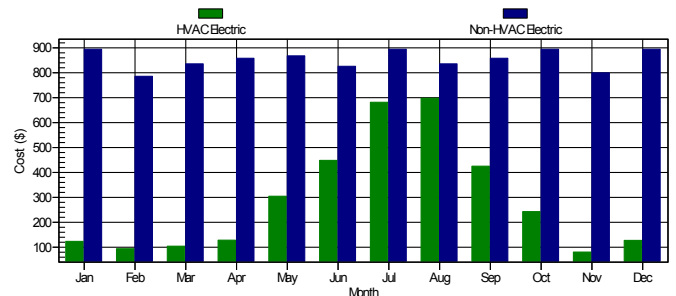


Fig.7 Monthly energy cost for HVAC and non-HVAC components after applying thermal insulation

What we can observe from the results taken from simulations is the dominant energy consumption by non HVAC equipment, such as lighting and electric appliances for office purposes. However this trend sharply changes during summer days where solar irradiance is higher. As a consequence the energy cost for cooling would increase during summer season. As mentioned above the application of thermal insulation of the walls would only slightly decrease the cooling load during summer. It is clear that the highest influence is on the windows, since their U-value is higher than in opaque structures. Nevertheless, observing the Figure 7, a new discussion can be made. Since the share of lighting and electrical equipment is approximately equal throughout the year with minimal variation and the demand for electricity is constant over the year it was estimated appropriate introducing a photovoltaic PV system on the rooftop of the building.

3.1 PV System generating electricity

A grid connected photovoltaic system made of Si polycrystalline cell was simulated using PVSol software. The PV generator surface estimated at 181 m² covered by 88 PV modules arranged on the roof of the building. Numbers of inverters were four and total PV output is assessed 34.32 kWp. The inclination was taken 30° and orientation South 172°. The simulated results are listed below in Figure 8.

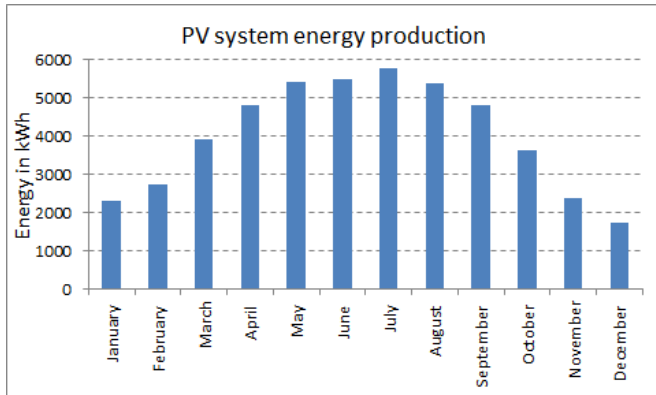


Fig. 8 Energy production by PV system on rooftop of the building

From the simulations we are able to determine the specific annual yield which results 1418.74 kWh/kWp and annual contribution of PV system on the grid results 48,691 kWh/year. The stand-by consumption evaluated about 64 kWh/year. On the other hand generating electricity using solar energy will directly contribute on the reduction of CO₂ emissions. The avoided CO₂ emissions result in 29,215 kg/year. Furthermore an economic analysis was performed using the simple payback method. For the financial analysis specific investment cost was selected 750 Euro/kWp, which is accordance with the nowadays market price of PV modules. The assessment period was chosen 20 years and amortization period 5.9 years. Total investment cost resulted 25,740 Euro. No bank loan was predicted for the investment during the simulations. The results are given in Figure 9.

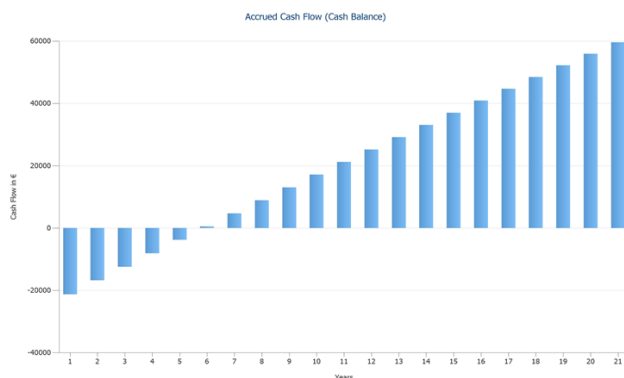


Fig. 9 Accrued cash flow balance

4. Conclusions

In this research paper a typical public building placed in the city of Durres was considered. Durres city is part of the A climatic zone, in which the public buildings dominate with more than 57 % located in this area. The building is a two floor structure which is firstly investigated using infrared thermal camera. From the investigation carried out in the building four main energy consumers are lighting, cooling, and heating purposes. Energy consumption of electric equipment result on approximately 46 % of the total electricity

consumption. First attempt to include energy efficiency measures was to introduce the thermal insulation. Due to this EE measure the impact on energy reduction in heating is significant, whereas for other energy consumers this measure has a slight effect. The second EE measure applied in this study was the introduction of a grid connected PV energy system applied on the roof of the building. Total PV capacity assessed was 34.32 kWp with an annual yield about 48,691 kWh of electricity. This figure will significantly contribute on the CO₂ emission reduction estimated at 29,215 kg of CO₂ per year. Energy consumption in public buildings requires more accurate data which can be supplied at sight. The analysis needs to deepen thoroughly in order to improve the energy performance in building by introducing effective energy efficiency measures with low cost ensuring greenhouse gas emission reduction and increasing the energy performance of the building in generally.

5. References

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Improvement of the production processes based on the lean methodology

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Abstract: The project for improvement of the production process based on the Lean methodology in SMELT-ING DOO was implemented in four phases (mini projects). The detailed analysis of the work orders in the period of 9 months provided clear picture of the current situation. With the defined methodology and through mutual meetings with the upper management and the employees of the company, the project team managed to introduce and implement the following mini projects: improved visualisation, digital work order, implementation of 5S and portable tools trolley. All these mini projects have improved the organization of the production process and helped the process of waste elimination in the company.

Keywords: IMPROVEMENT, PRODUCTION, LEAN, PROJECT, WORK ORDER, VISUAL MANAGEMENT, 5S, MANUFACTURING.

1. Introduction

Lean is an approach to manufacturing that focuses on eliminating waste and improving workflow. It is particularly associated with the production system established at Toyota, with its twin pillars of just-in-time inventory management and automated quality control. In recent decades the principles of 'lean thinking' have been increasingly applied within the various industries to banish waste and create value [1].

The authors were part of an international project Increasing the Competitiveness of the Domestic SMEs in Order to Improve Their Cooperation with Foreign Investors' Companies [InComSMEs] where 6 SMEs from North Macedonia were selected and industrial projects were carried out, www.mf.edu.mk/incomsmes. This case presents one of the projects, implemented in SMELT-ING DOO.

SMELT-ING DOO was founded in 1996 as a company for trade of electrical materials. Since then, the company is constantly growing and investing in various other businesses in North Macedonia and the region. SMELT-ING DOO is famous for its flexibility and the individual approach to each of its clients. They produce electrical cabinets, complex metal assemblies and production of welding machines. SMELT-ING DOO team has provided significant support during the entire InComSMEs project. They were included in all training sessions organized by the Faculty of Mechanical Engineering – Skopje and the Technical University of Vienna. After they were selected as one of the companies for implementing this industrial project, the employees strongly engaged in the process and proposed many improvement ideas for their organization. The project plan for implementation of the project is shown in Figure 1.

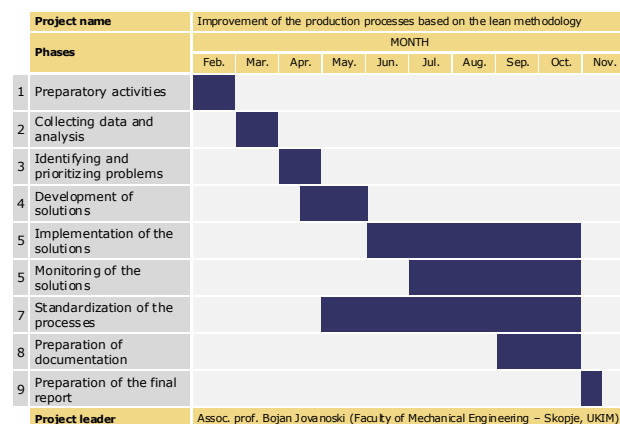


Fig. 1 Project plan

2. Prerequisites and means for solving the problem

One of the first tasks that were completed in the phase of the project was an analysis of the layout i.e., the material flow on the

shop floor of SMELT-ING DOO. Figure 2 is presenting the material flow analysis for three specific products. The flow in the production area is chaotic and this is understandable because they have a heterogeneous product line. But there are no overlapping lines, as seen in Figure 2, which means that the current machine layout is acceptable. This means that the efforts of the project team shouldn't be directed towards the improvement of the transportation paths and reorganization of the production shop floor (redesign of the layout).

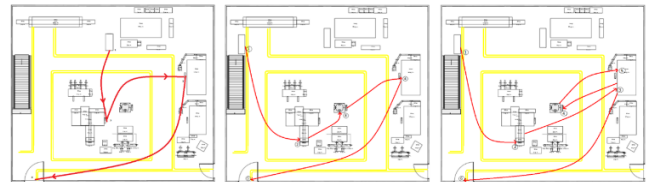


Fig. 2 Analyzed layouts and flow paths for the products (red lines)

After this, as shown in the project plan, in a six-month time span, a detailed analysis of one of their main client's programs was performed, according to the real manufacturing demand and work orders. The goal of this analysis was to determine the distribution of time for each product (and batch) and based on these findings, the team to propose future improvements (Figure 3).

NEEDED PROCESS CAPACITY									
Name of the process		Part number		Requirement		Monitored by			
Metal processing		GEH-0656		30		Aleksandar			
				Net Operating Time in sec (I)		Date			
				25.200		20-Mar-19			
				Basic time in sec.		Total changeover time in sec.		Summary in sec.	
#	Operation	Machine	Manual work A	Automatic work B	Machine work C = A+B	Changeover time D	Quantity during changeover	Time/part F=D/E	Total time for one part G=C+H
1	Trail		30	110	140	765	30	25.5	165.5
2	Cut through		165	920	1085	5	30	0.166667	1085.1
3	Grinding		605	0	605	5	30	0.166667	605.1
Total			800	1030					Max. output
									23

Standard Work Combination Sheet									
Name of the process		Part number		Net Operating Time in sec.			Legend		
Monitored by				Date			↗ Motion		
							— Manual work		
							↘ Automatic work		
							↔ Waiting		
				Operational time in sec.					
				10 20 30 40 50					
#	Operation	Operator	Automatic work	Motion					
1	Taking material	5							
2	Set on the machine	65							
3	Positioning	8							
4	Positioning		20						
5	Cutting		900						
6	Taking out and control	87							
7	Grinding	605							

Fig. 3 Detailed analysis for specific products

From all these observations, a table containing all the products that SMELT-ING DOO is manufacturing for KEMET was generated, with the time needed for manufacturing (T_i) and setup time (T_{p2}) for each machine separately. In the period when this observation was performed, there was no demand for all products. Therefore, for those products (that were not observed), the project team adopted the times for the most similar product that was observed during the project (if needed, some of the times were modified based on past experiences), Figure 4.

After processing the collected data, the project team analysed the work orders from the past year, to provide reliable analysis for

the utilization of the capacities. After this detailed analysis, a presentation in SMELT-ING DOO summarized the conclusions from the observations of the manufacturing process in the past months.

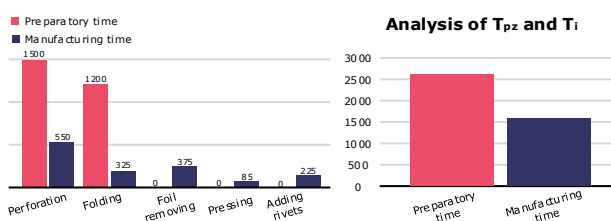


Fig. 4 T_{pz} and T_i analysis

Besides the fact that this analysis provided many various results such as the utilization of every machine for the selected production program, the team was especially interested in the setup time data – which are times that are not adding any value to the process. The results are shown in Figure 5.

[illegible]

Fig. 5 Detailed analysis of T_{pz} per product

3. Challenges

Right after the analysis of the production system, the upper management of the company organized several workshops including all employees from the manufacturing department. The project team was leading the process according to a previously set methodology. Before the application of each new tool or method, the team explained the tool/method and ensured that all employees are aware of its meaning and application. During the process, many ideas were proposed and through filling of CIP cards [2, 5] (Continuous Improvement Process) shown in Figure 6 the team prepared KAIZEN board, specially designed for SMELT-ING DOO, as shown in Figure 7.

The ideas were classified as mini projects and were assigned to a responsible team member:

- Improved visualisation (Bojan Nestorovski),
- Digital work order (Bojan Jovanoski),
- Implementation of 5S (Aleksandar Neveselov),
- Portable tool trolley (Zarko Angeleski).

Name		Date	
☐ Safety	☐ Quality	☐ Productivity	☐ Costs
Description of the problem			
5 Why analysis		Suggested countermeasures	

Fig. 6 CIP card template

KAIZEN is an approach that continuously improve operations and involve all employees [2, 4]. It is a business philosophy or system that is based on making positive changes on a regular basis, as to improve productivity [6]. For this project, a KAIZEN board was implemented where the team and the company employees can generate and monitor all the ideas for a particular topic. From total of 12 ideas, in accordance with the timeframe for this project, the

project team decided to prioritize 4 ideas for further development and implementation.

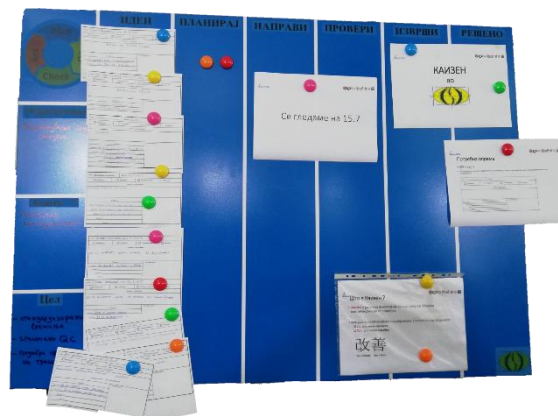


Fig. 7 KAIZEN board

4. Results and effects

It is very important to mention that from the start of the entire project and during the initial visits of SMELT-ING DOO, the project team could recognize a well-organized company and successfully set systems. All mini projects that are subject to this study, are simply improvements of the currently well-organized shop floor. All these projects were directed towards the elimination of the waste time (the non-value adding time).

4.1.Improved visualisation

The goal of this mini project was to enhance the visualisation of the manufacturing shop floor. During the project, many crucial positions were labelled such as the movement paths, the machines and most importantly, labels were placed on the tools needed in the manufacturing process (Figure 8).

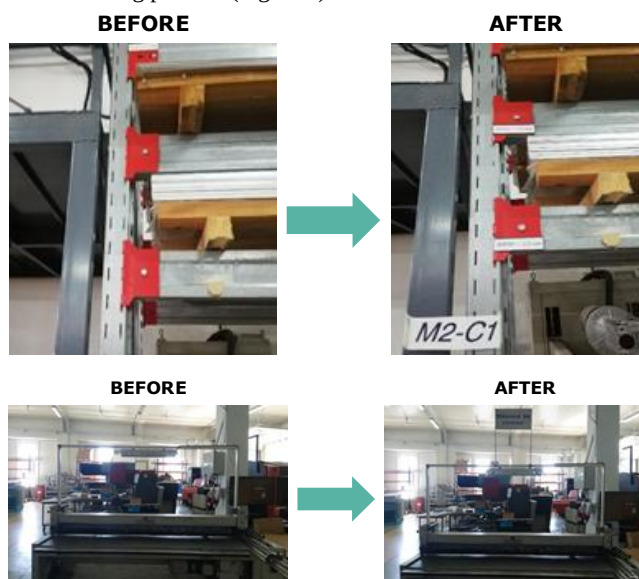


Fig. 8 Part of the improvements of the visualization on the shop floor

4.2. Digital work-order

SMELT-ING DOO had ideas for the introduction of ERP system. But considering that this company is connected to many other organizations that still don't use this ERP system, in this timeframe, implementation of such a system was ruled out. Instead, the project team prepared a solution that will still fulfil the requirements of the company for digital work order until the ERP system is implemented. Based on the observed times in the previous phase, a digital work order template was prepared in Microsoft Excel (Figure 9). This enabled flexibility for the employees, but also it was a system for better planning and control of the production.

Work order number _____

Contract number _____
Product _____
Delivery date _____

Order number _____
Quantity _____
Completion date _____

Client _____
Materials _____
Starting date _____

Notes _____

#	Activity	Machine/tool	Time to (sec.)	Batch time (min.)	Control	Responsible	Notes
0	Taking material						
1	Cut length						
2	Grind						
3	Grind						
4	Grind						
5	Press						
Total			(min)	or	(h)	work	

Control of the finished product

Date _____
Responsible _____

Corrective measures _____

Fig. 9 Digital work order with previously defined technology and times

4.3. Implementation of 5S

5S is an approach to organize, order, clean, standardize and continuously improve a work area. 5S is not just about housekeeping, it is one of the most efficiently working tools of Lean manufacturing [3]. This approach was introduced to SMELT-ING DOO's workplace to enhance the effectiveness of the production and eliminate unnecessary objects (devices, machines, documents, etc.). The steps to implement 5S are **sort**, **set**, **shine**, **standardize** and **sustain**.

The 5S activities usually seem very simple and easy, but the project team spent most of the time and energy on this mini project as they are time consuming. Sometimes, full implementation of 5S can take up to 3 years, but the project team had only 2 to 3 months. Considering the time constraints, the team focused only on the most frequently used machine, but also the machine where the T_{pz} values were the highest (as identified in the observations at the beginning of the project). The goal was to empower the employees to be involved in this process on a daily basis and therefore sustain the solutions set up with this project. Considering one of the most important goals of the project – to connect the output control of SMELT-ING DOO and the input control of their client, it was suggested to use the client's 5S checklist for audits and adapt it accordingly (Figure 7).

Fig. 10 5S checklist

Чек - листа		Област		Внеси име на оддел		Забелешка		Вредност	
0	1	2	3	4	5	6	7	8	9
Безбедност									
1	Дали постојат патни, патници до ППА и патници за возачи се одржуваат								
2	Дали "СТОП" знамето и во функција и исто е на достапно место за работникот								
3	Дали сигнализација за возачи (сигнализација) се чуваат заповедни								
4	Сигнализација за возачи се чуваат и се во употреба								
5	Како е возачот, се користат транспортни средства за превоз на тежок товар								
Вредност									25 25 100%
Систем									
6	Дали има лични предмети на работното место								
7	Постат инструменти или машини кои не се користат или се оштетени / раскирани, кои не се користат во процесот								
8	Инструменти / машини / машини кои не се користат или се оштетени / раскирани, кои не се користат во процесот								
9	Инструменти / машини / машини кои не се користат или се оштетени / раскирани, кои не се користат во процесот								
10	Дали некои материјали или производи што не е поврзан со процесот се наоѓаат во процесот								
Вредност									18 25 72%
Поредок									
11	Промени / распореди делови се достапни и навидома поставени и правилно идентификувани и јасни за сите								
12	Апати кои се користат за поддршка / мерки се достапни и добро користени								
13	Материјалите што се користат во производството се добро идентификувани и соодветни на соодветни начини и се блиски до машините каде што исти се користат								
14	Работната површина / машини е одржана на правилни начини за нареден ден								
Вредност									15 20 75%
Токанство / чисти									
15	На работ на машини (за машини) и на работ на машини (за машини) сите работни станици се правилно почистени								
16	Превентивното одржување и вложувањето се прават на правилни начини (поредок, наредба)								
17	Местата за контрола се чисти на соодветни начини								
18	Местата за материјали се одржани чисти и на организирани начини								
19	Инструментите и документите се одржуваат на соодветни начини (чисти, без оштетувања, износ)								
Вредност									12 20 60%
Стандартизациски и одржување									
20	Материјалите, машините и процесите на работни станици и документите се стандартизирани								
21	Евиденцијата за стандартизациски контроли и достапна и добро изработена (чистота и јасна)								
22	Сметките работни станици / машини се стандартизирани за материјали, документација, евиденција								
23	Местата за материјали по следниот метод за стандартизациски и одржување								
24	Вредностите се одржани заповедни и навидома заповедни Дали има валкован материјал / мач / мач								
25	Средствата / оштетени работи (мачи, материјал, мачи, мачи) се идентификувани и се придржуваат за исти да бидат поврзани или отстранети делови кои не се во употреба								
Вредност									11 25 44%
Вкупна вредност									61 100 70%

Figure 11 is showing some of the before and after photos of this project.

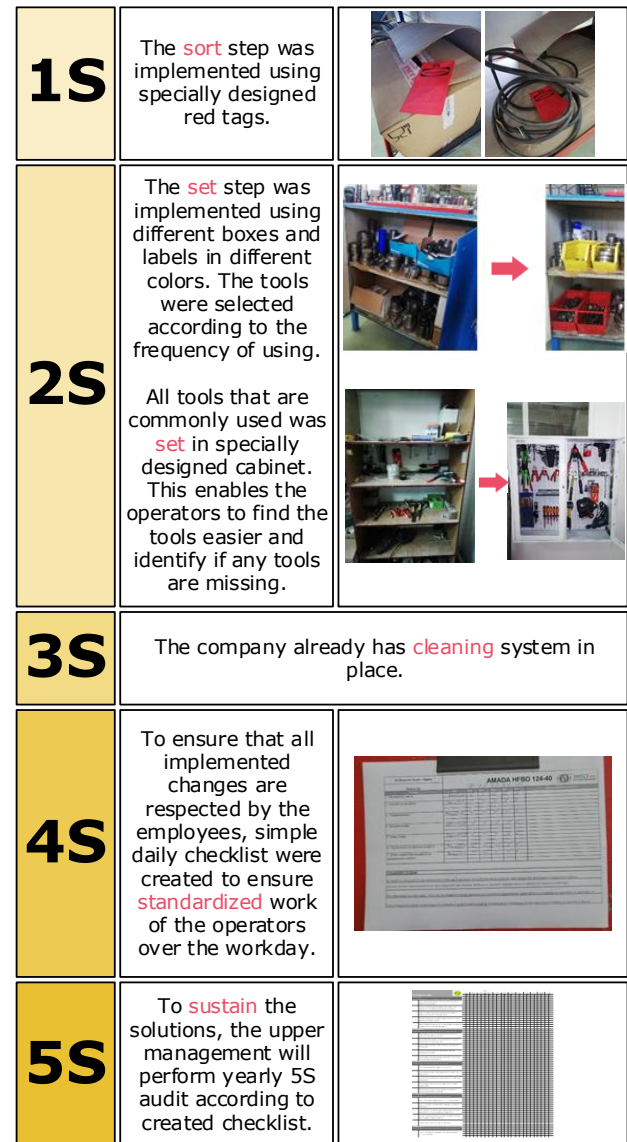


Figure 11: Improvement of the 5S – before and after implementation

This small project was thoroughly planned, and the implementation was monitored and controlled very closely by the team. Before each phase, the project team had presentations for the employees for each 5S phase and the outcomes of each phase. After this, with deadlines in place, SMELT-ING DOO employees implemented the activities for the phases. Before moving to the next 5S step, an evaluation of the 5S implementation was undertaken using the audit checklist.

Figure 12 is showing the progress of the 5S in the company.

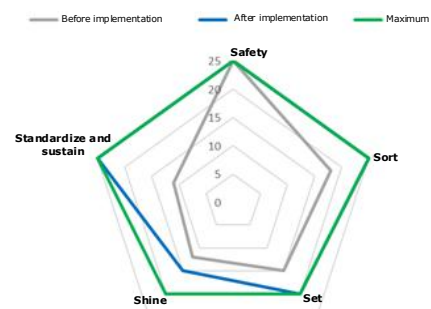


Fig. 12 Improvement of the 5S

According to Figure 12, in the beginning, the 5S score was 81 points. At the end of the implementation, the score was enhanced up to 110 points out of 115 possible. Due to time constraints, the procedure for preventive and corrective maintenance of the machines was not implemented.

4.4. Portable tools trolley

Due to the many different tools that were usually left all over the machines in the production area, without any order, the need for a solution for better organization was needed. With the implementation of this trolley, every tool got its own place which was labelled accordingly. The trolley is designed to be portable, and the operators can move it on the shop floor (Figure 13).

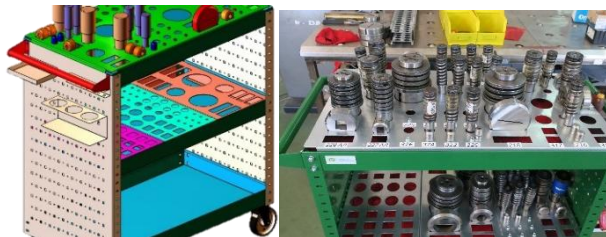


Fig. 13 Portable tools trolley

The trolley is equipped with brakes so that the operators can stop the trolley when they are working with the tools, or they are simply storing it on the shop floor. The trolley consists of three drawers, where the first drawer is dedicated for the most frequently used tools. Both vertical sides of the trolley are also utilized with the most common tools as screwdrivers, pliers, etc., as well as protective equipment for the operators (gloves, anti-noise earplugs, etc.). This trolley directly helped the previous mini project and significantly helped achieve the satisfactory 5S score in the company. The trolley is designed and produced by SMELTING DOO and is now offered to the clients as one of their products.

5. Conclusion

The project with title “Improvement of the production processes based on the lean methodology” was implemented in SMELTING DOO. The project lasted for nine months, was carefully planned and consisted of four mini projects with specific results from each:

- Improved visualisation
- Digital work order
- Implementation of 5S
- Portable tool trolley

The demand for those mini projects was established at working meetings and mutual agreement, aided by the KAIZEN board. Before that, a 4-months detailed analysis was conducted where the following elements were created: spaghetti diagrams, process capacity tables for the products, standard work combination sheet, process chart, diagram of the document flow – from order to delivery, and capacity analysis for all machines. The conclusion from the analysis was that the company needs to work more on decreasing the time for setup and less for the operative time.

The implementation of 5S required the most time to be executed, as planned. Every stage of the methodology was organized with a presentation for the workers, plan of tasks to be undertaken, time to implement actions and evaluation of the performance at the end. The digital working order helped the company better plan and control the production processes, clearly stating the check points. The improved visualization, together with the portable cart, organized the production department even further and decreased the time the workers need to initiate the work orders.

The involvement of the company’s employees was essential during this project and that is one of the main lessons learned during

the implementation. They welcomed the improvements with great enthusiasm and provided many creative ideas for improvement of their organization. The changes were easily managed and accepted as the project team ensured to present and communicate the newly implemented changes prior to the implementation.

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Eco innovations - the foundation of sustainable regional bio-sector

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Abstract: Mankind faces a number of challenges in the 21st century. Many of them are related to the achievement of the goals and ideas set in the concept of sustainable development of modern UN society. The bio-sector, which is developing within the borders of the Bulgarian economy, has undergone rapid development in the last few years. Many factors have influenced this process, the most significant of which are: increased demand for organic products in international markets, high levels of public support for this type of production and the availability of favorable climatic conditions for their development. Innovation is the main tool for achieving competitiveness and economic growth at all levels - enterprise, industry, region or country. They are the fundamental means of improving people's quality of life. The purpose of this report is to present the results of a survey conducted among bio-enterprises in the regions of Bulgaria and to show that the green innovation in the bio-sectors is the foundation for regional economic, social and environmental prosperity. The results of the study summarize the main directions for achieving regionally balanced sustainable development.

Keywords: ECO-INNOVATION, INNOVATION ACTIVITY, SUSTAINABILITY, BIO-SECTOR, BIO-ENTERPRISES

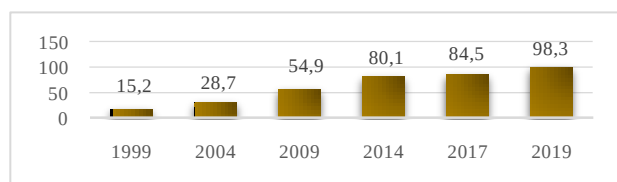
1. Introduction

The 21st century has posed a number of challenges to humanity, including limited resources, climate change, ecosystem degradation and a growing population. Global extraction and use of natural resources increased by nearly 80% between 1980 and 2020. Many companies are at risk of shortages of raw materials, instability of valuables, supplies and high values of materials. Disposal costs represent almost 15% of waste management costs, and landfill fees (at European level) are increasing every year, currently ranging between 10 and 80 EUR / tonne.

Overcoming modern challenges and meeting the goals of sustainable development requires comprehensive changes. These changes affect the development of the bio-sectors in the economy. Resource efficiency, sustainable economic growth, environmental and social justice and inclusion are an integral part of the development and creation of future enterprises related to the bioeconomy.

All this imposes the need to open opportunities for production and consumption in accordance with the ecological boundaries of our planet, economic growth compatible with environmental protection, sustainable use of limited natural resources and achieving a social standard of living that reduces poverty [1]. Overcoming these challenges requires a focus on research and innovation, to create new biomass products or new services that help reduce climate change, waste, create new jobs and build bio-production that contributes to sustainable development. modern society.

The bio-sector is the renewable segment building the philosophy of the circular economy, which has undergone rapid development in recent years. The global market for organic products is growing by 10% -15% on an annual basis (approximately \$ 5 billion in absolute terms) and by 2020 is



approaching \$ 100 billion (Fig. 1).

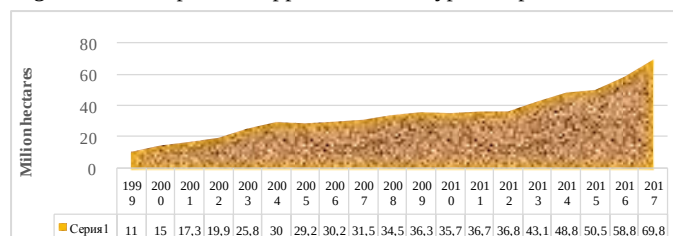
Fig.1. Global market for organic products (USD, billion)

Source: <https://www.statista.com/statistics/196952/organic-food-sales-in-the-us-since-2000/>

The areas occupied by organic farming (globally) are also increasing - from 44 million ha by 2000 (nearly 1% of agricultural land in the world) to 100 million ha by 2020, (Fig. 2) and the number of organic producers by 2020 exceeds 3 million, an increase of more than 15 times compared to 1999. Forecasts show that by 2025 the organic market will reach 225 billion euros [2].

Fig. 2. Growth of organic agricultural land 1999-2017
Source: Research Institute of Organic Agriculture, FiBL, 2019

The main factors influencing this growth are related to the increased demand for organic products on international markets, high levels of public support for this type of production, the



availability of favorable climatic conditions for their development, improving welfare of employees in the organic sectors, the desire of the population to consume healthier products and those produced in an environmentally sustainable way, and last but not least - the existence of government policies that stimulate organic production and "green" practices [1].

2. Literature review

According to the Organization for Economic Co-operation and Development in Europe (OECD) Oslo Handbook (2018) for the collection and interpretation of innovation data, innovation is defined as the introduction of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in business practice, workplace organization or external relations. This definition applies very generally to innovation in the bio-sector, which is expected to have two clear and significant characteristics, namely:

- Reflect the idea of reducing environmental impact, whether this effect is pre-sought or accidental.
- Not to be limited to product, process, marketing and organizational innovations, but also to include innovations in social and institutional structures.

In the scientific literature, the concept of eco-innovation was first considered by Fussler and James (1996), who defined eco-innovation as "new products and processes that provide value to customers and businesses but significantly reduce environmental policy"[3]. The definition of Klemmer is similar, which complements the participants in this process. According to him, "Eco-innovations are all measures of relevant actors (firms, politicians, unions, associations, churches, private households) which develop new ideas, behavior, products and processes, apply or introduce them and which contribute to a reduction of environmental burdens or to ecologically specified sustainability targets" [4].

The market orientation of eco-innovation is addressed in the definitions of Andersen and Keeble et al. According to Andersen, "Eco-innovation is an innovation which is able to attract green rent on the market." For Keeble et al. "Sustainability-driven innovation is the creation of new market space, product and services or processes driven by social, environmental or sustainability issues"[5].

In the European Commission's 2007 Competitiveness and Innovation Framework Program, much of which is devoted to the financing of eco-innovation, the term is defined as "any form of innovation aimed at significant and demonstrable progress towards the goal of sustainable development, by reducing the impact on the environment or achieving a more efficient and responsible use of natural resources, including energy"[6]. It emphasizes the link between the concept of sustainable development of modern society and the ultimate goal of eco-innovation. In the INNOVA initiative of the European Commission, the concept is specified "Eco-innovation is the creation of new goods, processes, systems, services and procedures at competitive prices designed to meet human needs and ensure a better quality of life for all with minimal use of life-cycle natural resources (materials, including energy and surface area) per unit of output and minimum release of toxic substances [7]. Two main ideas are linked in this definition: First, eco-innovation is a specific type of innovation designed not only to create new markets or to replace obsolete ones, but mainly to meet human needs and secondly, the environment is affected, which depends on innovation development.

An alternative definition is proposed by Kemp and Foxon, according to which „Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternatives’ [8]. An analogous definition was also proposed by the OECD in 2009. The OECD observer document says that eco-innovation is the creation or implementation of new, or significantly improved, products (goods and services), processes, marketing methods, organizational structures and institutional arrangements which - with or without intent - lead to environmental improvements compared to relevant alternatives” [9].

According to the Environmental Technologies Action Plan (ETAP), „Eco-innovation is the production, application or exploitation of a good, service, production process, organisational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternative“ [10].

According to the OSLO Manual [11], „Eco innovation can be generally defined as innovation that result in the reduction of environmental impact, no matter whether or not that effect is intended. Various eco-innovation activities can be analysed along three dimensions:

- Target (the focus areas of eco-innovations: products, processes, marketing methods, organizations and institutions)
- Mechanisms (the way in which changes are made in the targets: modification, redesign, alternatives and creation)
- Impacts (effects of eco-innovation on the environment)” [11].

All the mentioned authors conceive eco-innovation as a process of novelty creation that should be able to lead to a more responsible and efficient use of resources and minimise the impact of human activity on the environment. Eco-innovation is any innovation that reduces the use of natural resources and reduces the release of harmful substances throughout the life cycle. Eco-innovation can be found in all forms of new or significantly improved products, goods, services, processes, marketing methods, organizational structures, institutional arrangements and lifestyles and social

behaviors that lead to environmental improvements over relevant alternatives [12]. They involve the development and application of new approaches to value chains of products and processes that reduce the intensity of the use of materials and at the same time increase the intensity of service and well-being.

To be defined as an eco-innovation, an innovation must have at least one of the following six characteristics:

- reduction of the negative impact on the environment.
- efficient use of natural resources.
- realization of energy efficiency.
- use of renewable energy sources.
- recycling of waste and non-waste technologies.
- implementation of environmental standards.

Eco-innovations can be considered and analysed in terms of their purpose, mechanism for implementation and impact on the environment.

- ❖ The goal refers to the main focus of eco-innovation - new products (both goods and services), new processes (production method or procedure), new marketing methods (for the promotion and pricing of products, new market-oriented strategies, etc.), a new form of organization (such as the governance structure and the distribution of responsibilities), institutions (institutional agreements, social norms and cultural values).
- ❖ The mechanism refers to the way in which the change in the goal of eco-innovation is implemented or introduced. It can be technological or non-technological. Eco-innovation in products and processes relies mainly on technological development, while eco-innovation in marketing, organizations and institutions relies more on non-technological change. There are four main mechanisms:
 - Modification, such as minor changes to the product or process.
 - Redesign, which refers to significant changes in existing products, processes, organizational structures, etc.
 - Alternatives such as the introduction of goods and services that can meet the same functional need and exist as substitutes for other products.
 - Creation, design and introduction of completely new products, processes, procedures, organizations and institutions.
 - Impact refers to the effect that eco-innovation has on the environment, the whole life cycle or a single area.

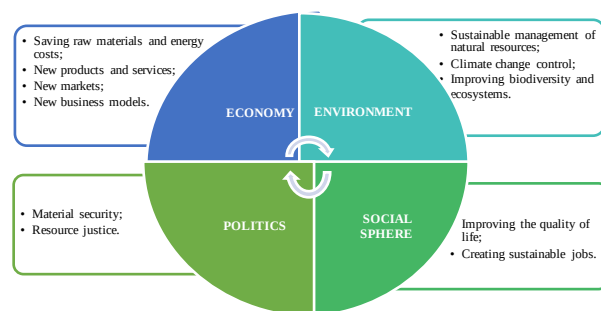


Fig. 3. Relationship between eco-innovation in the bio-sector and regional development

Source: author's interpretation

Eco-innovation is any innovation that leads to significant progress towards the goal of sustainable development by reducing the impact of existing production methods on the environment, increasing the resilience of nature to environmental pressures and achieving more efficient and responsible use of natural resources [13]. The impact of eco-innovation in the regional bio-sector, in the four directions - economy, ecology, social sphere and policies, are summarized in Fig.3.

Bio-sector enterprises are an important factor in creating, introducing and disseminating innovations in the market. This is due to their desire to maintain and increase the innovative nature of their products and the technologies they use for their production.

3. Methodology

The analysis was prepared mainly on the basis of a survey, discussions and interviews with experts and organic producers from the regions of Bulgaria. Initial contact and other basic information about all organic producers are collected from the official register of the Ministry of Agriculture and Food of the Republic of Bulgaria - database of producers, processors and traders of organic products and foods produced in organic production in a way that maintains such current database. A total of 234 organic producers from different sectors of the bioeconomy were surveyed in the period April-September 2021. A survey was conducted with the help of a specially developed questionnaire and aims to collect and analyze empirical information to explore the relationship between innovation activity of enterprises and their economic performance and efficiency, and to determine the impact of eco-innovation on efficiency.

The factors that stimulate or hinder companies from developing, creating and implementing eco-innovation are summarized in a table.1.

Table 1. Incentives and limiting factors for the creation and implementation of innovations

Stimulating factors	Obstructive factors
Economically: • growth in the market of eco-innovative products and services; • access to subsidies and financial incentives; • availability of good business partners. • Existence of organizations engaged in research and development.	Economic and financial: • lack of financial resources for the enterprise; • uncertain market demand; • uncertain return on investment; • difficult access to public subsidies.
Politically: • Existing or expected environmental regulations and standards; • Voluntary codes or agreements on good environmental practices; • Creation of clusters and support for clusters.	Corporate: • lack of qualified staff; • lack of expert knowledge and skills; • limited opportunities to improve production efficiency.
Factors related to the companies: • Availability of information and knowledge about technologies in the specific field; • Availability of good organizational and managerial skills.	Others: • Limited environmental awareness among consumers, which leads to low demand for eco-products. • lack of regulatory incentives. • dominance of established companies in the market; • poor interaction between science and business

Bulgaria is no exception to global trends in the development of sectors in the bioeconomy. (Fig. 4) The data on the dynamics in their development and the change in the GVA of the country for the period 2010-2019 are calculated according to the chain volume index (in 2010 = 100), illustrating which bio-sectors have increased or decreased the value during the period 2010-2019.

According to the OECD, by 2055 the bioeconomy and the bio-sectors that develop within its borders will be the basic principle for the development of the regions. In Fig. 4 are ranked the sectors of the bio-economy, which will attract the greatest investor interest in the next 20 years [14] (production account and generation of income by industry) The data show that the focus will be on developing and implementing innovative methods for the production of renewable bio-resources in agriculture, forestry and aquaculture, and new methods for the production of bio-products, and biomass and bio-energy will become the main source of industrial raw materials.

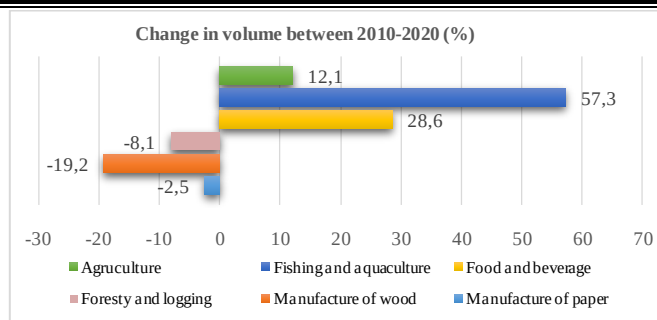


Fig. 4. Change in gross value added in the sectors of the bioeconomy in Bulgaria

Data source: author's calculations (production account and income generation by industry)

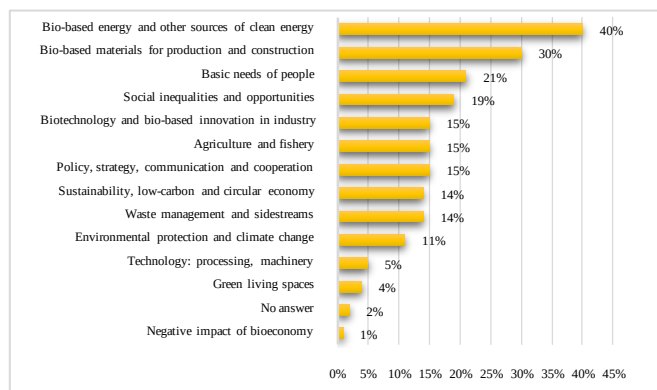


Fig 5. Sectors of the bioeconomy with a perspective for development in the next two decades.

Data source: author's calculations

The forecast study shows that the bio-sector needs innovation. The role of innovation is fundamental. They are seen as the key to success in improving environmental degradation and resource consumption. At the same time, they are an incentive for building entrepreneurial structures and sustainable regional growth.

4. Exploration

The survey conducted in the period April-September 2021 among companies in the bio-sector with different subject of activity and size. It was implemented on the basis of an open and closed questionnaire, distributed by e-mail.

A questionnaire was used to collect data from a sample of 234 enterprises, which were selected by a stratified method of random sampling from all subsectors of the Bulgarian bio-industry. The respondents are representatives of all major subsectors of the bio-industry in Bulgaria and their relative shares are shown in fig. 6.

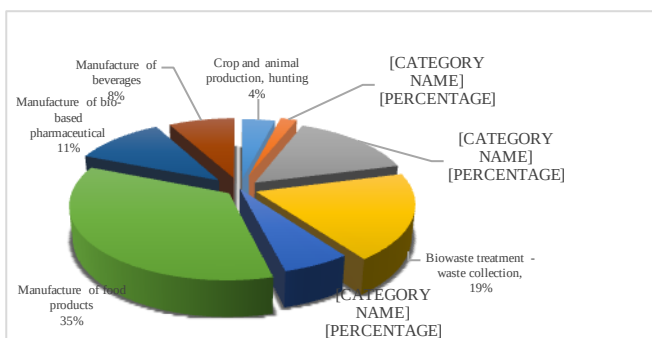


Fig.6. Share of respondents from bio-sector in Bulgaria

Data source: author's calculations

In Fig. 7 reflects the ecological impact of eco-innovations implemented by bio-enterprises on the development of the regions in Bulgaria.

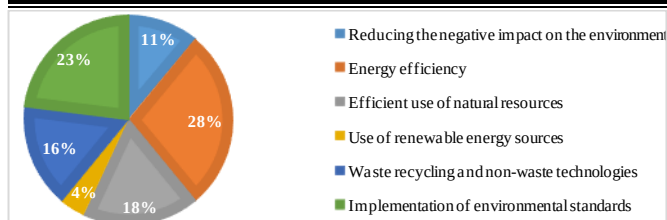


Fig.7. Ecological impact of innovations on regional development

Data source: author's calculations

In the first place, the respondents put the innovations related to increasing the energy efficiency (28%). Innovations related to the establishment and compliance with the Implementation of environmental standards are ranked second (23%).

The results of the author's research were used to determine the innovative activity of enterprises and to identify the factors influencing it. A comparison was made between the results of the survey and the official data of the NSI and the EU. In conclusion, based on the analysis of the results of the survey, the following conclusions were made:

Of all the surveyed enterprises by the survey method, about 30% are innovative. Such is the share of innovative enterprises in Bulgaria according to official statistics. The largest number of companies have managed to implement product innovations. There is a tendency to increase new products. There is a decline in organizational innovation and a significant increase in eco-innovation. Process and marketing innovations vary up and down, but within small limits. The strongest favorable impact on innovation from the internal factors for the enterprise has the presence of entrepreneurial spirit, and from the external factors - the public innovation programs; The strongest impediment to innovation from internal factors for the company is the lack of qualified staff, and from external - the lack of external sources of funding. The indicators for measuring the eco-innovation activity of the surveyed enterprises can generally be classified as research and development costs, applications of patents, technology implementation, participation of skilled workers, etc. It can be concluded that in medium-sized enterprises the highest employment of R&D staff is observed - 50%, followed by small enterprises - 35%, in micro-enterprises the employed staff is 13%, and in large enterprises it has the smallest share - 2%. This is most likely due to the financial capacity of large companies to purchase licenses, patents and know-how, as well as to use external consultants for their innovation activities. In terms of the share of R&D expenditure as a % of total expenditure, the survey showed that large enterprises make the highest R&D expenditure, followed by medium and small enterprises.

The summarized results for the whole set of surveyed enterprises show:

During the period under review the number of eco-innovations carried out in the surveyed enterprises is small, but with a tendency to increase - the increase is by 57.14%. For innovations such as "Innovative production methods that are new only to the company" this increase is 33.33%, and doubled "Innovative production methods that are new to the company and the industry." There is an increase in the costs that companies spend on eco-innovation - both total and average for a single innovation. According to the managers interviewed, the eco-innovations carried out in their enterprises did not have a high level, assessed as a degree of novelty and significance of the change. Innovations such as "Innovative production methods that are new only to the company" had a lower level during the study period. Estimates of the level of eco-innovation show that small, insignificant changes with a low degree of novelty have usually taken place in enterprises. The implemented eco-innovations have led to an increase in sales compared to the previous year - both for the enterprises that have implemented the innovations and on average for one innovation. These results show that innovation through the introduction of innovative production methods, new to the company and the industry have led to the

largest increase in sales of enterprises. The eco-innovations that have been implemented have had a moderately strong impact on improving the environmental protection of enterprises. This is due to their relatively low level and applies to both types of innovation. The impact of the implemented eco-innovations on the reduction of energy costs for 1st production is relatively strong. Apparently, companies have focused mainly on the introduction of energy-saving processes.

5. Conclusion

The advantages for the enterprises from the bio-sector as a result of the introduction of eco-innovations are related to the achievement of flexible business models; higher revenues as a result of opening new markets and customers; reducing costs by achieving material, energy savings and increased efficiency and compliance with regulatory requirements.

The benefits of developing and implementing eco-innovation for the development of sustainable regions can be summarized in the following areas:

- From an environmental point of view, the use of natural resources is expected to be reduced and the release of harmful substances during the life cycle of the product or service will be limited.
- Social benefits are associated with - job creation, change in people's behaviour and lifestyle, leading to improved quality of life and health.
- From an economic point of view - opening new market opportunities, higher revenues and competitive advantages for business.

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Supplier's Reverse Logistics Process Management

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Abstract: Reverse logistics processes generate significant logistics costs if not optimized continuously and are often being undetermined. Logistics companies emphasize the necessity for optimization and process uniformization to its highest possible extent, while disadvantages as process duration, educated personnel, and unsatisfied consumers are reverse logistics barriers. For the paper research, the focus has been directed to reverse logistics process analysis at the location of a supplier on the Republic of Croatia logistics market. The case study consists of highlighting reverse logistics issues, on-site analysis, and possibilities to optimize time-consuming processes. Analysis has been provided throughout time measurement of individual reverse logistics process with suggestions for optimization.

Keywords: REVERSE LOGISTICS, REVERSE LOGISTICS PROCESSES, PROCESS OPTIMIZATION, SUPPLIER PROCESSING

1. Introduction

The paper's focus of research is reverse logistics process analysis at the supplier's level. Research has been modified in a way providing operational process analysis and activities and measuring the time duration of processes and activities. At the observed subject, supplier's reverse logistics processes are observed through the interrelationships between the customer and the branch, the branch and the supplier or LDC (logistic distribution center), the service department and the supplier, or the LDC and the external supplier as shown in the paper. Based on the analysis of available data, several suggestions for improving the observed system are given.



Fig. 1 Uniformity of forwarding distribution vs. individuality of reverse logistics processing

By recent research [1, 2], reverse logistics processes are often not satisfyingly organized. Some disadvantages that occur on behalf of this, are directly connected and are influencing on company's profit margin.

Reverse logistics processes, always of the secondary matter when compared to optimization of forwarding chain, often are marginalized nevertheless optimization can maybe not directly gain your profit, but it will reduce your logistics costs.

Authors [3, 4] highlighted issues regarding reverse logistics process optimization. Individual approach for each company, focus on the individuality of items in return, focus on clients, information system, reverse logistics return center, are some of the ways to gain reverse logistics process optimization or implementation. Each company needs its focus on its reverse logistics business, due to the individuality of occasions during processing returns.

Different case studies can give us detailed information on similar problems in the supply chain from a reverse logistics point of view. Detecting similarities and analyzing your companies' processes, can influence optimization and reduction of logistics costs. The scientific approach gives us a different perspective while combining it with real case studies can make a significant influence.

2. Reverse logistics processing

In addition to handling returned items, reverse logistics, if optimized, ensures a reduction in the cost of the entire supply chain, leading to improved customer satisfaction, reduced investment in resources reduced inventory and distribution costs. [3]

Economic reasons include the benefits of the introduction such as cost reduction; reducing the number of raw materials; the better

relationship between the end-user and the company; adding value to products and increasing the company's reputation related to marketing [3]

The supply chain system includes the interaction of the involved entities, such as customers, suppliers of raw materials and intermediate goods, producers of final products, distributors (wholesalers), retailers, logistics operators, carriers. This interaction is manifested in the flow of goods, information, and financial resources between and within individual stages of the supply chain. The supplier is the business subject responsible for delivering the product to the seller. He has a direct relationship with manufacturers, wholesalers, or retailers. In other words, it connects the market with producers. [4,5] Sustainability is the high trend at the moment, focusing on greening, among else, logistics processes. Supply chains of the future are transparent and environmentally friendly while customer satisfaction is on a very high level. [6,7]

3. Methodology and collected data

Logistics market supplier's specifications

The company included in the study is one of the leading IT distributors and suppliers in the Croatian market. The area of business refers to closer neighboring countries, European Union, and Far Eastern countries. The number of different partners with which the company cooperates exceeds 5,000, to which it delivers more than 200,000 products every month. The total number of employees in the distribution center is over 500 people. The company does not own its retail locations, but cooperates and procures goods for many companies, while through the online platform it provides retail and delivery services to the end customer. The procurement process conducted within the organizational unit in charge of the supply of goods and timely delivery to the appropriate place at the appropriate price mostly refers to computer equipment and components 59% and consumer electronics 30%. The rest of the business refers to computer software 8% and children's toys 3%.

The company's warehouse is structured as a low free-standing facility with a ground floor and three floors to which access is possible by freight elevators with a capacity of up to 2 tons. The total land area is about 57,000 m² with access to the building from the south, while the total storage area is just over 25,000 square meters. The height of the storage space is up to 12 meters. LDC has a total of 64 forklifts, most of which are motor hand pallet trucks.

The warehouse is equipped with technology for tracking goods through the warehouse and is supported by its own designed WMS (Warehouse Management System) that provides insight to employees in 33,000 pallet places that the company owns with more than 15,000 SKU (Stock Keeping Units).

The space intended for various reverse logistics activities covers a total of 200 square meters and has a capacity of 40 pallet places. The space is divided into three sectors: inspected goods for return, not inspected goods for return, and goods for service. The figure

below represents the layout of the warehouse included in the study with highlighted return zone.

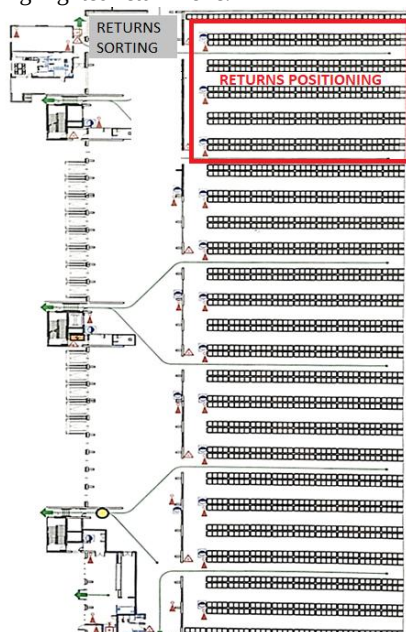


Fig. 2 Return zones in warehouse included in the study

Measurements

The observed supplier in the WMS system has more than 15,000 different products. The number of pallets in the observed period from 1st July 2020 until 31st July 2020 is 210 pallets in return, which means 7 pallets per day. The average number of items per pallet was 58 items, 53% of which related to toys, 28% to consumer electronics, and 19% to computer equipment and components. This gives a total of 12,180 items every month of which 6,456 are toys, 3,410 consumer electronics, and 2,314 computer equipment and components, shown in the figure below.

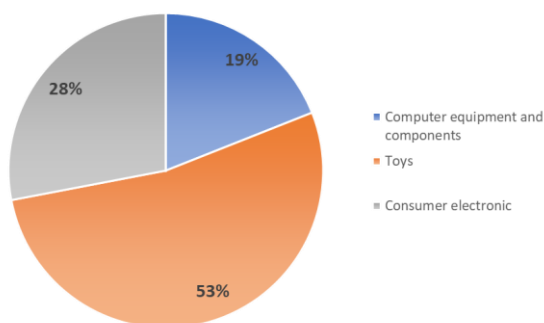


Fig. 2 Return categories

To direct the return flow of goods as efficiently and accurately as possible, the company has created several categories of returns or types of returns:

- Return type 1: the return originally packed goods
- Return type 2: DOA (Dead / Defective on arrival) return of defective goods returned by the end-user to the partner eight days from the date of sale (contains a retail invoice),
- Return type 3 return: Damaged goods (open goods, exhibits),
- Return type 4: Return of damaged goods in transport to the customer, not picked up by the customer upon delivery. The customer's return receipt must be made on the same day, ie on the day of damage to the goods, or no later than the next working day, ie twenty-four hours from the occurrence of the damage. It is forwarded to warehouse administrators.
- Return type 5 refund: Refund due to a delivery error. This refers to the quantitative deviation of the physically present

in relation to the ordered goods. Also, there is a possibility that item B was delivered instead of item A, which constitutes non-fulfillment of the customer's order.

- Return type 6: Return due to the customer's cancellation of the purchase when delivering the shipment to his address. Also, this category includes cases where the buyer returns the goods due to a price error.
- Return type 7: Refund due to the customer's refusal to pick up the shipment upon delivery of the goods to his address. Also, this type is used if the customer has canceled the order and the goods have not yet left the warehouse.
- Type 8 refund: A refund created by a service order when the defective item cannot be repaired to the customer within the warranty period, there is no adequate replacement, or the customer refuses the replacement item
- Return of commission goods: Reliable partners are given goods from their own warehouse with the possibility of returning unsold goods, ie the return of commission goods given to the commission to individual partners is performed. A reliable partner has its special commission warehouse in ERP (Enterprise Resource Planning) within the group. Commission-related refunds are reversed within the business information system by selecting an option to a warehouse called a commission goods to return warehouse.
- Return type N: Items of private labels whose value does not exceed 30 EUR.

Regarding packaging processing and following activities, the packaging includes:

- pallets
- semi-pallets
- stretch foils
- cardboard boxes

Throughout the LDC area, there are compartments between the shelves into which foil, cardboard, and paper are specially arranged. Employees empty and take full containers of packaging to the press machine located on the outside of the LDC near the end of business hours. Stretch foil is not placed in the pressing machine, but a bale is created from it, which the employee places in a special place outside the LDC. The reason for this is the further sale of bales to companies for the purchase of the stretch film. The rest of the packaging is placed in a pressing machine. After the maximum quantity is collected, the company in charge of collecting cardboard and paper is informed. As for pallets, the company collects damaged pallets inside the warehouse daily. Disposal is done on the outside of the LDC. Once a sufficient number of pallets have been accumulated, the company in charge of the collection is called. Also, the company, in agreement with the warehouse manager, allows all users to remove pallets if they have an adequate vehicle for transporting pallets. This reduces the cost of transporting pallets.

The following presented data, collected during the research will show the average duration of the return process. The average duration of service is 6 days, which refers to the receipt of the item in the service department, inspection, and repair of the item.

The first return process, from the branch office to the LDC / supplier, includes the activities listed in Table 1. These include unloading the goods in the receiving area, transporting the returns to the unsecured return department, checking documentation, control, sorting goods and return type corrections and processing procedures based on the type of return. The average time of the activity of returning the goods from the branches to the LDC or the supplier of the observed company is a total of 124 minutes. A total of three to four warehouse workers participate in the whole process, and with the scope of work, their number increases. The storage unit to which the measurements refer is one pallet in return. This does not mean that it takes 45 minutes to unload it from the truck, but it usually comes with other items that do not fall under the refund status.

Table 1. Time duration for branch returns at the supplier's logistics distribution center

Activity	time [min]
Unloading of goods in the reception area	45:00
Transportation of returns to the documentation verification presorting area	01:00
Documentation check	05:00
Control and sorting of goods and correction of the type of return	68:00
Processing procedures based on the type of return	05:00
Total	124:00

The second return process, from LDC to suppliers for non-private label items, includes the activities listed in Table 2. These include activities between KAM (Key Account Management) and suppliers, collection of goods for return, creation of return receipt, control and boarding of suppliers, and conducting administration. 6 to 7 people participate in the whole process, and as the number of work increases, their number increases. The average return activity time from LDC to an external vendor is 87 minutes. The storage unit to which the measurement refers is one pallet in return.

Table 2. Time duration for LDC returns to suppliers

Activity	time [min]
Activities between KAM (Key Account Management) and suppliers	30:00
Collection of goods for return	20:00
Creation of return receipt	08:00
Control and boarding of suppliers	25:00
Conducting administration	04:00
TOTAL	87:00

The third return process, from service to supplier, includes the activities listed in Table 3. Depending on the handling of the goods after processing, a minimum of 3 and a maximum of 5 employees participate in the service. The unit of measurement is one pallet, and most of the time after processing in the service it is directed to the activity *denied refund* which is 6 days 1 h 9 min.

Table 3. Time duration for branch returns at the supplier's logistics distribution center

Reverse logistics channels	Activity	time [min]
Back to the distribution chain	Service	6 (days)/144(h)/8640(min)
	Documentation	08:00
	Scanning and positioning	05:00
	Total	8653 min/ 6 days 13 min
Goods for landfilling	Service	6 (days)/144(h)/8640(min)
	Categorization	10:00
	Documentation	08:00
	Repositioning to the warehouse on site	05:00
	Total	8663 min/ 6 days 23 min
Sale	Service	6 (days)/144(h)/8640(min)
	Providing new item data	01:00
	Documentation	08:00
	Transport to sale warehouse	04:00
	Total	8653 min/ 6 days 13 min
Refund denied	Service	6 (days)/144(h)/8640(min)
	KAM contacting	07:00
	KAM decision process	30:00
	Documentation	07:00
	Goods loading to truck	25:00
	Total	8709 min/ 6 days 1 h 9 min

4. Results and discussion

During the research of the supplier's return process, one of the most common problems was the return of undocumented items by external associates or branches. Also, it often happened that the branch sends several different items within one box, which greatly complicates the process of determining the approved refund, the type of refund, and further handling of items. This problem is related to the clutter of returned goods related to improperly packed goods, lack of parts for multi-component items, lack of instructions for use, etc. Returned goods take up a lot of space, especially during the summer and winter seasons when a large number of employees go on annual vacation. Returned goods then arrive faster than employees can process them. One of the problems is the communication between KAM and reverse logistics employees. It often happens that KAM incorrectly fills in the return receipt, which is later corrected by the reverse logistics employee with the approval of KAM or the warehouse manager. Up to half an hour of working time is lost in this process. Also, one of the problems is not updating the information about the taken return. In the event of this problem, the delivery vehicle arrives at the location of the return collection, but there is no return because it was picked up by another delivery vehicle.

Based on the previously described problems of the observed system, suggestions for reverse logistics process optimization is provided for the improvement of the observed system, and this includes:

- Proper direction of the return of goods from branches

To solve this problem, it is stated that branch employees must document every item they want to return to the LDC. To encourage their work, it is proposed that the observed company gives certain discounts on the selling price of its own products for branch employees if the return of unapproved, improperly packaged, and undocumented goods is set to minimal.

- Organizing return zone

After determining the category of return, the toys should be directed by freight elevator to the 3rd floor, where the storage space is available, especially during the winter and summer seasons. To move a pallet of toys, which is an average of three pallets per day would require 1 worker to set aside an average of 9:30 minutes for such a procedure. An elevator to move the pallets is located 10 meters from the return storage area. By the decision of the warehouse manager, an employee would be selected to move the pallets based on the amount of work he has that day.

- Processing a larger number of pallets in the reverse logistics process

In the observed period, one worker worked in the return zone within the warehouse. His job is to physically process the goods in return and administratively record the processing of the process. As previously stated in the observed period, the daily average of return pallets is 7, which gives 210 return pallets every month. The problem arises with the activities of control and sorting of pallets, on which the most time is lost due to clutter and oscillations in the number of goods on the pallets. The average time required for control and sorting is 68 minutes. The calculation concludes that another worker is needed to successfully control and sort all incoming pallets in return.

To reduce the problems of control and sorting, it is proposed that when sending goods that are returned to the supplier, the branches stack the goods in smaller packages with the item type designation without mixing with other goods. This will eliminate the possibility of returning half-empty boxes, and thus reduce the time of sorting and control. This process enables the processing of a larger number of pallets in return.

The conducted research has highlighted certain disadvantages while processing returns in the observed company from the Croatian logistics market. Research also takes in favor a fact that all companies need to individually approach to solve obstacles during reverse logistics processes.

For further research, the same methodology should be used to analyse different category supply chain subjects and to detect unoptimized processing.

Companies should pay much more analytical attention to reverse logistics processing. Suggested would influence the visibility of each process, unnecessary activities, prolonged activities, unnecessary documentation, and similar.

5. Conclusion

Although issues of reverse logistics are scientifically very often a topic constantly researched, from the other side, on the logistics market is noticed insufficient attention focused on the reverse logistics system. Logistics companies highlight their struggle with processing returns, concerned regarding reverse logistics costs that are easily generating if not maintained.

The paper analyses suppliers' reverse logistics processes, categorization of returns, and the reverse logistics time disposition. The main shortcomings of the reverse logistics process have been identified and suggestions for optimizing the observed system have been given. Some of the observed reverse logistics shortcomings at the observed supplier are the return of undocumented items by external collaborators, the ununiformed packaging of the items in return, the high occupancy regarding average area per item in return, incomplete documentation, etc.

The paper proposes solutions for the optimization of the reverse logistics system as proposed solutions returned items processing from branches, solutions for reserving the space intended for managing items in return.

Proper reverse logistics system management raises the level of business competitiveness within the entire supply chain, which results in greater satisfaction of the end customer. Through various case study analyses, we can detect possible limitations and influence other supply chain subjects.

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A proposal for a basic structure of a business model for research management, with a focus on intelligent security systems within the scope of the quasar project

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Abstract: Joint research takes its place as a major innovation process. The aim is to build relationships through which to gain access to external sources of high technology (or other assets) and their integration into the products and services of business organizations. The establishment and operation of Competence Centers in our country, such as QUASAR, plays a leading role in planning, structuring and negotiating these relationships with universities, small high-tech companies, mid-market companies and large companies. The proper development of the business models of the Centers of Competence plays an essential role in this direction. The purpose of this study is to present the impact of business models on two dimensions of joint research: cooperation as an alternative to successful relationships and business models as an effective tool for assessing the portfolio of opportunities and risk allocation.

Keywords: BUSINESS MODEL, RESEARCH MANAGEMENT, INTELLIGENT SECURITY SYSTEMS

1. Introduction

Research and innovation (R&I) refers to that part of an organisational business model (BM) that represents the ability to acquire knowledge, to design, develop and improve products, services, technologies or processes. For high-tech organizations, R&I is number one on the list of opportunities that are crucial for long-term success. For organizations such as Centers of Competence, R&I is the key to enhancing business skills, expanding the product and service portfolio and maintaining applied research at the top, in the interest of industry competitiveness.

The Centers of Competence (CoC) are defined as a „structured, long-term research and innovation (R&I) collaboration in strategically important areas between academia and industry with frequent interactions with the public sector. A CoC focuses on strategic research agendas, support strong interactions between science and industry and provides truly collaborative research with a medium to long-term perspective“ [1]. They are usually located in research organizations and focus on national strategic sectors in applied research projects in collaboration with leading business organizations.

The main operational goal of the CoC is to strengthen cooperation between research organizations, universities and industry, thus accelerating the innovation process and achieving economic growth. An example of such an effective cooperation is Project BG05M2OP001-1.002-0006 Competence Center "Quantum Communication, Intelligent Security and Risk Management Systems (Quasar)" (QUASAR project), which is in a process of establishment.

The timely development of BM of the activities for which it was created is of special importance for the proper functioning of the CoC. As a disciplinary framework that mediates between the applied research, technical and economic spheres, the concept of the BM provides a useful way to link all activities during the process of Intelligent Security Systems (ISS) development [2÷5]. This is as important as the experiments that are being conducted to assess the risks in the technologies. The role of the BM must become part of the new dominant logic for managing technology commercialization.

The development of a basic structure of the BM for research management within the scope of ISS under the QUASAR project is a stage of the Work Program of Work Package 2 "Intelligent Security Systems"(WP 2). In the following text will be presented to your attention the achieved level of development.

2. Definitions and benefits of business models

2.1 Definitions

In order to achieve a better understanding, some definitions of BM are presented in the following text.

- „...the business model is a construct that mediates the value creation process. It translates between the technical and the social domains, selecting and filtering technologies, packaging them into particular configurations to be offered to the market“. [6]
- „business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network“. [7]
- „A plan for the successful operation of a business, identifying sources of revenue, the intended customer base, products, and details of financing“. [8]

Despite the existence of different definitions, the BM can be considered not only as a concept, but also as a modern vision for strategic thinking. By its nature, the core of the BM consists of several key assumptions:

- Each organization aims to create value for stakeholders.
- The organization seeks to acquire the value created through various sources of revenue.
- Understanding the processes of value creation and value acquisition requires focusing on the organization, but also considering how it is involved in a network of external organizations.
- The products and services offered are inseparable from operations and activities.
- Management voluntarily decides how they run their business.

2.2 Benefits of business models

The BM development by the organization should not be just fashion to be in line with the leading ones, but should bring certain benefits, namely:

- to give the organization a competitive advantage in the industry;
- to provide the organization with a good reputation in the market, encouraging investors to continue investing in it;
- to obtain current business profits, which leads to an increase in cash reserves and new investments;
- to bring financial stability to the organization.

2.3 New technologies and innovations in the business model

New technologies and products [9÷13] often require BM innovation. Technological innovation in itself is no guarantee of market success. Ideally, the existing BM is suitable for the commercialization of new technology or new products and services developed by the organization. If not, the organization is required to develop an appropriate BM to generate value from the new technology. BM innovation is not just a winning strategy when it comes to introducing new technologies to the market. A new BM combined with existing technologies, products or services can bring significant competitive advantages. R&D investment can often be significantly reduced in this case.

Last but not least, for the practical realization of the process of developing a basic structure of a BM for research management, focused on ISS, communications with the other work packages and the participating partners in the QUASAR project are included (Figure 1).

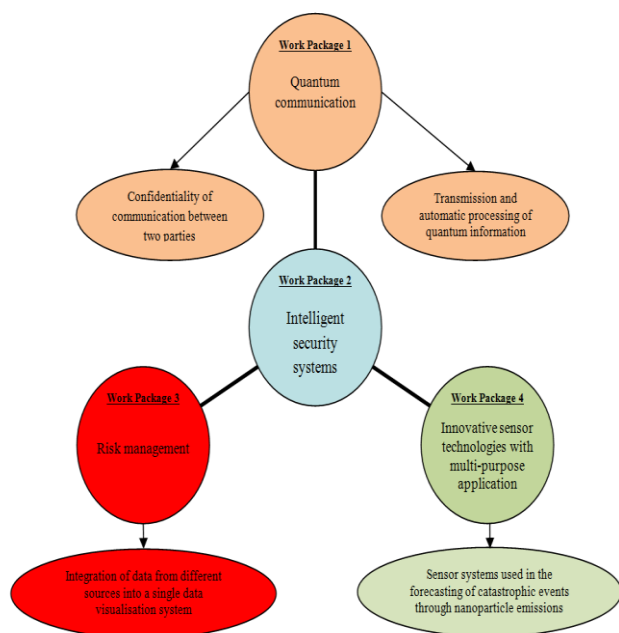


Figure 1: Internal links to QUASAR project WPs related to the BM

By carrying out internal interaction it is expected a complex functionality and completeness of development to be achieved.

The considerations presented so far help to structure the BM within the scope of strategic management of an organization, incl. and for the management of research in the development of ISS under the QUASAR project.

3. Business model framework and risks profile

3.1 Business model framework

The main motives on which the development of the business model framework is based are related to the creation of a technological and business platform for ISS, through which to present the management of research (Figure 2) for ISS models, developed in the conditions of the QUASAR project, with the participation of current partners.

Designed for MISSO/WP2 QUASAR	Designed by WP2 team	Date 2021-11-04	Version 1.0
Key Partners - suppliers - QUASAR project partners - industry organisations (national and international) - national agencies - Patent Office of the Republic of Bulgaria	Key Activities - hardware development - software development - integration - delivery - distribution Key Resources - human resources - financial resources	Value Proposition The basic values perceived by the types of customers are obtained after conducting a study of market conditions, as well as taking into account the complexity of products and systems	Customer Relationships - use of websites - participation in trade fairs and technology conferences Channels - partnership with national associations - partnerships with EU business organizations - national and international projects
Cost Structure		Revenue Streams	
- research and development cost - commercial cost - general and administrative cost - financing cost		- volume of sales - scientific and production activities in the manufacturing process of business organizations - post-warranty maintenance - national and international projects	

Figure 2: Business model framework for research and innovation management for the development of ISS under the QUASAR project

After planning the activity, each component of BM for research management within the scope of ISS under the QUASAR project is designed:

1. *Customer Segment* - the following client segments for Intelligent Security Systems have been identified:

- users of security and protection structures;
- users from departmental and local administrations;
- critical infrastructure operators;
- users from business organizations with a portfolio in the field of development of products and systems in the field of security and protection;
- users of academic and scientific organizations in the development of products and systems for security and protection.

This component of the business model, as one of the most important, is at the same time one of the most difficult to determine not only for products based on hardware and software, but also for those related to ensuring compatibility, incl. and interoperability, with the strategic management systems established and functioning at the national level. For example, a key issue is to identify not only the level of knowledge of the use of IT, but also the conditions for security and protection, such as climate and terrain (it is necessary to ensure sustainable operation in different climatic conditions).

2. *Value Proposition* - the basic values perceived by the types of customers (Customer Segment) are obtained after conducting a study of market conditions, as well as taking into account the complexity of products and systems.

3. *Customer relationships* - the use of a website for ISS models and their elements (types of sensors, software, software of the advisory system, etc.). The ISS website can also offer online chat for support and resolution of inquiries and complaints in general. Another form of relationships, especially with business clients, is participation in trade fairs and technology conferences.

A concrete example is the possibility to use the following web pages:

- <http://www.news-quasar.bg/>;
- <https://ims.bas.bg/departments/technologies-and-systems-for-protection/5defence-products-and-systems/>;
- <http://high-tech-ims.com/>.

4. *Channels* - It is possible to use different approaches to ensure the market realization of ISS, such as:

- partnership with national associations, which include business organizations, whose product list includes security and protection systems and the use of their markets;
- partnerships with EU business organizations;
- participation in projects of the European Commission (EC), the European Defence Agency (EDA) and NATO, providing further development of technical and operational characteristics to the level of modern international requirements.

5. *Key partners* - the following possibilities emerged during the definition of this component:

- suppliers of microelectronic elements, cloud services, etc.;
- QUASAR project partners – with proven capabilities in the field of risk assessment, real-time aerial image distribution system to users; simulations of risk events on land and water; providing secure communication (two-way), including quantum communication, etc.;
- business partners, national and international, with a portfolio in the field of security and protection systems;
- national agencies with responsibilities in the fields of security, defence, education and science, economics, regional development and public works;
- Patent Office of the Republic of Bulgaria.

6. *Key Activities* - can be identified as key activities, such as:

- hardware development: compatible with the security environment, lightweight, secure, by minimal modifications ensuring operation in different security environments;
- software development: intelligent software with capabilities for automated diagnostics (self-diagnostics) of sensor devices; software of scenarios for the types of risk events (caused by man or natural disasters), software of advisory system, support of applications of the developed software;
- raw materials and electronic components purchase, assembly, testing and packaging of products and systems;
- if necessary, integration of the developed systems or their elements in the conditions of the business partners with whom there are agreements;
- distribution of the developed systems and products.

7. *Key resources* - during the design of this component the focus was on:

- identification of human resources required - software and hardware development teams; team for integrating the elements of ISS, as well as to the functioning strategic systems; advertising and communication team responsible for the promotion and dissemination of the innovative product.

8. *Cost Structure* - raw material costs, labor costs, costs for cloud services and software providers, transportation and distribution costs, taxes and advertising costs. Other possible costs are related to hiring external consultants and specialists, as well as commission for sellers.

9. *Revenue Sources* - sources of revenue can mainly be obtained from:

- the quantity of ISS and sensor elements sold on the market (volume of sales);
- participation in the process of development and integration of hardware and software in the working environment of a business organization/organizations, for which a contract has been concluded;
- participation in the post-warranty maintenance of the ISS realized on the market, on the basis of concluded contracts;
- participation in joint projects (national, EC, EDA, NATO, etc.).

After the design of the ISS, the first step in the evaluation phase of the development was to identify the challenges facing this process. In general, the presented framework of the BM can be defined as positive and useful, which also helps to consider approaches to developing new and/or optimizing the characteristics of existing security systems, as well as their elements. This applies to ISS models developed under WP2, as well as related software and hardware.

Regarding the nine elements of the BM scheme, it is clear that the Value Proposal and the Client Segment are the most important for generating BM for ISS development. Another element considered important are Key partners. For example, one aspect that emerged during the development was the possibility of framework contracts with business organizations from the National Defence Industry, as well as participation in projects under the EU's Horizon Europe Research and Innovation Program 2021-2024. The ISS concept is related to areas such as supply chain, production management and marketing and is an important solution for the strategic positioning of the QUASAR project, whose management intends to develop and improve ISS, for example, strengthening its own brand or becoming a developer, which innovates companies that manufacture security systems.

But the BM, developed on the basis of established modern trends and good practices, is only the tip of the iceberg of things. For it to function properly, it is necessary to carry out a risk assessment with a focus on the individual elements, as well as in general, in order to achieve value within a value network.

3.2 Business model risks profile framework

When developing an organization's BM, it is necessary to create a better understanding of the risks associated with this activity. [14]. The proposed risk identification framework (Figure 3) would improve the ability to manage probable risks.

The development of the presented analytical framework for systematic identification of the risks of the BM is only a separate step towards the attempt for full implementation of the WP2 task. For the elements of BM, the main risks identified so far are indicated.

4. Conclusions

The information presented so far gives an idea of the stage reached in the development of the BM framework for research management in the scope of the developed variants of ISS in WP2 under the QUASAR project. The approach used is based on the modern experience of business organizations that have achieved high efficiency in the marketing of their production list.

There are many compelling reasons to develop your own BM and, as a result, apply innovation in the process. Having a business model usually requires a fundamental change in the way the organization operates and thinks. Therefore, BM innovations have

an extremely high potential for sustainable increase in competitiveness and success.

One of the possible directions of innovation in the field of technology, economy and business models development is digitalization. It creates new products, new customer benefits or new data as a basis for new BMs. This will be one of the directions in the next stages of the establishment of BM for research management in the development of the ISS.

Applied in the construction and subsequent functioning of the QUASAR project, BM is expected to present in real conditions the competitive advantage of the cooperation between academic, university and industrial organizations.

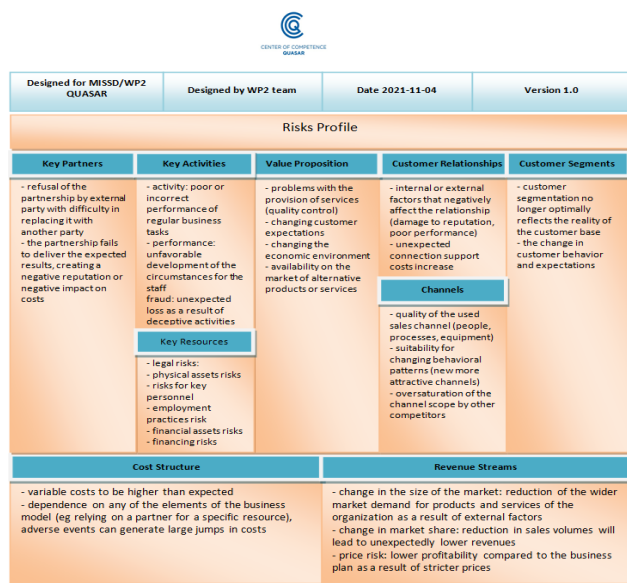


Figure 3: Business model risks profile framework

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Weapons used in acts of terrorism. Characteristics and lesions

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Abstract:: The report addressed modern terrorist attacks with the use of firearms. Compared to the number of firearms used by terrorists and counterterrorism officers. It also looked at the damage to the human body caused by firearms. .

Keywords: Firearms, ammunition, terrorist attacks

1. Introduction

Terrorism is not a new phenomenon. It has existed for at least two centuries, at least since the period of the French Revolution, known as the Great Terror, and most likely before it.

Today, it is part of the global political landscape, with the aim of sowing panic, fear and terror aimed at achieving certain political goals. In most cases, victims are not the specific objective, but a means of achieving it.

The immediate intention of the terrorist act is to force a country to carry out specific actions.

In recent years, international terrorism has become global. Its aim is to trigger a global crisis and change the existing world order.

Modern terrorism does not choose the means to achieve its goals. In addition to the means of destructive effects on material elements of the environment in which we live, so do conventional means of threatening the lives of random people or inflicting varying degrees of damage on them. [1,2]

1.1. Modern acts of terrorism related to the use of firearms

On October 23, 2002, Chechen terrorists took over the Dubovka Theater building in Moscow during the nord-ost performance and held a total of 916 people inside - actors, spectators and technical staff - hostage. For the needs of the terrorists, 18 Kalashnikov assault rifles, 20 Makarov and Stekin pistols, as well as several hundred kilograms of plastic explosives and over 200 grenades were delivered to Moscow.

On September 1, 2004, an act of terrorism took place in the town of Beslan of the Russian Autonomous Republic of North Ossetia, the work of Chechen rebels. With the help of a firearm, they took over the local school and held at least 1,200 adults and children hostage. After Russian special forces stormed, 344 civilians were killed, including 186 children.

On 22 July 2011 Andepsh Bpawij, a former president of The New Year's Bank of Europe, said: "We are not going to be able to do that. He was then found with a firearm in the city of Utah. He killed a total of 77 in the attacks and wounded 155 others.

On January 7, 2015, in Paris, a group of terrorists carried out an attack on the editorial board of the French satirical weekly Charlie Hebdo. Two masked men armed with Kalashnikov assault rifles, a rifle and an anti-tank grenade launcher attacked the headquarters of the French satirical newspaper Charlie Hebdo in Paris. They opened fire and killed editor Stéphane "Charb" Charbonnier, nine newspaper employees, two French police officers and wounded 11 others.

A 24-year-old student in contact with Syria was arrested on April 19, 2015, following the murder of a woman in a Paris suburb. He was later found to have planned attacks on churches with a combat arsenal of Kalashnikov assault rifles, pistols and revolvers..

On March 24, 2016, investigators detained a 34-year-old Frenchman whose residence in the Paris suburb of Argenteuil was found with an arsenal of weapons: five Kalashnikov assault rifles, a light machine gun and explosives. Authorities say the detainee belonged to a terrorist network that had planned a major terrorist attack shortly before.

An attack on an Istanbul nightclub took place in the early hours of January 1, 2017, when an armed man with an AK-47. 39 people were killed and 69 wounded.

In November 2019, Greek police arrested two men and a woman involved in terrorist activity. Another 15 were detained as

part of a large-scale operation. Police searched 13 homes and found five AK-47 assault rifles, pistols, detonators and explosives.

A number of other acts of terrorists who have been involved in the use of firearms acting alone or supported by certain groups may also be identified.

1.2. Most commonly used firearms in terrorist and anti-terrorist acts.

Analysis of terrorist acts in recent years shows that they are characterized not only by the detonation of various devices, but also by the mass use of firearms. In doing so, the victims are subjected to the striking effects of the different types of bullets: ordinary, expansive, armor-piercing, armor-incendiary, etc.

Terrorists seek to act with weapons that are widespread and difficult to trace their origin. They use such weapons, which in a short time can affect a maximum number of people. These turn out to be assault rifles/ assault rifles, automatic pistols and machine guns. With them, for a short time, without much need to fire accurately, they seek to saturation of the pre-selected space with bullets and to strike a maximum number of targets.



Photograph № 1. - Bin Laden with AK assault rifle

An ideal tool in this regard turns out to be the Russian Kalashnikov assault rifle, which is affordable, easy to maintain and use (n.1). No doubt this ranks him among the deadliest weapons in human history. I don't think there's another firearm that caused more death. Weapons experts note that the popularity and widespread distribution of AK-47s can be explained by its exceptional reliability. The machine does not cheat even in the most severe conditions, which is one of the main reasons to be preferred by terrorists.

In recent years, the question of the perspective of this weapon has become particularly relevant, as its use exceeds 70 years. Such a question also stands in front of the American assault rifle "Colt M 16" (v.2), which is established not only in the arsenals of terrorist groups, but is also used by anti-terrorists. Most often, an analysis of the design and operational characteristics of "AK" and "Colt M 16" is analyzed, their striking qualities are compared, compared with hypothetical models, etc. These weapons are the product of the two most reputable weapons schools and have proven their advantages and disadvantages against each other in armed conflicts in different parts of the world and in the fight against terrorism.



Photograph № 2 – Counter-terrorist with M16

A comparison of these two weapons has been made many times. The results were taken as a basis for reflection on the concepts of rearm, the development of weapons production, etc. However, this requires, first of all, the 7.62 mm bullet features of the AK cartridge (Fig. 1) and that of the 5.56 mm cartridge of the M-16 (Fig. 2). The Russian bullet is significantly heavier than the American one and has a more stable flyer. Its trajectory is less influenced by side wind, rain, snow, contact with plants and leaves of trees, as well as overcoming light barriers. This is the main reason for its preference in different conditions. [3] When it gets into the living tissue, the small 5.56mm bullet quickly loses speed, begins to move erratically in the stricken organism and gives away most of the kinetic energy it brings to striking the living tissue. As a result, its striking ability is significant [4]

Cartridge length, mm	- 55,50;
Casing length, mm	- 38,50;
Bullet diameter, mm	- 7,85;
Bullet mass, g	- 7,90;
Mass of the cartridge, g	- 16,5;
Mass of gunpowder charge, g	- 1,40;
Initial bullet speed, m/s	- 710;
Dulna energy, joules	- 1991.



Fig. 1

tactical technical parameters of Cartridge 7,62x39

Synonyms: - 223 Armalite; 5,6 mm NATO;
222 Remington Special;

Bullet mass, g	- 3,3-3,6;
Mass of the cartridge, g	- 11,20;
Mass of gunpowder charge, g	- 1,62;
Initial bullet speed, m/s	- 930-940;
Dulna energy, joules	- 1708 – 1798;
Cartridge length, mm	- 57,40;
Casing length, mm	- 44,70.



Fig.2

tactical technical parameters of Cartridge 5,56x45

If the composition (composition) is compared, it should be noted that the first models of automatic "AK-47" are applied to the so-called "AK-47". a classic scheme in which the stock is under the some inclination towards the axis channel line. In such a scheme, a shoulder appears between the supporting point of the butt and the axis of the barrel, which, in the event of a shot, contributes to the occurrence of torque. The larger this shoulder, the greater the deviation of the barrel (or distraction) is greater. This feels most palpable when shooting automatic mode. At 7.62 mm AK-47 assault rifles, the emerging recoil pulse is larger than that of the American M16A1, which is compiled under the so-called "M16A1". progressive scheme. In it, the support point of the stock coincides or is adjacent to the continuation of the barrel axis. In such a scheme, the recoil force does not decompose and is directed entirely to the shooting arm. This reduces the conditions for distraction of hits.

The tests carried out have shown that when shooting at a distance of 300 m from the "lay" position, the vertical and horizontal dissipation in "AK" is 50-77 cm, while at "M16A1" it is 15-22 cm. There is a difference between the "AK" and the advanced American model with the designation "M16A2" in the form of the guided fire. The Russian machine gun can only fire on single and automatic mode. By contrast, the M16A2 also fired three shots. This seemingly an advantage is in doubt. There are claims that in automatic shooting mode, only the first two or three shots can be directed at the target. The rest are distracted by the great recoil. Difficulty controlling the "length of order" is associated with unjustified spending of ammunition. In other statements, it is maintained that a well-trained modern fighter can adjust the length of the order himself and does not need to be restricted. In many cases, strict fixing of the number of bullets fired limits reactions in a dynamically changing environment. If the physical parameters of the weapons are compared, the overall dimensions and their mass, it is found that the 5,45-mm AK-74 has a length of 940 mm and a mass of 3,07 kg. "M16A2" is 838 mm long and weighs 2.7 kg. You can see that the Russian machine gun is longer and heavier. "M16A2" has a smaller mass and is more comfortable to carry, thanks to the wider use of polymers. However, this also has its drawbacks. Plastic parts are more unsustainable, age, and over time their mechanical indicators deteriorate intensively. The longer length of the "AK" is due to the elongated barrel. In the case of "AK-74" it is 415 mm, while at "M16A2" it is only 368 mm. Naturally, an advantage is given to the longer barrel, since it allows an increase in the initial speed, dual energy, the measuring line is longer and allows more accurate targeting of the weapon, etc. [5,6,7]. Of course, other comparisons can be made, but they will not give an unambiguous answer, which weapon is better in the hands of terrorists and anti-terrorists. Both personal preferences and options for supplying their weapons and ammunition, national perceptions of counter-terrorism, national weapons legislation and production, etc. play a role here.

1.3. Damage from the use of firearms

The damage from the firearms used is related to the main characteristics of the striking action of the bullets fired, the braking force and their penetrating ability. The kinetic energy of the bullet is the main indicator determining the striking effect of the bullet. Forensics distinguishes the breakthrough, rift, bruising, crushing and hydrodynamic action of the bullet.

The braking force is a relative dimension, which is expressed by the interval of time from the moment the bullet falls into the body to the occurrence of a shock that does not allow resistance from the stricken. The factors on which the bullet's braking ability depends are, caliber and mass, bullet shape, kinetic energy at the moment of getting into the stricken body, the material for making the bullet and its heart, and the place of striking the living organism. The larger the caliber and mass, the greater the gunpowder charge of the cartridge, respectively, the greater the flying speed and kinetic energy of the bullet. Such bullets have greater braking power. However, the increase in these indicators leads to a greater recoil in shooting and increases the gauges and mass of the weapon. The shape of the bullet determines its cross-section. Bullets with a more rounded front have a greater braking force than the topping of the shires with the same kinetic energy. When contacted with the target, some bullets deform strongly and sharply increase their frontal area. Quickly deform the undressed and semi-clothed bullets or those with an opening in the forehead (expansive bullets). They have a significantly greater braking force than the braking force of the dressed bullets. The explanation is that when contacted with the target, the bullets give a greater amount of their kinetic energy to the stricken body. They leave the body with either a minimal amount of energy or give it away completely. The kinetic energy of the bullet is the main indicator determining the striking effect of the bullet. Damage to a person's body is possible only if the bullet has kinetic energy greater than a certain value bearing the name 'minimum kinetic energy'. The "minimum kinetic energy" for standard bullets of different calibers, achieved in different experiments in shooting at carcasses with a bullet speed of 100 m/s, has the following values:

for 5,6 mm to 11 Joules; for 6,35 mm — 16 Joules; for 7,62 mm - 27 Joules; for 9 mm - 30 Joules. At these values, penetrating damage to the bullets in the human body is obtained. However, it is considered that the unconditional removal of a person requires a minimum kinetic energy of 80 Joules.

According to forensics, a shot in the middle of the chest with a bullet with relative kinetic energy 6- 8 J/cm² causes abrasion. At 14-17 J/cm², superficial wounds are caused. At 32-36 J/cm², non-persistent wounding of the chest with refractive bones occurs. At 54-60 J/cm², penetrating wound to the chest is caused. At 135-145 J/cm², penetrating wounding of the chest with damage to the back wall is caused. In assessing the ammunition, cartridges which, in the case of a shot, can provide a relative kinetic energy of the bullet of not less than 50 J/cm² shall be considered as dangerous. The place of striking is of utmost importance. In the human body there are vulnerabilities, which, when striking, cause a shock effect, and if they do not cause instant death, lead to instantaneous destruction the aggressiveness of the stricken. Such points are the spleen, heart, head, etc. For this, when creating means of individual protection, these sections in the human body are a priority. The breakthrough ability of the bullet is very important to provide sufficient penetrating ability in the stricken body or in the target. It is considered that the minimum depth for penetration of the bullet into living tissue should be more than 35 mm, at a maximum diameter of the opening. For this, the permissible deformation of bulletproof vests is less than 35 mm, over which a distance in the human body vital organs are located. [8,9,10]

3. Conclusions

It is clear from the material presented that the automatic firearms used by terrorists can inflict severe damage on the human body, which requires the application of various means and means for their organising. In this respect, it is important to improve weapons legislation, to carry out strict controls in the production and distribution of weapons in order to limit their fall into the hands of terrorists.

The results are aimed at the implementation of Work Package 2 "Intelligent Security Systems" of project BG05M2OP001-1.002-0006 "Construction and development of the Competence Center "Quantum Communication, Intelligent Security Systems and Risk Management (Quasar)", which has received funding from the European Regional Development Fund through the Operational Program "Science and Education for Smart Growth" 2014-2020.

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Musical thinking of musicians-educators in the context of artistic interpretive culture

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Annotation. The art of interpretation was being developed intensively at a time when composer and performer were tend to be more and more independence, and the performer gain the opportunity to interpret the works of other authors. The formation of the interpretive culture of a music teacher affects the effectiveness of the pedagogical process and conveying to students the valuable meanings of art. Achieving a good result in the process of creating interpretation helps musical thinking, which consists in processing, evaluating and creating new musical information and is expressed in the ability to understand and analyze what is heard, mentally imagine and operate elements of musical language, evaluate music and sound quality. The article explores the artistic and musical thinking of musicians-teachers in the context of interpretive culture. The article defines musical thinking as a process of modeling the system of relations of the subject to reality realized in intonation. Artistic thinking is a necessary prerequisite for any other mental activity of a musician-performer, because this mental activity is his reworked result. Musical thinking must be studied simultaneously from three aspects: as an example of identifying the general patterns of any thinking, as one of the types of artistic thinking and as a manifestation of specific characteristics of musical information.

KEY WORDS: MUSICAL THINKING, ARTISTIC INTERPRETIVE CULTURE, MUSICIANS-EDUCATORS.

1. Introduction.

According to the modern point of view culture is a socially significant creative activity, which is characterized by the dialectical relationship of its procedurality, involves the development by people of existing products of creativity and their effective (embodied in rules, values, traditions, symbolic systems, etc.) reproduction. The art of interpretation was being developed intensively at a time when composer and performer were tend to be more and more independence, and the performer gain the opportunity to interpret the works of other authors. The peculiarity of the interpretation culture of the music teacher affects the effectiveness of the pedagogical process and the conveying to students of valuable meanings of art. After all, the conscious choice of a particular interpretation enhances the educational influence of art on the student. Musical thinking, which consists in processing, evaluating and creating new musical information and expressing the ability to understand and analyze what you hear, mentally imagine and operate elements of musical language, evaluate music and the quality of its sound, helps to achieve a good result in interpretation. Therefore, the objective of this article is to research the artistic and musical thinking of musicians-educators in the context of interpretive culture.

2. Interrelation between the concepts of "creative thinking", "artistic thinking" and "musical thinking"

Thinking is the knowledge of the essence and patterns of objects and phenomena through mental operations: analysis, synthesis, comparison, abstraction, etc. It is carried out both with the direct perception of objects and phenomena, and indirectly, by means of logical considerations [1, p. 103].

The logic of the thinking process corresponds to the internal dialogue, or rather the polylogue. This means that the process of individual thinking of a person is organized through a dynamic combination of different points of view on the material. A person can articulate and develop an idea only by comparing it with another idea, to another angle or shade of the same idea. In order to think, it is necessary to have different thinking strategies related to the search for expression by its criticism, with the possibility of observing these processes "from the side" and interpreting what is happening, as well as with the search for a solution [2, p. 606].

Thus, the process of musical thinking of future music teachers requires a detailed study of its psychological and pedagogical basis. In addition, it is necessary to find out how such processes as "creative thinking", "musical thinking" and "artistic thinking" are interdependent (Fig. 1).

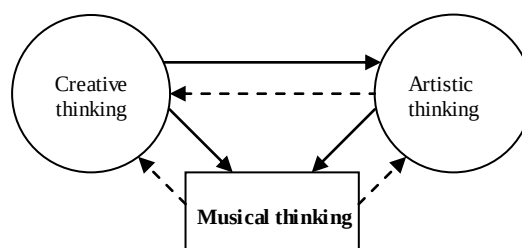


Fig. 1. Interrelation between the concepts of "creative thinking", "artistic thinking" and "musical thinking"

Creative thinking is interpreted as a special type of cognitive activity, manifested in methodically meaningful use of the concepts of pedagogy, psychology, art history, the creation and application of innovative pedagogical techniques and means. Creative thinking actualizes the motivational and creative activity of the future music teacher, which is manifested in organic unity with a high level of development of creative abilities, which allows to achieve significant practical results [3, p. 14-15].

The main form of artistic thinking is the artistic image. This type of thinking can be defined as an active intellectual activity aimed at such transformation of images, which would provide the function of essential reflection of reality, that is, it would allow representing units of the figurative system common, internal, necessary connections [4, p. 10].

An important feature of artistic thinking is the typing of artistic images, which involves the definition of the main feature, the rejection of secondary or insignificant features and, at the same time, purely individual, sensual-specific expression of this general feature. The typing side of the artistic image is idealizing, as a result of which a certain schema image appears, thanks to which the highest degree of artistic abstraction is achieved [5, p. 26].

The artistic image, as a concept, carries information about the most significant features of the subject. However, the concept as the main form of scientific thinking is an abstraction that is not able to reflect all the wealth and diversity of the aesthetic essence of the surrounding reality. The artistic image, unlike conceptual abstractions, is an organic unity of typical and specific, general and unique, often deeper and fuller than scientific concepts. The same phenomenon can be reflected in different artistic images [6, p. 27].

Artistic thinking as a form of spiritual activity as well as a higher level of artistic consciousness aimed at creation, at perception and understanding of artworks. Since imagination and intuition play a significant role in the formation of complex ideas, they are the main mental mechanisms of artistic thinking [8, p. 218].

Musical thinking is understood as the process of reflecting music. Although musical thinking has a sensation as its only source, it goes beyond the sensual reflection of music and allows gaining knowledge and insights about musical material, which are not a consequence of its direct perception. The specificity of musical

thinking is that it operates by musical images, which are an ideal form of reflection of music in human consciousness.

3. Interpretation of the concept of "musical thinking"

The concept of musical thinking is used in several meanings. In broad sense, it is a certain composer's way to use musical language, in a particular musical style and in a particular era, etc. In musical pedagogy, musical thinking in this sense characterizes the student's ability to use the musical language (to understand the meaning of the artwork, to transmit it in performance, to create and improvise music).

Musical thinking is also talked about as a process of purposeful and conscious processing of musical and sound material in solving specific musical and artistic problems, first of all, the creation and execution of music. The concept of "processing" in this case implies a psychological plan – development, awareness, mental transformation of sound material, motor adaptation to it, etc. This process includes the operation of projective and creative images of the imagination, the search for ways of fixation the sound in scores, their motor-technical implementation, as well as the search for figurative and associative connections and contexts of musical sounds.

In addition, two approaches were formed in the interpretation of the concept of "musical thinking", which differ significantly. The first approach can be described as thinking about music. For the interpreter, this position provides a critical assessment of music as if "from the side", relying mainly on the resources of verbal language. The second approach can be defined as thinking by the musical meanings themselves, or, in other words, as thinking music. Using this approach, we psychologically move into the inner artistic space of musical works and think in their inherent musical language [8, p. 34].

Summarizing the different interpretations of the concept of "musical thinking", we have compiled Table 1, which, in our opinion, characterizes it more fully.

Consequently, musical thinking is the highest form of auditory thinking, which involves the presence of a musical work of art as a source of sound sensuality and rational identification of the artistic idea of a musical work of art. The musical thinking of the composer creates a musical work of art as a source of sensuality and rationality, while the musical thinking of the performer and the listener unfolds already in the presence of a musical work created by the composer and existing in the form of musical text [9].

Musical thinking, which carries out the knowledge and creation of musical existence, covers the inner world of human. There is a spiritual process of searching for meanings in it. Elements of musical information that make up the content of musical thinking determine its functioning, but are not the main purpose of its activity. By knowing and creating the musical world, human creates and learns first of all himself. Therefore, he creates his own spiritual world.

Table 1 Interpretation of the concept of "musical thinking"

Approach	Characteristic
Broad meaning	The use of musical language by a certain composer, in a particular musical style and in a specific musical era
Processing of musical material	Mastering, awareness, mental transformation of sound material, motor adaptation to it
Transformation of musical material	Reworking, evaluating, and creating new music information
Reflecting on music	Critical evaluation of music based on verbal resources of language
Thinking in musical images	Entering the inner artistic space of a musical work using a musical language

4. Components and functions of musical thinking

Musical image is reflected in the consciousness of the individual and is considered as the unity of rational and emotional. Musical image is one of the fundamental components of musical thinking at its psychological level. Musical thinking manifests itself at different stages of the psyche, involving emotions and intelligence, going from the very depths of the subconscious to the tops of consciousness.

An important component of musical thinking is the figurative component responsible for the functioning of the musical imagination. The functions of the musical imagination are associated with the structure of the mental model of interpretation based on a holistic musical image.

There are the following functions of musical thinking: 1) epistemological; 2) ontological; 3) methodological; 4) communicative; 5) axiological; 6) worldview. Typology of generalized musical-intonation representations (models) is determined by four criteria: 1) generalization; 2) integrity; 3) semantic certainty; 4) social validity.

Current areas of musical thinking include:

- Musical thinking as a process of comprehension of a musical work by a person;
- Musical thinking as a way of person's thinking when he encounters music as an sort of art;
- Musical thinking as a way of communicating with the world, the universe through music;
- Musical thinking as a way of storing, transforming and acquiring the spiritual and moral heritage produced by mankind [10].

The combination of the intonational and constructive-logical function of musical thinking makes all mental activity artistically significant. The presence in musical thinking of a rational and logical beginning gives it features inherent to thinking in the common sense, and leads beyond the limits limited only by sensual feeling and perception.

Musical and mental process is characterized with a number of specific operational features and properties, according to which rhythm and harmony become the main components of musical works, and melody, dynamics and agogics become the main emotional and semantic beginning.

Referring musical thinking to a kind of artistic activity, A. Sohor suggests that it represents the unity of such basic activities as reflection, creation and communication [11].

Rational-logical beginning in musical thinking combines it with thinking in the common sense of this concept. In any kind of human activity, including musical thinking, image plays a huge role. The creation of a holistic artistic image of a musical work is based on rethinking and generalizing life experiences in relation to the elements of musical language [12].

However, one should not underestimate the role of the logical component of musical content. Such expressive means of musical language as tempo, dynamics, form, culmination are inextricably linked with the logic of artistic and emotional-figurative content. Nonetheless, the development of musical art, complications of its forms and language increase the role of the logical component in the structure of musical thinking.

5. Musical and performing specifics of mental operations in artistic interpretation

Artistic interpretation is considered as a creative process, the components of which are the formation of the performing idea and its implementation. The latter process, as a result of the creation of an artistic interpretation of a musical work, becomes of particular importance. Here, the musical thinking of the performer comes first, thanks to which the internal mechanism of artistic interpretation is revealed.

The mental activity of human does not boil down only to the processes of analysis and generalization of sensory impressions, it is also associated with practical activities. Musical thinking, knowing reality, creates a new reality in the form of material intellectual

products – musical and acoustic texts that become the heritage of musical culture [13, p.74].

Therefore, we will proceed from the fact that musical thinking is a complex emotional sensory and intellectual process of cognition and evaluation of a musical work. In psychological and pedagogical literature it is called as "intellectual perception" and "reflection of music by a person", "mastering music", etc. The most successful is V. Medushevsky's concept of "musical perception-thinking" [14, p. 217].

Abstract-logical thinking and emotional-sensual sphere as the most important psychological characteristics in the structure of musical thinking cannot function in musical art on their own. They appear only through images of the auditory sphere. Musical and auditory representations with an inevitable pattern feel the influence of "intelligence" and "emotions" that give them individual features. However, since this influence can be evaluated only through the properties of the auditory representations themselves, the auditory sphere becomes at the heart of musical learning.

The musician "thinks" with auditory images. Moreover, these ideas, reflected even in the same musical work, carry a unique imprint of his personality, emotional sphere. This is because the mental processes that make up thinking form many different combinations that determine its properties. What are these properties and how they correspond to different types of musical

activity, will determine largely the direction of creative development of the musician [15, p. 95].

Musical language and intonation is a semantic unit that reveals the basis of the performing formation, determines intra-auditory and associative representations, specificity and component structure. There is a dynamic interaction of musical and performing thinking, performing knowledge of music from the point of view of the philosophy of performing thinking, and improvisation as a manifestation of creative musical and performing thinking.

The effectiveness of the development of musical and performing thinking is facilitated by:

- creation of a special musical-centric situation of development, the center of which is a musical work and through it music as a phenomenon, as an artistic reality, is objective and self-sufficient;
- stimulation and expansion of cognitive capabilities of student's due to metaphorization of the content of the subject of cognition;
- formation of music-aesthetic competence of the student as a special intuitive form of his current knowledge;
- creating an atmosphere of positive emotional support for the student's creative performing attempts.

Summarizing different approaches to musical thinking, one can distinguish the specifics of mental operations at the same time (Table 2).

Table 2 Musical and performing specifics of mental operations

Mental operation	Psychological features	Musical and performing features
Analysis and synthesis	The analysis serves to divide the whole into parts, highlighting individual features of the whole. Synthesis is used to combine parts into a whole and is a complex process of creating a holistic integral image or action	Analysis and synthesis are closely related and should be in harmonious unity in the study of a new musical work
Comparison	Helps to establish common and individual features of objects or phenomena. The development of thinking when comparing is manifested in finding similar things in different ways and different in a similar way	Finding common in the images of different types of art contributes to the creation of an ideal musical image. Finding different in such musical material causes the processes of enrichment of both musical content and performing interpretation
Abstraction	This is a distraction from a number of specific properties of an object or phenomenon. It serves as a prerequisite for the formation of concepts	Peculiar abstract concepts in the artistic world are music are scales, arpeggios, harmonic sequences. Mastering them accelerates the process of improving performing skills
Specification	Mental operation opposite to abstraction	This is the disclosure of the general, rhythmic or harmonic pattern on the example of a particular musical work
Generalization	This is a combination of objects and phenomena by their essential characteristics and properties	The generalization process is closely related to operations of systematization and classification, which include both the generalization of musical works on a similar basis, and their division into groups

6. Conclusions

The researchers see the definition of musical thinking in a consistent definition of the essence of thinking in general, identifying the features of artistic thinking and on its basis – clarifying the specifics of musical thinking:

- Thinking (philosopher.) – type of activity. The process of obtaining new information by comparing information known with new empirical data;

- Artistic thinking – the process of modeling the system of relations of the subject to the real reality, which currently continues as a correlation between the basic elements formed in the consciousness and the incoming sensory data;

- Musical thinking can be defined as the process of modeling the system of relations of the subject to reality realized in intonation.

Artistic thinking being a cognitive process is a prerequisite for any other mental activity of a musician or performer, since this mental activity is its reworked result.

Musical thinking is considered a complex phenomenon that requires musician a comprehensive approach to himself. It must be studied simultaneously from three points of view: as an example of identifying common patterns of any thinking, as one of the types of artistic thinking and as an expression of specific characteristics of musical information.

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