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Submission date: 12-Oct-2020 01:11PM (UTC+0700)
Submission ID: 1412609456
File name: of_Bioethanol_Content_from_Coconut_Fiber_Waste_and_Mengkudu.pdf (2.06M)
Word count: 124746
Character count: 643190

Journal of Computational and Theoretical Nanoscience
Vol. 16, 5224–5227, 2019

RESEARCH ARTICLE

The Effect of Time and Volume Stater of Bioethanol Content from Coconut Fiber Waste and Mengkudu

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Mengkudu and coconut fiber are a plant which frequently find in Indonesia. Mengkudu is a plant that has many advantages and carbohydrate content as 51,67%. Coconut fiber has high enough cellulose content as 43,44%, with high carbohydrate content and high cellulose content they can be utilized as basic ingredient in the making of bioethanol. The purpose of this research is to determine the best condition in the process of making bioethanol from them. Bioethanol was made by fermentation which was helped by bactery, that was *Saccaromyches cerevisae* or often known as bread yeast. The results of this research were obtained fermentation time and volume of the stater used in making bioethanol from mengkudui fruit in order to get the best content bioetanol is in 60 hours using a stater volume of 10% which produces 6.26% bioethanol, while for the manufacture of bioethanol from waste Coconut coir is at 72 hours using a 6 gr volume of starch which produces bioethanol 13.80%.

Keywords: Mengkudu, Coconut Fiber, Bioethanol, Time Variety, Stater Volu, Saccaromychescerevisae.

1. INTRODUCTION

The increase of human population and the develop of industry are directly proportional with the increase of dependency number with oil fuel. In 2018, the total production of oil in Indonesia was only 680.000 barrel per day (bpd), while the total consumption was bigger as 1,27 million bpd. Besides that, the alternative of world oil in Indonesia had decreased from 2007 as 8,4 billion bpd to 7,72 billion bpd at 2010 [1]. Decrease Oil reserves are caused by two main factors namely years of oil exploitation and lack of exploration or geological surveys to find the latest oil reserves. This situation causes fossil fuel reserves such as petroleum for national reserves is predicted to only remain available for the next 23 years in 2007. So in 2013 our petroleum reserves remain 17 years from now [2]. Therefore, it needs an alternative material as a substitute of world oil in the making of fuel. Bioethanol is one good alternative and can be used as a fuel in order to solve energy problem right now. Bioethanol production in various countries has been carried out using raw materials derived from agricultural and plantation products [3]. Bioethanol used as fuel in the form of a mixture of bioethanol with besin is bioethanol with 99.5% or more ethanol content or bioethanol [5]. Anhydrous bioethanol used as a fuel is more popularly known as FGE [6]. Bioethanol is an alcohol compound with a hydroxyl group (OH), 2 carbon atoms C, with the chemical formula C_2H_5OH, which is made by sugar fermentation using yeast [7]. It can be produced from materials that has a rough fiber with high carbohydrate and cellulose fiber. Bioethanol can be produced from materials containing crude fiber with high carbohydrate and cellulose fiber. Cellulose is a natural resource that is found in nature, and has the potential to produce useful products such as glucose, ethanol, and also fuel [9]. Coconut fiber waste has high cellulose fiber as 43,44% and mengkudu has high enough starch as 51,67 gr [8]. The most important part of the linocellulosic is cellulose wrapped in lignin with a strong bond [10] the compositions od coconut fiber and mengkudu are as follows. This is a chemical composition of fiber coconut.

The purpose of this research is to determine the best condition in the process of making ethanol using mengkudu and coconut fiber waste with by considering fermentation time variety and stater volume in order to produce good bioethanol. Ethanol or ethyl alcohol is a chemical found in alcoholic or alcoholic beverages, this material is widely used as a solvent in the pharmaceutical and food and beverage industries. Ethanol is colorless and tasteless, but has a distinctive and flammable odor (see Tables I and II). Besides being used in food and drinks,

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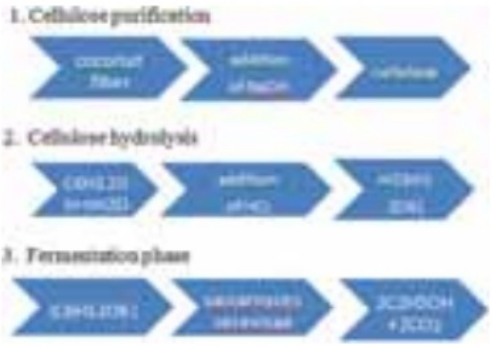
1546-1955/2019/16/5224/004 doi:10.1166/jctn.2019.8590

Table I. Chemical composition of coconut fiber [4].

Contents	Amount
Kalori (kal)	167
Vitamin A (IU)	395,83
Vitamin C (mg)	175
Niasin (mg)	2,5
Tiamin (mg)	0,70
Besi (mg)	9,17
Calsium (mg)	325

ethanol can also be used as a fuel for motor vehicles; petroleum substitutes [11].

The making of ethanol from coconut fiber has 3 phases [12]:



The making of Mengkudu has 3 phases:

1. Hydrolisis phase
2. Alcohol fermentation process
3. Result analysis.

In previous research [13] got the result in making of bioethanol using fermentation, role of microorganism is very important and usually microorganism that is used to fermentation has some requirements as follows:

1. It has the ability to ferment the appropriate carbohydrate fast
2. It tends to form flacculation and sedimentation
3. It has stable genetic (not easily mutated)
4. It sensitives on high alcohol (between 14–15%)
5. It has fast regenerate character. Then, previous research [14] in purification of cellulose needed alkali pretreatment using NaOH with the 1:4 ratio of material ripe solvent and heated up for 2 hours with 100 °C.

Table II. Nutrient content compositions 8 in 100 gr mengkudu [8].

Contents	Perscent (%)
Selulosa	43,44
Hemiselulosa	0,25
Lignin	45,84
Air	5,25
Abu	2,22

According to Suharty lignin is more soluble in NaOH than Alk-benzen, hot water and cool water. Furthermore, the making of bioethanol from Siwalan fiber had obtained the best time fermentation that was 240 hours with addition of 9 grams nutritient $(NH_4)_2HPO_4$ and 1 gram yeast tape.

2. RESEARCH METHOD

Research method in the making of bioethanol from coconut fiber wasye and mengkudu as follows:

1. Flow Diagram of making a Bioethanol from coconut fiber waste

2. Flow Diagram of making a Bioethanol from Mengkudu

Materials that were used in the making of Bioethanol from coconut fiber, were: HCL, NaOH, tape yeast, Aquadest, and coconut fiber.

While materials that were used in the making of Bioethanol from mengkudu, were: Mengkudu±250 gr

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(5 Kg), Aquadest 1000 ml, HCl 20 ml, KH_2PO_4 5 gr, NaOH 10 ml, and Saccharomyces cerevisiae.

Tools that were needed were erlenmeyer, glass, stirer, sample bottle, analytical scale, oven, digital weigher, hot plate, spatula, pumpkin, arlojy glass, magnetic stirer, volumetric pumpkin, and blender.

3. FINDINGS AND DISCUSSION

The data was got from this research the making of bioethanol from mengkudu and coconut fiber waste with time variety and stater volume, as follows:

From the result of table date was the ratio from fermentation time variety and volume stater level was on impact of percent yield bioethanol.

In Figure 1 above showed that the longer fermentation time was given the greater %yield bioethanol was produced, yet at the time of 72 hours had decreased alcohol level when it was given volume stater 12%. The result of this research was appropriate with fermentation time from the best mengkudu was at the time of 60 hours using volume stater 10% that was produced 6,26% Bioethanol.

In Figure 2 above the effect of stater variety and fermentation time in making of bioethanol from coconut fiber waste, showed that the longer fermentation time was given the greater %yield was produced, yet there was a decreased alcohol level at the time of 80 hours time fermentation. The greater volume stater was given the greater alcohol level was produced yet there was a decreased alcohol level at 7 gr volume stater. The best alcohol level which was produced by coconut fiber waste was at the time of 72 hours fermentation and using 6 gr volume stater that was produced %yield Bioethanol as much as 13,80%. Moreover, the decreased of bioethanol level on fermentation time for 72 hours of mengkudu and 80 hours of coconut fiber waste caused by the total of microbes more decreased that would went to death phase because bioethanol that was produced became more while nutrient became less. Besides, bioethanol that was produced had oxidized more became [15]carboxylic acid [15]. Saccaromyches cerevisiae would use glucose as carbon source on processing of bioethanol production. The more addition of Saccaromyches cerevisiae the greater alcohol yield

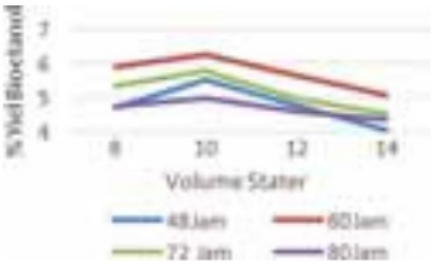

Fig. 1. The relationship between fermentation time and volume stater on %yield bioethanol from mengkudu.

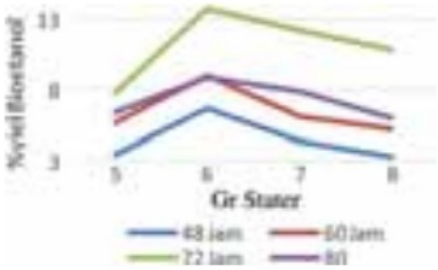

Fig. 2. The relationship between time fermentation and gr stater on %yield bioethanol from coconut fiber waste.

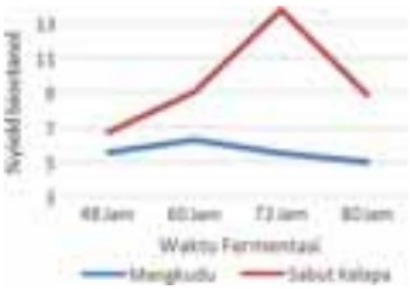

Fig. 3. Comparison of bioethanol yield obtained from noni fruit and coconut fiber.

that was produced from sweet potato starch [16, 17]. It showed from the research result above that maximum point at 10% and 6 gr, yet at 12% stater level and 7 gr there was decreased caused of the total of microbes became more while nutrient became less.

In Figure 3 above, the graph shows the %bioethanol yield from coconut fiber at the maximum point at 72 hours of fermentation, which is 13.80% greater than the %bioethanol yield produced by noni fruit at a maximum of 60 hours at a maximum of 60 hours producing only 6.26% bioethanol.

4. CONCLUSION

The effect of fermentation time and volume stater variety was really influental on determining %yield of bioethanol that would be produced. To produce the best %yield of bioethanol from mengkudu was at the time of 60 hours fermentation that using 6,26% bioethanol, and the making of bioethanol from coconut fiber waste was at the time of 72 hours fermentation using 6 gr volume stater that would produced bioethanol as much as 13,80%. Among mengkudu fruit or coconut fiber, the best material used to become the raw material for biethanol is coconut fiber, which produces bioethanol at a maximum point of 13.80%.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5228–5232, 2019

RESEARCH ARTICLE

The Effect of Type and Concentration Yeast with Fermentation Time and Liquifaction Variations on the Bioethanol Concentration Resulted by Sorgum Seeds with Hydrolysis and Fermentation Processes

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Sorghum is one of the plants that can be used as raw material for making bioethanol. Sorghum has seeds with a starch composition of 73.8%, which is potential as a raw material for making bioethanol. Sorghum starch can be converted into bioethanol through the hydrolysis process (the process of converting carbohydrates into glucose) which consists of liquefaction and saccharification processes and is followed by a fermentation process. The hydrolysis method is carried out enzymatically. In this study alpha amylase and gluco amylase enzymes were used with various types of yeast including *Saccharomyces cerevisiae*, Rhizopus oryzae, Acetobacter xylinum, Mucor sp, and Aspergilus niger which varied with liquefaction temperatures including 80, 85, 90, 95, and 100 °C. Obtained the most optimal yeast is *Saccharomyces cerevisiae* with an optimal temperature of 95 °C resulting in a bioethanol concentration of 4.3%. After getting the optimal yeast and temperature, the fermentation step of the two variables is used in the next step. In the fermentation process, variations of yeast concentration and duration of fermentation were used, the optimum yeast concentration was at 2.5% with 48 hours of fermentation resulting in bioethanol concentration of 11%.

Keywords: Bioethanol, Hydrolysis, Fermentation, Sorghum, *Saccharomyces cereviceae*.

1. INTRODUCTION

Energy is an important aspect of daily life. Energy needs always increase with the rapid rate of population growth and the rapid industrialization of the world which results in the depletion of large amounts of energy reserves, especially fossil energy, which is the world's main energy source. Global economic recovery driven by high economic growth in Asia is accompanied by an increase in energy demand for industry and consumption, contributing to the increase in world energy prices. The proportion of petroleum as the main source of energy currently reaches 40% of the world's total energy demand, but reserves continue to decrease. In 2011 world oil demand growth reached 1.7%. The increase in production which only reached 0.9% and the diminishing global petroleum reserves caused countries including Indonesia to be vulnerable to the risk of the world energy crisis. Petroleum reserves are currently proven in Indonesia to be 9 billion barrels, with an average production rate of 0.5 billion barrels per year, and are expected to run out within 18 years. Gas reserves are estimated at 170 TSCF (trillion standard cubic feeds) while production capacity reaches 8.35 BSCF (billion standard cubic feeds). Meanwhile, coal reserves are estimated at 57 billion tons with a production capacity of 131.72 million tons per year [1]. The depletion of fossil energy reserves is of particular concern. Indonesia, which has been making fossil energy as the main energy, must start implementing alternative energy or new and renewable energy (RE). The government wants to increase the share of RE in the energy mix to 23 percent by 2025. At present, the portion is still below 15 percent [2]. This is in line with Regulation Number 5 of 2006 and Presidential Instruction Number 1 of 2006 dated January 25, 2006, on the National Energy Policy to develop alternative energy sources as a substitute for fuel oil [3]. Indonesia as a rich country in natural resources has a wide opportunity for the development of bioethanol to replace the fewer fossil energy sources. At this time bioethanol has begun to be produced [4]. Bio ethanol is ethanol produced

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1546-1955/2019/16/5228/005 doi:10.1166/jctn.2019.8591

from biological raw materials with biochemical technology, through the fermentation process of raw materials [5]. Indonesia has natural resources that have the potential as raw materials for bioethanol production. One of them is sorghum. Sorghum has a high adaptability to climate change because of its efficient use of water. When other crops such as rice and corn fail, sorghum can thrive and give good results. Sweet sorghum plants have a high yield, which is 80 tons/ha/year [6]. Sorghum has seeds with a composition of 73.8% starch, which is potential as a raw material for making bioethanol. From the results of *4–6* t/ha seeds can be produced 3.6 tons of starch flour or 1,800 liters of ethanol/ha [7]. Sorghum starch can be converted into bio ethanol through the hydrolysis process (the process of converting carbohydrates to glucose) and fermentation. The hydrolysis method can be carried out with an acid catalyst and enzymatically. Enzymatic hydrolysis method is more often used because it is more environmental friendly [5]. In a study conducted by ErniNurFitriana, fermentation was carried out yeast *Saccharomyces cerevisiae* with variations of 2, 4, 6, 8 and 10% (w/w) for 7 days. The level of bioethanol without hydrolysis results without acid followed by fermentation of 3.33; 3.19; 3.99; 3.79 and 3.49%, and direct fermentation of 1.00 and 0.81% in the use of yeast 4 and 6% (w/w) [8, 9]. In the research conducted by Nova [10]. With the liquefaction temperature variables of 75 °C, 85 °C and 95 °C. For the temperature of 75 °C the highest productivity value is obtained at 24 hours fermentation time, which is 3% or 30 g/L. At a temperature of 85 °C the highest productivity value is obtained at 24 hours, which is equal to 5% or 50 g/L. Meanwhile, at the liquidation temperature of 95 °C the highest productivity was obtained at an ethanol concentration of 5% or 50 g/L with a 24-hour fermentation time [9]. Research by Jhonprimen HS et al., about the effect of yeast types on bioethanol fermentation process for 3 days using variables in bread yeast with masses of 5, 7, 10 grams yielding ethanol levels which tend to increase ie successively 13.73%, 19.22%, and 20.37%. In tape yeast with successive periods of 5, 7, 10 gr, the ethanol content tends to increase, which are 18.05%, 19.67%, and 24.01% respectively [10]. From the research that has been done, there are important variables that can affect the yield of bioethanol. Therefore, this study aims to obtain the most optimal type of yeast and its concentration and obtain liquefaction temperature and duration of fermentation.

2. RESEARCH METHODS

Bioethanol is made in several stages, namely hydrolysis (liquifaction and saccharification), fermentation, and distillation (see Fig. 1).

The ingredients used in this study were sorghum seeds, alpha amylase enzyme, glucosyl amylase enzyme, luffschrool solution, H_2SO_4, aquadest, *Saccharomyces cerevisiae*, rhizopusoryzae, acetobacterxylinum, mucorsp,

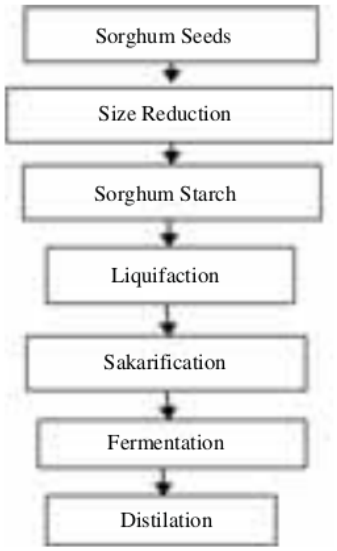

Fig. 1. Bioethanol making scheme.

and aspergilusniger. While the equipment used in this study is a set of fermentors, a set of distillation tools, 10 ml and 25 ml measuring pipettes, rubber balls, universal indicators, 250 ml and 500 ml beakers, 100 ml measuring cups, drip pipettes, stirrers, pumpkin necks three, 100 ml and 250 ml pumpkin, watch glass, 250 ml and 1000 ml erlenmeyer, hot plate, magnetic stirer, 100 °C thermometer, boiling stone, and analytical balance.

3. RESULTS AND DISCUSSION

In the manufacture of bioethanol from sorghum seeds, before the fermentation stage is carried out, a sugar concentration test is carried out using a luff-schoorl solution. The results of the analysis can be seen in the following table.

From the Table I above it can be seen that in the temperature range 80–95 °C the sugar concentration increases in concentration, whereas when the temperature is raised to 100 °C the sugar concentration decreases. It can be said that the optimum liquefaction temperature in the formation of sugar is at a temperature of 95 °C which is equal to 13.998%. Visually the increase and decrease in sugar concentration can be seen in the Figure 2.

Table I. Concentration of sugar in starch sorghum.

Liquifaction temperature (°C)	Sugar concentration (g/L)
80	11.254
85	11.879
90	12.424
95	13.998
100	12.872

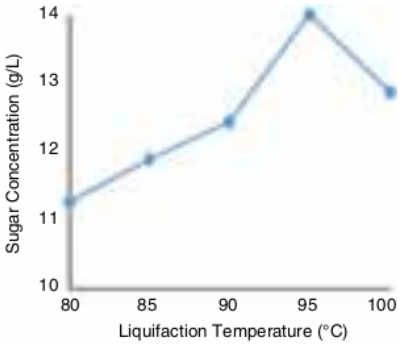

Fig. 2. Effect of liquifaction temperature on sugar concentration.

3.1. Effect of Yeast Type on Bioethanol Concentration with Liquifaction Temperature Variation

The liquefaction results are then carried out in the fermentation stage. Each variable has different results. Bioethanol acquisition data which is influenced by the type of yeast and the temperature of the liquefaction can be seen in Figure 3.

From Figure 3, it can be seen that in liquefaction process with temperatures of 80 °C and 85 °C, the highest concentration of bioethanol is 2% using *Saccharomyces cereviceae* yeast, at liquefaction temperature 90 °C and 95 °C, bioethanol concentration is increased, each of which is obtained 3% bioethanol concentration and 4.3% using *Saccharomyces cerevisiae* yeast. But when liquefaction temperature is increased by 5 °C, the bioethanol yield obtained decreases. This happens because at a temperature of 100 °C, the amount of sugar concentration decreases. Sugar is a transition product before the product turns into biethanol. When the sugar breaking activity that occurs at temperatures of 100 °C occurs so slowly. This occurs because the activity of enzymes that break down complex carbohydrates into simple carbohydrates becomes more decreased because the enzymes used work optimally at a temperature of 95 °C (see Table II).

Table II. Obtaining bioethanol with variations in yeast types and liquifaction temperature.

	Concentration of bioethanol (%) with liquifaction (°C) temperature variation				
Types of yeast	80	85	90	95	100
SC	2	2	3	4,3	3,7
RO	1	1	1,2	2	1,8
AX	0,6	0,65	0,8	1	0,9
M	1	1,5	2	2	1,7
AN	1,1	1,2	1,2	1,4	1,2

Information: SC: *Saccharomyces cerevisiae*, RO: Rhizopus oryzae, AX: Acetobacter xylinum, M: Mucor sp., AN: Aspergilus niger.

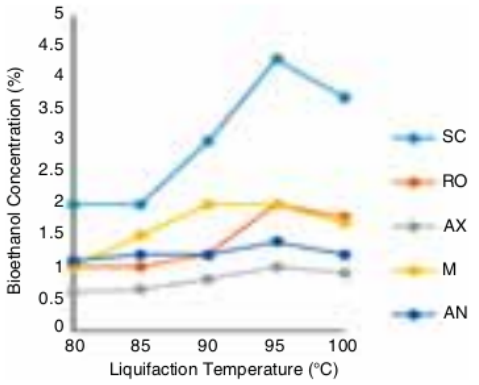

Fig. 3. Effect of yeast type variation and liquifaction temperature on bioethanol concentration.

3.2. Effect of Yeast Concentration on Bioethanol Concentration with Variations in Fermentation Time

The fermentation process is done anaerobically in the fermenter column. Based on the results of the research on the variety of yeast types above, *Saccharomyces cerevisiae* yeast was taken as the most optimal yeast in the process of determining the optimal time for fermentation. Yeast *Saccharomyces cerevisiae* functions as a decomposing bacterium of glucose into bioethanol in the fermentation process. The reactions that occur during this fermentation process are as follows:

$$C_6H_{12}O_6 \longrightarrow 2C_2H_5OH + 2CO_2$$

The variation of yeast concentrations used in this study were 1, 1.5, 2, 2.5, and 3%, while the variation of fermentation time was 24, 32, 40, 48, and 56 hours. In this research process the following data were obtained (see Table III).

In the fermentation process, the concentration of bioethanol is determined by an alcohol meter. The process of forming bioethanol using *Saccharomyces cerevisie* yeast begins with the hydrolysis process. This hydrolysis process ims to break down carbohydrates into glucose. Two stages occurred, namely liquifaction and saccharification stage.

Table III. Bioethanol yield with yeast concentration variation and fermentation time.

	Bioethanol concentration (%) with fermentation time variation (hours)				
Yeast concentration (%)	24	32	40	48	56
1	2	6	7,8	9	7,3
1,5	3	4,5	6	8,3	8
2	3,2	6,7	7,2	8,5	7,8
2,5	3	6	8	11	9
3	2,5	5,2	7,5	9,3	7,1

At the liquifaction stage occurs at an optimal temperature of 95 °C for 90 minutes. The liquifaction process which is part of the hydrolysis process aims to convert starch in sorghum to sucrose with the help of the alpha amylase enzyme catalyst. Whereas the saccharification stage aims to break down the sucrose obtained in the previous stage with the help of the gluco amylase enzyme catalyst. This process takes place at a temperature of 60 °C for 90 minutes. Sucrose is broken down into simple sugars, glucose, which is then adjusted to bioethanol in the fermentation process with the help of metabolism from *Saccharomyces cerevisiae*. The fermentation process takes place at room temperature which is 30 °C with a time variation of 24, 32, 40, 48, and 56 hours. The concentration of bioethanol produced in this time variation and yeast concentration can be seen in Figure 4.

It can be seen in Figure 4, that in all variations of the fermentation time, the highest bioethanol concentration was obtained at the yeast concentration of 2.5% in 48 hours which is 11% but decreased in addition to the yeast concentration to 3%. From the data obtained it can be concluded that the higher the yeast concentration used, the higher the concentration of bioethanol obtained. This occurs because of the increasing metabolic activity of microorganisms that takes place during the fermentation process, so that glucose is converted into more ethanol. But in this condition the optimal yeast concentration is at 2.5%. This statement is in accordance with Murray (2009) in Ilham [5], 2016 which states that the more enzymes, to a certain extent, the more substrates are converted because the higher the enzyme activity, but excessive enzyme concentration will also affect the rate of enzymatic reactions [3, 5]. Similar research states that substrate concentrations that are too high can inhibit the growth of microorganisms so the conversion rate becomes slow [11, 12]. This is consistent with the data obtained in this study that the most optimal yeast concentration is at 2.5% and the activity of *Saccharomyces cerevisiae* has decreased at 3% yeast because under these conditions, *Saccharomyces cerevisiae* is no longer working optimally. In addition to yeast concentration, fermentation is also influenced by fermentation time. Similar to yeast concentration, fermentation time also cannot be said the longer the process takes place, the higher the concentration of bioethanol obtained. From Figure 4 it can be seen that the most optimal fermentation time is at 48 hours and decreases in the next 8 hours. This happens because at the 56th hour the concentration of sugar decreases because it has been converted to bioethanol. Another thing that causes this decrease in bioethanol concentration is if the fermentation time is too long then over time bioethanol can be converted to acetic acid. Like the following reaction [5].

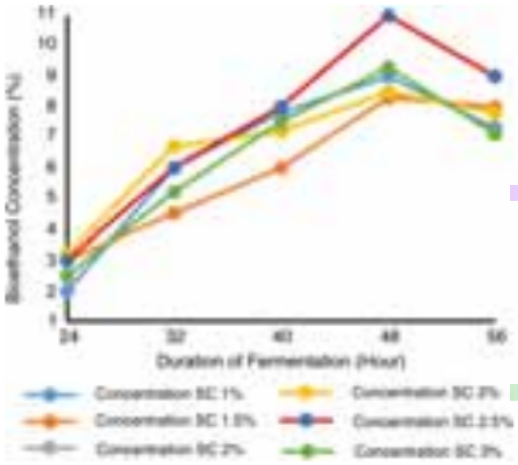

Fig. 4. Effect of variation in yeast concentration and fermentation time on bioethanol concentration.

$$C_1H_5OH + O_2 \longrightarrow CH_2COOH + H_2O$$

4. CONCLUSION

Based on research that has been done, it can be concluded that the optimal liquefaction temperature is 95 °C with the resulting sugar concentration of 13.998 g/L and the type of yeast used is *Saccharomyces cereviceae* with the yield of a bioethanol concentration of 4.3%. In the fermentation process, the most optimal concentration of yeast *Saccharomyces cereviceae* is 2.5% with a fermentation time of 48 hours obtained a bioethanol concentration of 11%.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5233–5237, 2019

RESEARCH ARTICLE

On Optimal Thickness of the Curve at Calculating the Fractal Dimension Using the Box-Counting Method

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Fractal curves are found in various fields of science and technology, and the calculation of the dimensions of the curves is an actual direction. The fractal dimension (FD) is a metric used to characterize the filling of a plane with a curve. The choice of the thickness of the curve line at calculating its FD using the box-counting method (BCM) is not obvious. This is the subject of the present paper. First, we consider a straight horizontal line with different thicknesses, and calculate FD for different thicknesses, using BCM. Using the exact dimensional value for a straight line, the initial conclusion is made about the thicknesses that give a correct FD. In the next step, the dimensions of straight lines rotated by a certain angle in the range from to 90 degrees are calculated. At any angle of inclination of the line, the FD values should also remain equal to unity. The range of FD values depending on the rotation angle is analyzed. The result is an "optimal" line thickness equal to 3 px. At this value, the FD values are the closest to one for any angle of inclination. As a result it is received that at dimensional calculation by means of BCM, it is enough to choose the initial image of 200 on 200 pixels, and boxes to choose the sizes from 2 to 50 pixels with step of 2 pixels. The stability of dimension calculations on the grid offset has been verified. The algorithm's error is estimated on the example of the calculation of FD for the Koch fractal.

Keywords: Box-Counting Method, Curve Dimension, Line Thickness, Calculation of Dimension, Optimum Thickness.

1. INTRODUCTION

Fractal curves are found in various fields of science and technology [1–3]. Similar structures arise in physiology [4], architecture and urban planning [5, 6], biology [7], antenna design [8–11] and many other areas. One way to evaluate such structures is to characterize the geometry of the lines forming these structures. This characteristic can be FD [12]. In the two-dimensional case, FD is the metric used to characterize the filling the plane with a curve. Dimension values for a continuous line vary from one to two. Various types of metrics can be used [13]. Examples of such metrics are the dimensions of Hausdorff and Minkowski [14, 15]. Different algorithms are used to calculate and estimate these dimensions [16]. Methods such as BCM, walking-divider method, prism counting method, epsilon-Blanket method and other hybrid methods are used [17–19]. The most common is BCM with various modifications [20]. The essence of BCM is to calculate the blocks covering the examined image. However, this procedure is subject to quantization errors due to arbitrary grid arrangement and, as a consequence, incorrect block counting [21–23]. In this paper, we do not address this issue in detail, but only slightly. Our goal is to analyze the influence of the line thickness of the investigated curve on the FD values. We consider horizontal line with different thicknesses and calculate its dimension using BCM. Knowing the exact value of the dimension (FD = 1), we make an initial conclusion about the thicknesses that give the correct answer. In the next step, we calculate the dimensions of straight lines rotated by a given angle. In this case, the angle varies from 0 to 90 degrees. At any angle of inclination, the line must have FD values equal to one. We analyze the range of FD values depending on the angle. As a result, we obtain the "optimal" line thickness at which the FD values are closest to one for any inclination angle. To check the accuracy of the calculations, we calculate the dimension of the Koch prefractal of the seventh iteration.

2. BOX-COUNTING METHOD

We consider the line with coordinates $A(x_1, y_1)$ and $B(x_2, y_2)$. We suppose that $y_1 = y_2$, i.e., the line under consideration is considered horizontal. We calculate the dimension of the line using BCM. To perform the

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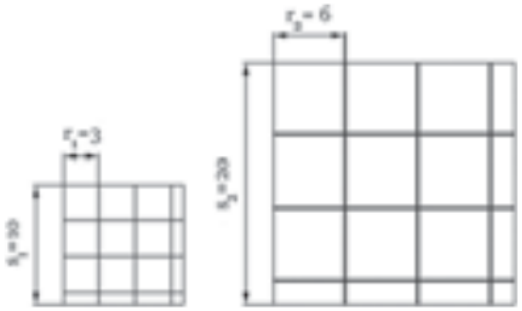

Fig. 1. Example of two images of different sizes with the same grid proportions.

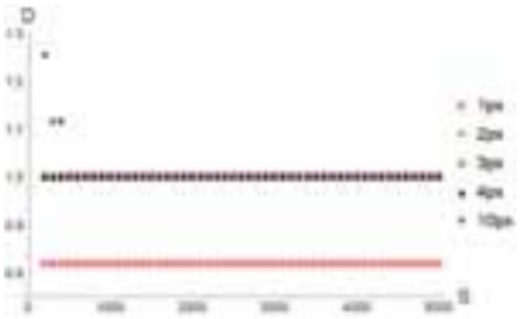

Fig. 2. Ratio of dimension D and image size S for a line-thickness of 1, 2, 3, 4, 10 px at the maximum grid increment $\varepsilon_{max} = 1/3$.

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calculations, it is necessary to cover the original image with a grid of size of S on S px. The new coordinates of the vertices of the line segment will be changed proportionally to the S

$$A(x_1(S), y_1(S)), \quad B(x_2(S), y_2(S))$$

where $x_i(S) = x_i * S$, $y_i(S) = y_i * S$.

We enter the relative size of the grid step ε. Then the absolute value of the grid step can be defined as $r(\varepsilon) = \varepsilon * S$.

As an example, we consider the grid at $\varepsilon = 0.3$ for two square images with $S = 10$ and $S = 20$, respectively. Figure 1 shows two grids with absolute grid pitch equal to $r_1 = 0.3 * 10 = 3$ and $r_2 = 0.3 * 20 = 6$.

Let E be any non-empty limited set, where the subset $A \subset E$ is the object for which FD is calculated. We cover a set of E with these boxes with side r, then FD is defined as follows:

$$D = \lim_{r \to 0} \frac{\ln N(r)}{\ln (1/r)}$$

where $N(r)$ is the number of boxes containing the object.

We form an array from sets of $(\ln N(r_i), \ln (1/r_i))$, where $i = \overline{1, m}$. We put the initial value $r_1 = r_{min}$ and the final value $r_m = r_{max}$. The values of r change evenly, i.e.,

$$r_i - r_{i-1} = r_{step} = \text{const}, \quad \forall\, i \geq 2$$

where the step of change $r_{step} = (r_m - r_1)/m$.

We build a regression line for a set of points Ω. Then the tilt angle tangent of the curve k: $\ln N(r_i) = k \ln r + \beta$ is an estimate of FD of the object.

3. CALCULATION OF THE HORIZONTAL LINE DIMENSION

We consider horizontal lines with thicknesses not exceeding 10 px. We cover each segment with an S by S pixel grid. The values of S be changed from 200 to 5000 px in steps of 100. In this case, the coordinates of the vertices of the segment remain unchanged. We calculate the FD by changing the grid size from $\varepsilon_{min} = 1/100$ to $\varepsilon_{max} = 1/3$ in increments $\varepsilon_{step} = 1/100$. Dimension values we designate as $D = D(S)$. The obtained dependences of D values on the size of the whole image S for thicknesses of 1, 2, 3, 4 and 10 px are shown in Figure 2.

It can be seen that the line of 1 pixel thickness gives dimensional values for any grid $D = 0.82$. The lines with a higher line thickness of 2 to 4 px give the correct value of $D = 1$ for any of S. With sufficiently "thick" lines, large 4 px (inverted triangles in Fig. 2, corresponding to lines with a thickness of 10 px), the calculated values of FD exceed one for small S. Thus, we can clearly conclude that the minimum grid size S should be increased when the line thickness is increased. For example, the size of $S = 200$ px gives exact values from 2 to 4 px, and for a line thickness of 10 px S it is necessary to choose not less than 500 px. We also got an important conclusion that with the thickness of the line 1 px for any S we get the wrong value. Therefore, we will not consider the lines with the thickness of one pixel below.

4. CALCULATION OF THE SLANTING LINE DIMENSION

Now, we consider lines with thicknesses from 2 to 10 px. We turn each segment, fixing the left vertex, at the angle of θ. The angle values of θ be changed from to 90 degrees in 5 degree steps. The tilted segments obtained in this way are mesh covered with S sides on S px, where S as in the previous paragraph changes from 200 to 5000 with step 100. Having obtained the FD values for the different angles of rotation and line thicknesses, we calculate the standard deviation estimate for D based on the unbiased dispersion estimate, which is determined by the following formula:

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (D_i - 1)^2} \qquad (1)$$

Here n is the number of images with different sizes S. Note that if we calculate σ for the horizontal segment, as

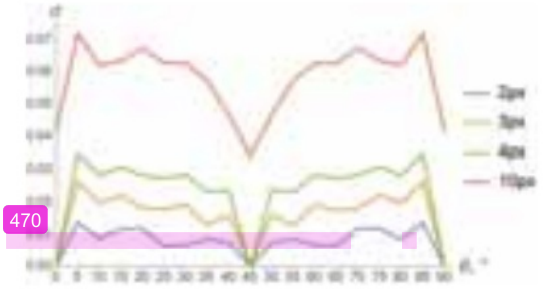

Fig. 3. Dependence of the standard deviation σ on the angle of inclination θ lines for thicknesses of 2, 3, 4 and 10 px.

follows from Figure 2, we get zero values for the thicknesses of 2, 3 and 4 px. For a thickness of 1 px the value is $\sigma \approx 0.182$, and for a thickness of 10 px the value is $\sigma \approx 0.042$.

Analyzing the graph in Figure 3, we can conclude that the increase in the thickness of the line leads to an increase in the value of σ. It is also easy to see that at the inclination angles of θ of 0, 45 and 90 degrees, we get the most accurate values for the dimension at a fixed line thickness. Note also that all the curves are symmetrical with respect to the value of 45 degrees. As mentioned above, during calculating FD, the grid size changed from $\varepsilon_{min} = 1/100$ to $\varepsilon_{max} = 1/3$; and this choice gave good results. However, it is often more profitable to choose another value of ε_{max}. We consider the question about the correctness of the choice of this value on the example of the line with the thickness of 3 px, rotated by $\theta = 45°$ at $S = 200$ px.

Figure 4 shows the dependence of dimension values on the value of ε_{max}. Here you observe the values of ε_{max}, which vary from 1/50 to 1/2 incrementally in 1/100. Analyzing the location of the points in Figure 5, we can conclude that the exact values of $D = 1$ are achieved at ε_{max} at 0.02 and around 0.2. We choose the most "exact" value

Fig. 4. Relationship between dimension D and maximum grid increment ε_{max} for line segment with the thickness of 3 px rotated $\theta = 45°$, image size $S = 200$.

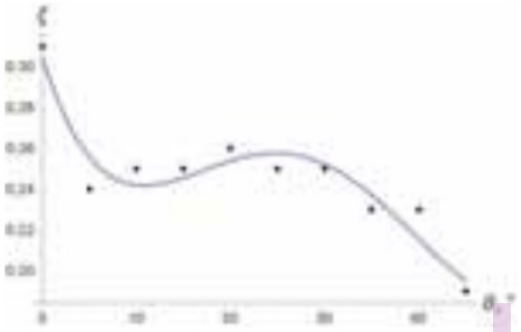

Fig. 5. The relationship between the optimal maximum grid increment ξ for a curve with a thickness of 3 px.

ε_{max}. In this case, we obtain that for a line with a thickness of 3 px, rotated to $\theta = 45$ degrees, the optimal value of ε_{max} is around 0.2. Thus, we find the optimal value of ε_{max} and mark it with ξ. We perform this operation for all the considered angles of rotation of the line segment with the thickness of 3 px. The obtained results are shown in Figure 5. It can be seen that the values of ξ from 5 to 40 degrees are not scattered much, and the largest differences are located at the ends at θ, equal to and 45 degrees. We draw the regression curve for the points shown in Figure 5:

$$\xi(\theta) = 4.104 - 0.0512 * \theta + 0.00387 * \theta^2 - 0.000105 * \theta^3 \quad (2)$$

The same procedure of calculating the values of ξ and building the regression curve in the form of a cubic polynomial is also carried out for lines with a thickness of 2, 4 and 10 px. The obtained regression curves are shown in Figure 6.

It is supposed that the dimension have to be calculated for broken curves, which can be represented by a set of small slanted segments. Since the calculations are performed with the same value ε_{max} for all segments with different slope angles, it is necessary to choose the thickness of the line for which the spread of points in the corners will

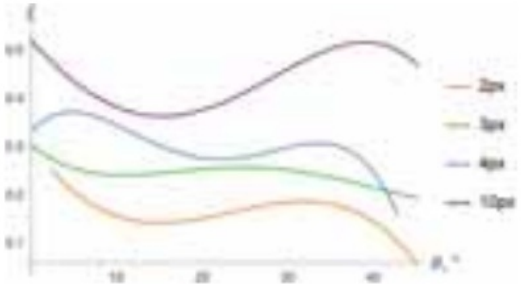

Fig. 6. Relationship between the optimal maximum grid increment ξ and the slope angle θ for curves with a thickness of 2, 3, 4, 10 px.

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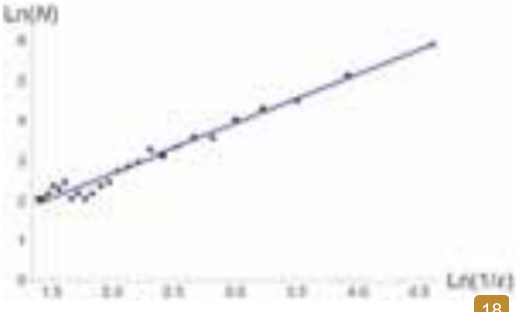

Fig. 7. Dependence of the number of boxes covering the seventh iteration of the Koch curve on the boxsize. Curve thickness is 3 px, $\varepsilon_{max} = 0.246$, image side $S = 5000$ px.

be minimal. Analysis of the regression curves in Figure 6 shows that the minimum spread has a line with a thickness equal to 3 px. The average value of ε_{max} is 0.246.

Thus, we conclude that the optimal curve thickness is 3 px. At calculating the dimension, the boxes should be selected from $\varepsilon_{min} = 0.01$ to $\varepsilon_{max} = 0.246$ with the increment of $\varepsilon_{step} = 0.01$. It is enough to choose the values of S equal to 200 px.

5. ESTIMATION OF THE ACCURACY OF FRACTAL DIMENSION CALCULATION

We estimate the accuracy of calculating FD at a line thickness of 3 px. The first thing we do is to check the effect of quantization error. When shifting the grid covering the segment, the regression curve is close to the curve shown in Figure 6 (green line). Moreover, the largest deviations of the values of ξ are taken at the angles of and 45 degrees. Average values at different grids are close to the value $\xi = 0.246$. Second, we check the accuracy of the Koch curve dimensional calculation. It is equal to $D = \log 4/\log 3 \approx 1.2618$ [24–26]. We consider the seventh iteration of Koch prefractal, believing that its dimension value is close to 1.2618. The optimal values $\varepsilon_{max} = 0.246$ were obtained at $S = 200$ px. However, such detailing is not enough to take into account the details of the seventh iteration. Therefore, we put $S = 5000$ px, leaving the remaining parameters of the algorithm unchanged.

The obtained values of the number of boxes covering the Koch prefractal are shown by the dots in Figure 7. The regression line is represented by a blue line. The result of the calculations gives the value of dimension $D = 1.2386$. It can be estimated that the calculation error is around 0.02.

6. CONCLUSIONS

The dependence of the dimension values on the line thickness is investigated. The conclusion is drawn about the optimal segment thickness of three pixels, at which the dimension value has the most stable values when turning and shifting the grid. The minimum optimal parameters of the algorithm are determined at which the obtained value of the dimension of the segment is obtained closest to the theoretical result. In this case, the box size must be selected from $\varepsilon_{min} = 0.01 * S$ to $\varepsilon_{max} = 0.246 * S$ with a increment $\varepsilon_{step} = 0.01 * S$, the size of the entire grid is enough to choose 200 by 200 pixels. The presented algorithm computed the fractal dimension of the seventh iteration of the Koch curve, obtained good agreement (an error in the dimension value is around 0.02). The results can be used in the selection of parameters for the correct calculation of the size of curves having complex geometry.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5238–5242, 2019

RESEARCH ARTICLE

Separation of Water-Oil Emulsion Using Polyethersulfone Membranes Treated with High-Frequency Low-Temperature Plasma

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A study of the water-oil emulsion separation by polyethersulfone membranes with a mass of cutoff particles 10 kDa was carried out. The membranes were treated with a low-temperature high-frequency capacitive reduced pressure plasma in an argon and nitrogen medium (70:30) at a voltage of $U_a = 1.5–5.5$ kV and processing time $\tau = 1.5–7$ minutes. Round flatfilter elements with a diameter of 47 mm were used in the capacity of membranes. The emulsion with a concentration of 3% (by volume) was prepared on the basis of Devon oil from the Tumutukskoye oil field and distilled water and was stabilized by the Kosintol-242 surfactant. The experiments were carried out on a laboratory ultra filtration separation unit. Based on the results of the studies, an increase in the separation productivity of the water-oil emulsions after plasma treatment of the membranes is shown; an increase in the studied process efficiency from 95.1 to 98.4% with the exposure by plasma at $U = 3.5$ kV and $\tau = 7$ min is noted. Using electron microscopy, sedentary droplet, and IR spectroscopy methods, we have revealed an increase in the surface roughness of the membranes after plasma treatment with nitrogen argon, as a result of which the contact angle of distilled water decreased from 75.3° to 65.3°, which indicates an increase in hydrophilicity and, respectively, water absorption, and in addition, the formation of oxygen-containing functional groups and the hydrogen bonds in the surface structure of the polymer polyethersulfone membrane.

Keywords: Polyethersulfone, Membrane, Plasma, Oil, Emulsion.

1. INTRODUCTION

The need to increase the effectiveness of environmental protection measures is due to the continuing deterioration of the environmental conditions throughout the planet caused by increased mining volumes and expansion of human activities at all, and, as a result, exhaustion of resources and pollution of ecosystems. The prompt solution of the problem under consideration is advisable both from the standpoint of ecology and from the point of view of the economy, since it's easier and cheaper to protect nature today than to try to restore it at exorbitant prices tomorrow, and the day after tomorrow there will be nothing left! All the components of the biosphere: earth, water, air, animals, plants, microorganisms, and people, are affected by anthropogenic impacts from environmental and organisms degradation to habitat destruction and extinction of populations. One of the ways to prevent these phenomena is the use of effective technologies that ensure the most complete neutralization of hazardous waste by converting it into safe substances, and preferably into secondary material resources. Moreover, the cost of such technology should be adequate for the resulting environmental effect. Membrane technologies are based on separation under the influence of a driving force (which is pressure used in most cases (baromembrane technologies)) of a mixture with various qualitative and quantitative composition using a membrane as a filtering element. The mixtures are separated into the permeate (filtrate) which passes filter and is less concentrated relative to the initial flow and detained and more concentrated retentate (concentrate). Upon that, varying the membrane process parameters (the membrane material, its layout, pore size, surface area and pressure) various values of productivity and separation selectivity, which are required to solve specific scientific

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1546-1955/2019/16/5238/005 doi:10.1166/jctn.2019.8593

and production problems, could be achieved. In particular, when separating a water-oil emulsion formed as a waste in the oil industry and containing one of the ten most dangerous pollutants-oil, the use of membrane technology helps to produce purified water which, depending on the degree of purity, can be used in a technological recycling or dumped into a sewer or a reservoir, as well as to produce a hydrocarbon concentrate, which in turn can also be used as a raw material or product [1] or disposed of. Despite the variety of membrane systems offered by domestic and, to a greater extent, foreign manufacturers the possibility of increasing the efficiency of membranes is relevant. Various methods are used for this; they can conditionally be divided into:

—Mechanical, carried out by direct contact of the processing tool and the work piece (membrane),

—Chemical, using chemical reagents to modify the structure of membrane filter elements [2]

—Physical, based on the action of energy fields (ultraviolet, *x*-ray and radioactive radiation [3], plasma [4–6], heat [7], laser [8], corona discharge [9, 10]). The first method is mainly used for the manufacture of membranes and the formation of general productivity and selectivity characteristics, while the second and third methods can and shall be used for fine-tuning the membranes for the purpose of their operation in order to solve specific problems. In the case of oil-water emulsion separation, the necessary property is the hydrophilicity of the filter element surface, which ensures a greater passage of the aqueous phase and repulsion of hydrocarbons. The plasma effect of certain gaseous media, for example, argon, oxygen, and air on the surface of the processed material, leads to its hydrophilization. This circumstance is due to the nature of the plasma consisting of charged particles of ions and electrons, which upon contact with the object being modified lead to various physical and chemical processes occurring on its surface, among which etching, oxidation, destruction and formation of chemical compounds are most likely; having combined together, they form a complex picture of changes in the structure of the object, and, accordingly, its characteristi

2. METHODS

Based on the above, in this paper, we study the separation of a model oil-water emulsion simulating the corresponding waste with the use of plasma-treated polyethersulfone membranes. A water-oil emulsion (WOE) was prepared by mixing 967 ml of distilled water with 3 ml of Kosintol-242 surfactant at a temperature of 40 °C, followed by mixing with 30 ml of Devonian oil from the Tu kskoye field. The chemical oxygen consumption value of the obtained 3% oil-water emulsion was 23400 mg O/dm^3. Polyethersulfone (PES) membranes in the form of films with a thickness of ≈0.1 μm, a diameter of 47 mm, and a mass of cut off particles of 10 kDa were selected as a filter element because of their thermal and chemical stability, and most importantly their surface hydrophilicity. The experiments with membrane separation were carried out in a laboratory setup—a cell made in the form of a plastic cylinder, in the lower part of which a membrane with a magnetic stirrer armature on its surface is installed on the stand, and the divided medium in the amount of 50 cm^3 is poured on top, after which the mixing device immediately starts creating the flow in the cross-flow modeto prevent the phenomenon of concentration polarization on the surface of

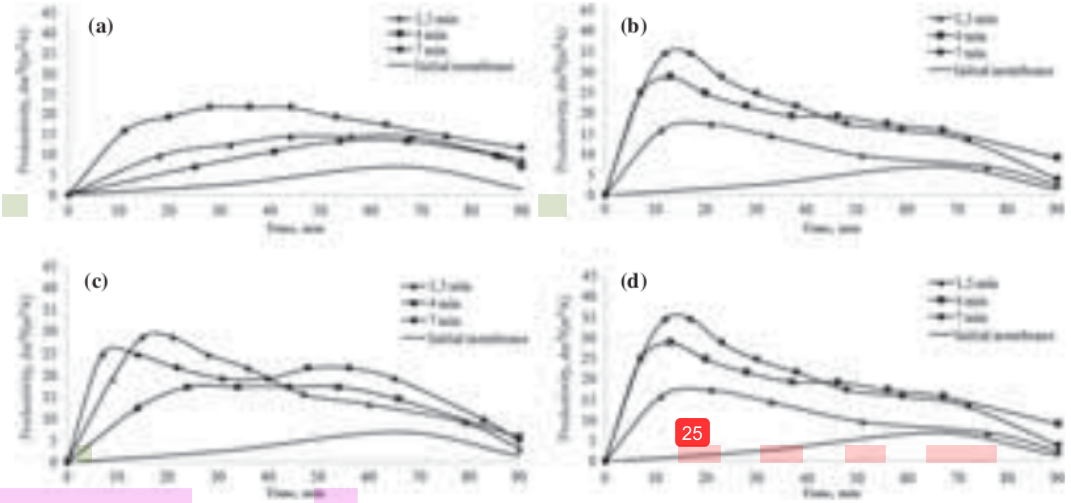

Fig. 1. Productivity of VNE PES separation by membranes treated in a plasma flow at a voltage value: (a) 1.5 kV; (b) 3.5 kV; (c) 5.5 kV; (d) 7.5 kV.

Table I. Filtrate chemical oxygen consumption values.

	Chemical oxygen demand, mgO/dm^3		
	Treatment time (τ), min		
Anode voltage (U), kV	1,5	Four	7
1,5	960	1280	2880
3,5	1440	1080	360
05.5	2160	1800	2520
Initial membrane		1152	
Water-oil emulsion		23400	

the filter element. The module is sealed with a clamping system, and then 2 atm pressure created by the compressor which determines the beginning of the separation process is fed through the nozzle of the upper cover [11, 12]. The membranes were processed with a high-frequency reduced pressure capacitive plasma in a mixture of argon and nitrogen gas media (70:30) at a voltage (U) of 1.5, 3.5, 5.5 kV and a treatment time (τ) of 1.5, 4, and 7 min, current strength was 0.5–0.7 A, pressure-26.6 kPa, gas mixture flow rate-0.04 g/s. The initial stage of the study determined the main oil-water emulsion separation characteristics with the initial and plasma-treated polyethersulfone membranes:

—Performance as the ratio of the mixture stream volume passed through the filter element to the product of the membrane surface area and the processing time,

—Efficiency (selectivity), determined by changing of the chemical oxygen demand (COD) value of the oil-water emulsion after membrane separation determined according to the titrimetric method. The results are presented in Figure 1 and Table I.

3. RESULTS AND DISCUSSION

Based on the presented graphical dependencies, an increase in the water-oil emulsion separation performance as a result of plasma treatment of polyethersulfone membranes is shown. It was not possible to identify the dependences on the voltage and processing time, which is apparently due to the complexity of both processes-plasma exposure and membrane separation, which when interacting lead to disordered results, as shown by the data in Figure 1.

Table I data analysis shows disordered values similar to the results for performance (Fig. 1). Moreover, in most cases, the values for the chemical oxygen consumption from the filtrates by modified filter elements are greater than the initial value, which, together with an increase in productivity, is explained by etching of the surface of the functional layer of the membrane and, accordingly, the passage of larger amount of hydrocarbons. However, plasma processing at $U = 1.5$ kV and $\tau = 1.5$ min, $U = 3.5$ kV and $\tau = 4$ and 7 leads to an increase in efficiency, in particular, from 95.1% (for the initial membrane)

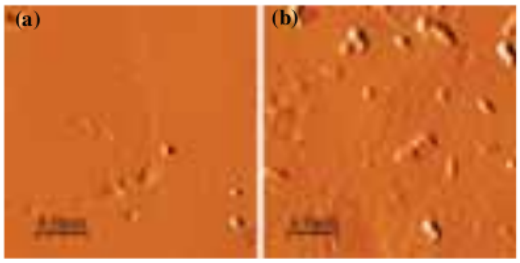

Fig. 2. Images of the PES membrane surfaces: (a) Initial (b) plasma-processed.

to 98, 4% ($U = 3.5$ kV and $\tau = 5.5$ min), while the value of the considered parameter decreases in 3 times from 1152 mgO/dm^3 to 360 mgO/dm^3. This circumstance is explained by that in addition to the aforementioned etching, other processes occur that contribute to an increase in the separation efficiency of a 3% oil-water emulsion, the nature of which is currently difficult to clearly identify. We can only talk about the possible partial oxidation and sintering, due to which the structure of the polyethersulfone membrane can change, which leads to an increase in efficiency. In order to qualitatively determine the surface deformations of plasma-treated filter elements during the study by electron microscopy using a probe microscope of the Multi Mode V brand, we obtained images of the initial and plasma-treated polyethersulfone membranes with the corresponding histograms, shown in Figures 2 and 3. The image of the modified membrane relative to the original one appears rougher; this is also confirmed by histograms. As a result of plasma treatment of the polyethersulfone membrane in an argon and nitrogen medium, the number of nodes with a size of 100 nm decreases from 35000 to 1000, at the same time, protrusions up to 300 nm in size appeared, which is a consequence of burning out the main selective layer by about 100–200 nm and confirms that the etching process flows. An increase in roughness is a prerequisite for increasing the wettability of the filter element surface, in connection with which, using the sedentary drop method with the Kruss DSA 20E apparatus, this parameter was measured. The results are shown in Figure 4.

Based on the images presented in Figure 4, an increase in wettability is shown by a decrease in the wetting angle of a distilled water drop on a polyethersulfone membrane from 75.3° to 65.3° as a result of argon and nitrogen HF plasma treatment of the latter, which confirms the above connection with an increase in roughness, and also a consequence of a possible change in the chemical structure of the polymer due to the formation of oxygen-containing functional groups on the membrane surface. In this regard, using the Infra LUM FT-08 brand Fourier infrared spectrometer, we obtained spectra of the studied membrane

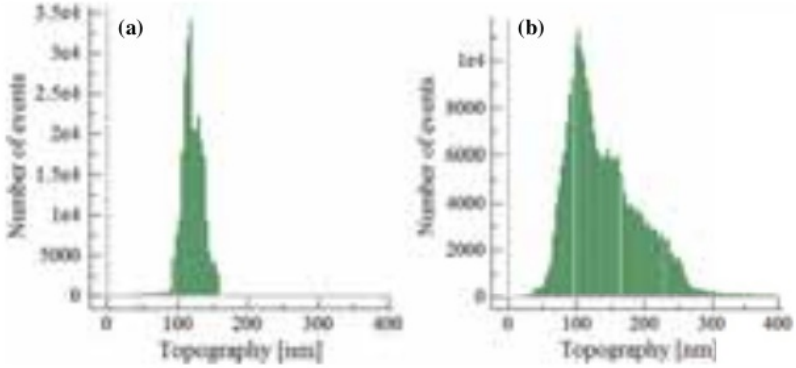

Fig. 3. Histograms of PES membrane protrusion distribution: (a) Initial (b) plasma-processed.

samples in the frequency range 600–4000 cm^{-1} shown in Figure 5.

As a result of a comparative analysis of the presented IR spectroscopy data, in particular, an increase in the C–O stretching vibrations in the C–O–C group was observed at 1260 cm^{-1}. They can also make a significant contribution to increasing the hydrophilicity of the filter element surface and therefore, its performance and selectivity. An increase in the intensity of the region of a wide spectrum band of 3300 cm^{-1} is also observed, which indicates an increase in the number of hydrogen bonds and, accordingly, additional crosslinking of the polyethersulfone polymer chains, which can lead to a change in the pore geometry and throughput.

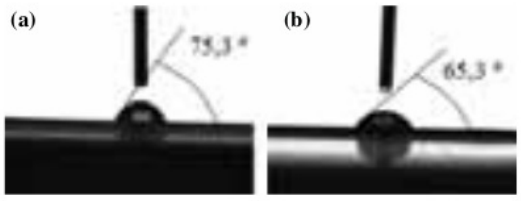

Fig. 4. Images of PSA membrane wettability by distilled water drops: (a) Initial; (b) plasma-processed.

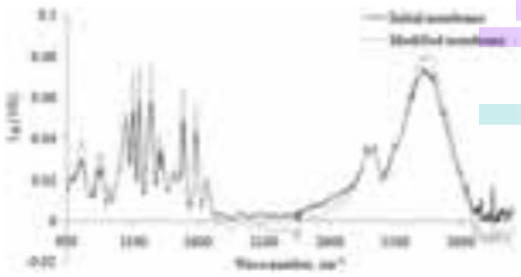

Fig. 5. Infrared spectra of the membrane: (a) initial, (b) plasma-processed.

4. SUMMARY

Based on the research results presented in this work, a positive effect of plasma exposure on polyethersulfone membranes was revealed, i.e., a slight increase in the selectivity and separation efficiency of the oil-water emulsion due to hydrophilization of the filter element surface due to increased roughness and partial chemical modification. However, the nature of these changes is disordered due to the complexity of the nature of interactions between plasma and membranes.

5. CONCLUSIONS

Nevertheless, the lack of full knowledge formed in viable hypotheses and theories about the mechanism according to which membranes are processed by plasma is not an obstacle to the practical use of plasma-modified filter elements. In general, it has been shown that it is possible to increase the efficiency of membrane water purification from oil by pretreating of polyethersulf one membranes in a stream of HF reduced pressure plasma in argon and nitrogen (70:30). Thus, a lesser supply of hydrocarbons to either a water body or to a subsequent purification step will result in a lower subsequent burden on the environment.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University. The work was supported by a grant from the President of the Russian Federation for state support of young Russian scientists—PhDs (MK-1107.2019.8).

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5243–5247, 2019

RESEARCH ARTICLE

The Role of the Subject "Mathematics" Content in the Learning Motivation

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The future of any country depends on the quality of education, in particular, mathematics. This paper represents an investigation of the possibilities of using motivation, which is one of the main conditions for improving the quality of teaching mathematics. Educational motivation, as a particular type of motivation, is determined by many factors: the educational system, the organization of the learning process, the subjective characteristics of a student and teacher. In our opinion, the factor associated with the very specificity of the subject matter "mathematics" remains insufficiently studied. Experience has shown that practice teachers and beginning teachers underestimate the role of motivation in teaching mathematics. They unconsciously or quite consciously skip the stage of motivation when introducing mathematical concepts, studying theorems, etc., not seeing the potential of the subject matter for the implementation of motivation. The purpose of the study is to identify the capabilities of the subject matter "mathematics" in the implementation of motivation, as well as the pedagogical conditions for preparing future teachers for its implementation. The research methods for this problem are the theoretical analysis of the knowledge of this issue, questionnaires, overt observation. The study showed that students and beginning teachers knowing the general techniques and methods of motivation do not see the potential possibilities of the subject of mathematics and specific topics for its implementation. At the same time, we have established that motivation can be carried out at any stage of training: by introducing mathematical concepts, algorithms, studying methods of action, methods for solving problems and theorems. Improving the training of future mathematics teachers is associated with the development of mathematical, pedagogical and methodological thinking of students, allowing motivation to introduce to study mathematics as a subject. To do this, in the classes on the teaching methodology, it is worth to purposefully teach the methods of motivation for educational activity in all substantive lines of the school course in mathematics to supplement the training content with courses on the choice of "Methods of student motivation," "The role of motivation in teaching mathematics," "Motivation for learning through the content of the subject.

Keywords: Teaching Motivation, Subject Matter "Mathematics", Methods of Teaching Mathematics, Future Mathematics Teachers, The Importance of Motivation in Teaching Mathematics.

1. INTRODUCTION

One of the main conditions for improving the quality of teaching mathematics is motivation. It has a significant impact on the internal state of a person, his/her satisfaction with the results of his/her own activities, on the ability to perform certain actions, including educational ones [1]. The psychological foundations of motivation are disclosed in the scientific research of domestic and foreign scientists Maslow, Kuhl, Vygotsky, and Levin. Motives are considered by them as stable manifestations of a human personality, stimulating him/her to activity, and motivation is defined as a set of motivating factors that reveal the activity of an individual [2–4]. Researchers were interested in the personal view of pupils and students on their own motivation [5], motivational factors that influence the increase in academic performance [6, 7]. The pedagogical conditions for the activation of the motivational sphere of students are defined in the works of Russian scientists Schukin, L. M. Friedman et al. In their opinion, the selection of the educational material content provides an individual educational trajectory of a student, an individual approach to the design of educational activities, the choice of teaching methods at each stage of educational activity and the nature of the interaction between the subjects of the educational process [8]. Educational motivation, as one of the types of motivation, is influenced by the educational system, the

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organization of the learning process, the subjective characteristics of a student and a teacher, etc. We dwell on one of the little-studied factors based on the specifics of the subject "mathematics." Observations and pedagogical experience show that the role of motivation in teaching mathematics is underestimated. Teachers often miss the stage of motivation when introducing mathematical concepts, studying theorems, methods of action, and methods of solving tasks without using the potential features of the subject matter. The purpose of the study is to identify the role of the content of the educational material in the motivation of learning.

2. METHODS

The research methods of this problem were the theoretical analysis of the knowledge on this issue, questioning, overt observation, analysis of the creative activity products. The study involved students and graduates of the teacher education department of the N.I. Lobachevsky Institute of Mathematics and Mechanics, and also students of the Volga Centre for Advanced Studies and Professional Retraining of Education Workers of Kazan Federal University. At lectures and practical exercises on the methodology of teaching mathematics, methods, techniques and means of increasing the motivation of students that can be used by future mathematics teachers in their upcoming professional activities are studied. Below are some of them:

- Motivate by example;
- Show interest in the student's position;
- Demonstration of the practical application of mathematical knowledge [9, 10];
- Emphasize the achievements of students, praise them for successful assumptions, highlight non-standard methods of solution [11];
- Use various forms of an educational organization in lessons [12];
- Offer students feasible study assignments, and clearly articulate homework [13];
- Organize mutual verification and mutual evaluation of written works and answers at the blackboard;
- Encourage students who are faster than others in completing the proposed tasks.

3. RESULTS

The teacher's professional standard defines competencies that increase the motivation for student learning. A teacher must:

(K1) promote the formation in students of positive emotions from mathematical activity;
(K2) form the idea of students that mathematics will be useful to everyone, regardless of the chosen speciality;
(K3) facilitate the preparation of students for participation in mathematical olympiads, contests, research projects, student conferences;
(K4) recognize and maintain high motivation, run circles, optional and elective courses;
(K5) to achieve that in any lesson in the classroom and when doing homework, each student receives a result in solving at least one problem [14].

Assessment of the listed competencies on a hundred-point scale (%) for students and teachers with various pedagogical experiences is presented in Table I.

Beginning teachers have difficulties in forming positive emotions in students in mathematics lessons, in forming ideas about the importance of mathematics in life, in ensuring that each task can be correctly solved duringa lesson and at home. They do not know how to properly prepare students for participation in mathematical olympiads and competitions; run circles and elective courses. The possibilities of the subject of mathematics for the implementation of motivation were studied. Students studying the methodology of teaching mathematics (28 people) were asked the question: how can you motivate 6th-graders to study the topic "Proportions"?

Here are some typical student responses:
—show how this concept will be applied;
—compare two relationships;
—rely on the subjective experience of pupils and find out how they understand the word "Proportions";
—offer a feasible task for direct and inverse proportionality;
—start directly with the topic announcement.

It should be noted that a significant part of students intends to study this topic in an abstract-deductive way. A small number of students offer to rely on a practical task. But at the same time, they find it difficult to give an example of a specific problem or situation that necessitates the introduction of a new concept. To determine the idea of the importance of motivation in teaching mathematics, we conducted a survey of students of 1–5 courses (72 people) and working mathematics teachers (59 people) with various lengths of service. Respondents were asked to indicate the length of service and to rank the following factors affecting the quality improvement for teaching mathematics in decreasing order: timely monitoring; cabinet equipment; the desire

Table I. Competencies assessment.

Competencies	Bachelors (4–5 courses)	Teachers (work experience—1–3 years)	Teachers (work experience—5 and more years)
K1	50	50	100
K2	10	50	100
K3	10	10	100
K4	10	10	50
K5	10	50	100

of apupil himself; motivation; class discipline; role-playing methods; an individual approach to each student; pupil's interest in the subject; other factors. We were interested in answers where respondents give the first three places to the motivation factor. The survey results are shown in Table II.

Thus, the significance of these factors undergoes changesas students move from year to year of education. At the same time, leading positions are given to motivation. A third of the teachers surveyed give motivation a second place (which corresponds to methodological expediency), a quarter gives it first place. More than half of the teachers surveyed also assign motivation to one of the leading roles. As part of the study, the lessons of trainees and beginning teachers were visited and analysed, their reporting documentation, self-examination sheets, lesson videos, results of control assessments of schoolchildren were studied. Observations of the lessons showed that trainees and beginning teachers do not fully master the methods of motivation, but, precisely, do not use the possibilities of the content of the subject "mathematics" for its implementation. Here are examples of unrealized learning situations. In a mathematics lesson in grade 7, the teacher immediately formulates the topic of the lesson: "Linear function" and introduces its definition without preliminary work with pupils. The topic provides an opportunity for pupils to independently formulate it. After constructing several points belonging to this function, pupils see that they are located in one straight line and offer the name of the function. In this case, the teacher "missed" the opportunity to motivate children when they are learning a new concept. When studying the topic "Actions with fractions" in grade 5, and demonstrating a rational solution to the equation $1/7 \cdot x = 11$, the teacher suggests pupils multiply both sides of the equation by 7, without focusing on the need to get a factor equal to unityfor the unknown value: $7 \cdot 1/7 = 1$. An opportunity to motivate finding a new mode of action was "missed." It is worth to motivate the finding of a solution why zeros at the end of a decimal fraction are insignificant, presenting this fraction in the form of an ordinary fraction, which can be reduced, etc. For our study, the ability to carry out motivation based on the very content of the subject "mathematics" is significant. Teachers do not know how or do not consider it necessary to motivate up the introduction of new concepts, theorems, methods of action, the choice of a method for solving the problem. Special classes should be given to the formation of appropriate skills.

Table I. The motivation ranks.

Rank	The number of students of the year (% to total number) I	II	III	IV	V	Teachers
1	15	8	20	30	23	25
2	15	12	25	20	14	31
3	25	20	25	20	14	18
4 and lower	45	60	30	30	49	26

4. DISCUSSION

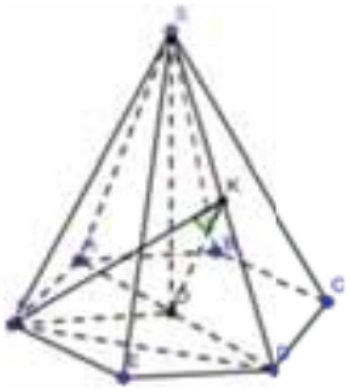
We consider examples of motivation when studying some of the structural elements of mathematics in classes on the methodology of teaching mathematics.

4.1. Introduction of New Concepts

- Introduction of the "Logarithm" concept in the 11th grade. The lesson begins by solving the equation $4^x = 16$. This equation is solved by reducing both sides of the equation to power with the same base equal to 4. Pupils are then asked to solve the equation $4^x = 7$. The considered method cannot solve it. But the equation has a solution, which is shown graphically. We say that the unknown is "an index of power to which you need to raise the number 4 to get 7." You must enter the appropriate term. Thus, the introduction of a new concept is motivated [15, 16].
- The introduction of a new concept "Proportion" at the 6th grade is useful to start with an expedient. The teacher offers a situation in which it should be noted that the time of movement and the distance travelled is directly proportional at a constant speed of movement.
- Introduction of a new representation of the quotient a and b $(a : b)$ in the form of a fraction (a/b). We can also start with a task. Thus, it becomes necessary and possible to present the quotient in a new form. Pupils notice that these two characters are combined on the corresponding calculator key $(\div)$.

4.2. The Solution of Geometric Problems

The problem of finding the angle between straight lines in space is proposed. When determining the angles between crossed straight lines, teachersthen pass to the angles between the lines parallel to the given ones, and then, after considering the corresponding triangles, they rely on the cosine (sine) theorem or use the area formula for the orthogonal projection of a polygon.



Task 1. In the regular hexagonal pyramid $SABCDEF$, the lengths of the sides of the base of which are 1, and the lengths of the side edges are 2, the point K is the middle of the edge SD. Find the cosine of the angle between the straight lines AS and FK. *Solution.* From considering the angle between the straight lines AS and FK, we move on to considering the angle between KO, the middle line of the triangle ASD (parallel to AS) and the line FK. Since the regular hexagon lies at the base of the pyramid, the segment FO is equal to its side, that is, $FO = 1$. Hence $KO = AS/2 = 1$.

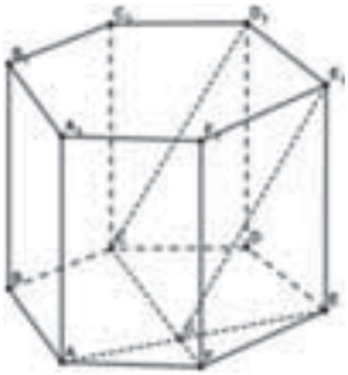
To find FK, consider the isosceles triangle FSD, in which $FS = SD = 2$, and $FD = \sqrt{3}$ (smaller diagonal of a regular hexagon with side 1). Using the formula for the length of the median of a triangle, we find

$$FK = \frac{1}{2}\sqrt{2FS^2 + 2FD^2 - SD^2} = \frac{\sqrt{10}}{2}$$

And then according to the cosine theorem

$$\cos(\angle FKO) = \frac{FK^2 + KO^2 - FO^2}{2FK \cdot KO} = \frac{\sqrt{10}}{4}$$

Answer: $\sqrt{10}/4$.



Task 2. In the regular hexagonal prism $ABCDEFA_1B_1C_1D_1E_1F_1$, the base side lengths of which are 1 and the lengths of the side ribs are 2, find the angle between the planes BA_1D_1 *and* AA_1E_1.

Solution. Quadrangles BA_1D_1C and AA_1E_1E are sections of this prism by the planes BA_1D_1 and AA_1E_1.

Let G denote the midpoint of the segment AE. Since the segments BA, D_1E_1 and CF *are* perpendicular to the plane AA_1E_1 (each of them is perpendicular to AA_1 and AE), the trapezoid AA_1E_1G will be the orthogonal projection of the trapezoid BA_1D_1C to the plane of the section AA_1E_1E. In an isosceles trapezoid BA_1D_1C lateral sides $BA_1 = CD_1 = \sqrt{1+4} = \sqrt{5}$, and the bases $A_1D_1 = 2$, $BC = 1$.

In trapezoid BA_1D_1C, height

$$h = \sqrt{CD_1^2 - \left(\frac{A_1D_1 - BC}{2}\right)^2} = \sqrt{5 - \left(\frac{2-1}{2}\right)^2} = \frac{\sqrt{19}}{2}$$

and the area is

$$S_{BA_1D_1C} = \frac{A_1D_1 + BC}{2} \cdot h = \frac{3 \cdot \sqrt{19}}{4}$$

In a rectangular trapezoid AA_1E_1G bases $A_1E_1 = \sqrt{3}$, $AG = \sqrt{3}/2$, height $AA_1 = 2$, square

$$S_{AA_1E_1G} = \frac{A_1E_1 + AG}{2} \cdot AA_1 = \frac{3 \cdot \sqrt{3}}{2}$$

According to the formula:

$$\cos\varphi = \frac{S_{np}}{S} : \cos\angle(BA_1D_1, AA_1E_1) = \frac{S_{AA_1E_1G}}{S_{BA_1D_1C}} = 3\frac{\sqrt{3}}{2} : 3\frac{\sqrt{19}}{4} = \sqrt{\frac{12}{19}}$$

Answer: $\arccos\sqrt{12/19}$.

As we can see, the first problem is solved through the cosine theorem and the second through the formula of quadrangle orthogonal projection area. Making a decision, teachers show only "how" to act, without explaining "why." The solution itself remains "not transparent" to pupils. Until the last step, the pupils do not know why they are doing something: why they look at triangles, find their medians, this or that trapeze, and find their areas, etc. Essentially, all actions taken are not motivated for pupils. Only at the end, the idea of solving the problem becomes clear. And the main thing in the process of solving the problem should be the answer to the question: "how to understand where to start?"

Obviously, the motivation of a particular method of solving the problem is closely related to the need for analysis. Otherwise, pupils are forced to act by trial and error.

5. CONCLUSIONS

The study shows that students and beginning teachers knowing the general techniques and methods of motivation do not pay attention to the motivation of learning mathematics as a subject. They do not see the potential possibilities of specific topics for their implementation. They often build an unmotivated course of solving a problem, while pupils need to master the way to solve this class of problems, rather than the course of solving a specific problem. It was revealed that the motivation of learning mathematics as a subject can be associated with the introduction of mathematical concepts, algorithms, methods of action, methods for solving problems, and studying theorems. Improving the training of future mathematics teachers should be aimed at the development of mathematical, pedagogical and methodological thinking of pupils, which allows motivation of mathematics as a subject. In the

classes on teaching the methodology, one should purposefully teach methods of motivating educational activity in all the substantive lines of the school course in mathematics and include in the curriculum for training future teachers of mathematics courses on the choice of "Methods of pupil motivation," "The role of motivation in teaching mathematics," "Motivation for learning through the content of the subject," etc.

Acknowledgment: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5248–5253, 2019

RESEARCH ARTICLE

Evaluation of Electromagnetic Exposure to Heavy Oil Stock

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One of the promising and environmentally acceptable ways to radically solve the problem of improving the quality of bitumen is the creation of an intensive physical and chemical technology for their production based on the use of residual oil fractions activated by an electromagnetic field. The task of maximizing the involvement of heavy oil residues in refining is very urgent in the face of increasing competition in the oil products market, on one side, and viseversa the background of inceciment of demands on their quality in view of environmental protect, on the other side. To assess the potential of high viscosity oils and natural bitumen and, as well as conventional oils, it is necessary to conduct thorough investigations to determine the curves of the true temperature curve (TTC), density, sulphur content, low temperature and viscosity features, fractional and hydrocarbon compositions. It has been established that prolonged irradiation has a destructive effect on most known organic particles. So, there is a request to study the performance features of materials like plastics, coatings and bitumen in the area of electromagnetic radiation and its capability to withstand exposure to radiation. The effect of electromagnetic radiation on organic parts has recently been investigated to evaluate the impact of electromagnetic waves on bituminous materials, specially for asphalts, and to utilize in practice the data gained. Bituminous particels vary significantly in their composition that relates to the resource of raw particles and the method of obtaining the particles.

Keywords: Electromagnetic Effects, Activation, Oxidation, Heavy Oil Residues, Bitumen.

1. INTRODUCTION

In Russia, the main source of bitumen production is the oxidation of residual oil fractions (ROF) [1–4]. An urgent task at present for oil refineries is the increasing involvement of high-paraffin resinous oils, using special methods of preliminary activation of raw materials (acoustic excitation, rotary hydrodynamic source of mechanical vibrations, wave action, etc.) in the production of oil-oxidized bitumen of improved quality, modern refineries use tars of various oils, cracking residues, extracts of selective oil refining, asphalts of the deasphalting process, fuel oils, pyrolysis resins, etc. as raw materials for bitumen production [5, 6]. This leads to the need for effective regulation of both the characteristics of raw particles and the features of the bitumen production procedure with a mentioned set of performance features [7].

2. METHODS

The main stages of the work [8–10] were: analysis of raw materials, activation of heavy oil residues (HOR) by an electromagnetic field, vacuum treatment of heavy oil residues, oxidation of heavy oil residues, study of the dynamics for the physicochemical features of oxidation productions of heavy oil residues, comparison of chemical and physical features of the gained oxidized bitumen with Russian GOST 22245-90 and the European standard EN 12591. Consider that the chemical parts of the original oil stock and methods for its procedures have a significant effect on the performance features of the obtained bitumen [8]. According to the BashNIINP classification, oils with a certain ratio of asphaltenes, resins and paraffins: $A+C-2.5P>8$ are most proper for the product of road bitumen. Note that due to the limitedness of oil reserves which have a certain ratio of the above components, the residues of almost any processed oil are used for the road bitumen products, which leads to a low quality of the bitumen produced. For a mixture of oils from Romashkinskoye and Prikamskoye fields, this ratio is $4.2+22.6-2.5*8.3=6.05$, and for a mixture of oils from Devonian and Carbonic oils: $2.60+20.20-2.5*2.22=17.25$.

3. RESULTS AND DISCUSSION

In this work, we selected residual fuel oil from a mixture of oils from Romashkinsky and Prikamsky deposits

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1546-1955/2019/16/5248/006 doi:10.1166/jctn.2019.8595

Table I. Physicochemical properties of blended vacuum residues product.

Indicator name	Devonian and carbonic oil	Romashkino and Prikamsk production field
1. Mass density, under 20 °C, kg/m^3	955. 5	1003.8
2. Assumed viscosity, sec.		
Under 60 °C	–	137.1
Under 80 °C	20,20	30.7
3. Flashpoint, °C	230	265
4. Ring-ball temperature, °C	27,2	31.5
5. Conradsoncon carbon, % wt.	9. 51	13.5
6. Mass content, %:		Trace levels
Sulphur	2,39	4, 5
Asphaltenes	2. 97	7.6
Resins	31. 6	56.5
7. Distillation characteristic, %:		
IBP (initial boiling point) −300 °C	N/A	N/A
8. Column bubble point, °C	350	300

in the capacity of raw material for the oxidation process; the physicochemical properties of those oils are presented in Table I. An urgent task was being solved related to the development of the raw material base for the production of high-quality bitumen due to the containment of heavy oil residues of the paraffin-naphthenic base.

When studying the influence of electromagnetic waves, it should be taken into account that, in essence, all kinds of bitumen are hydrocarbon mixtures containing various fractions of saturated, olefin, or aromatic compounds and carbon (or a material with a high molecular weight) in a colloidal state. When fuel oil is exposed to oscillations with a frequency of 72.2 kHz, it is excited. The arising oscillations of the elastic (liquid and gaseous) medium entail the emergence of successively alternating compression and rarefaction zones. Due to the elastic bonds of the particles, the pressure is transferred to neighbouring particles which, in turn, act on the following, as a result of which an increased pressure zone moves in an elastic medium. A high-pressure zone is followed by a low-pressure zone. Thus, fuel oil is subjected to alternating effects of compression and rarefaction. Elastic shear deformations also arise, causing the excitation of transverse (shear) waves. In this case, the particles oscillate perpendicular to the direction of wave propagation, while the

Table II. Properties of Elkhovsky vacuum residues product after exposure to electromagnetic field (210 °C, 2 hours).

Indicator name	Value
1. Mass density, under 20 °C, kg/m^3	931.3
2. Assumed viscosity, sec. Under 80 °C	3.35
3. Fractional composition, °C:	% wt.
IBP (initial boiling point)—	
105	0.12
105–120	0.36
120–150	2.72

Table III. Characteristic of Elkhovsky vacuum residues product after temperature control (350 °C).

Indicator name	Value		
	10 min	15 min	20 min
1. Mass density, under 20 °C, kg/m^3	936.2	947.6	9549
2. Assumed viscosity, sec. at 80 °C	4.23	6.28	7.6
Fractional composition, °C:	% wt	% wt	% wt
IBP (initial boiling point)—			
105	0.2	0.63	0.8
105–120	0.35	0.28	0.2
120–150	2.5	2.7	3
150–190	1.8	3,5	4

longitudinal wave propagation velocity is much greater than the shear wave distribution velocity. Compression and rarefaction of heavy oil residues lead to the formation of discontinuities in molecules, in particular in C–H compounds, i.e., the cavitation effect occurs. The time interval of the cavitation effect is very short, and significant energy is released at the time of compression, so, the hydrocarbon material is heated, as well as ionization and dissociation of molecules take place. The characteristics of residual fuel oil after exposure to an electromagnetic field for 120 minutes at a temperature of 210 °C are given in Table II.

The properties of thermostatically controlled fuel oil at 350 °C for 10–20 mins after exposure to an electromagnetic field, depending on the temperature control time, are given in Table III.

3.1. Features of the Chemical Technology for the Oxidation of Heavy Oil Residues

During the oxidation of raw materials to bitumen, a lot of reactions take place, the rate constants of which are different [11]. With increasing oxidation temperature, the rate of oxidation reactions accelerates. Relating to the

Table IV. Changes in the physicochemical properties of the vacuum residues product.

Indicator name	Oxidation time, min			
	120	240	420	600
1. Penetration (needle penetration depth), 0. 1 mm: −25 °C; −0 °C	>350	>350	202	90
2. Ring-ball temperature, °C	36	39	42	44
3. Fraas brittle point, °C	–	–	−21.8	−35.8
4. Flash temperature, °C	231	231	241	241
5. Bitumen stretching property, cm −25 °C; −0 °C	11.4	16, 1	20.5	18.6
6. Index of penetration	–	–	0.88	−1.5
7. Adhesion via sand or marble, points	3.0	3.0	3.0	3.0
8. Change in softening temperature after warming up, °C	–	–	2, 8	3

nature of the raw material and the required characteristics of bitumen, the appropriate oxidation temperature should be selected. At temps., below 210 °C, the reaction rates are low and the oxidation time of the crude oil becomes long. At temperatures up than 280 °C, the prevailing reaction is the formation of carbenes and carbides which worsen the quality of bitumen. So, in practice, oxidation for most types of raw materials, taking into account economic feasibility, proceeds at temperatures nearby the 250 °C. The consumption of compressed air and the degree of dispersion over the cross-section of the oxidizing column significantly affect the intensity of the process and the properties of bitumen. An increase in airflow to a certain limit, ceteris paribus, leads to a proportional increase in the oxidation rate. In a continuous process, with an increase in air supply, the total volume of the reaction mixture of air and raw materials increases. Consequently, the weight hour space velocity increases and the residence time of the raw material in the reaction zone decreases, penetration decreases, and economic and energy expenditures increase. The increase in pressure in the reaction zone contributes to the oxidation process

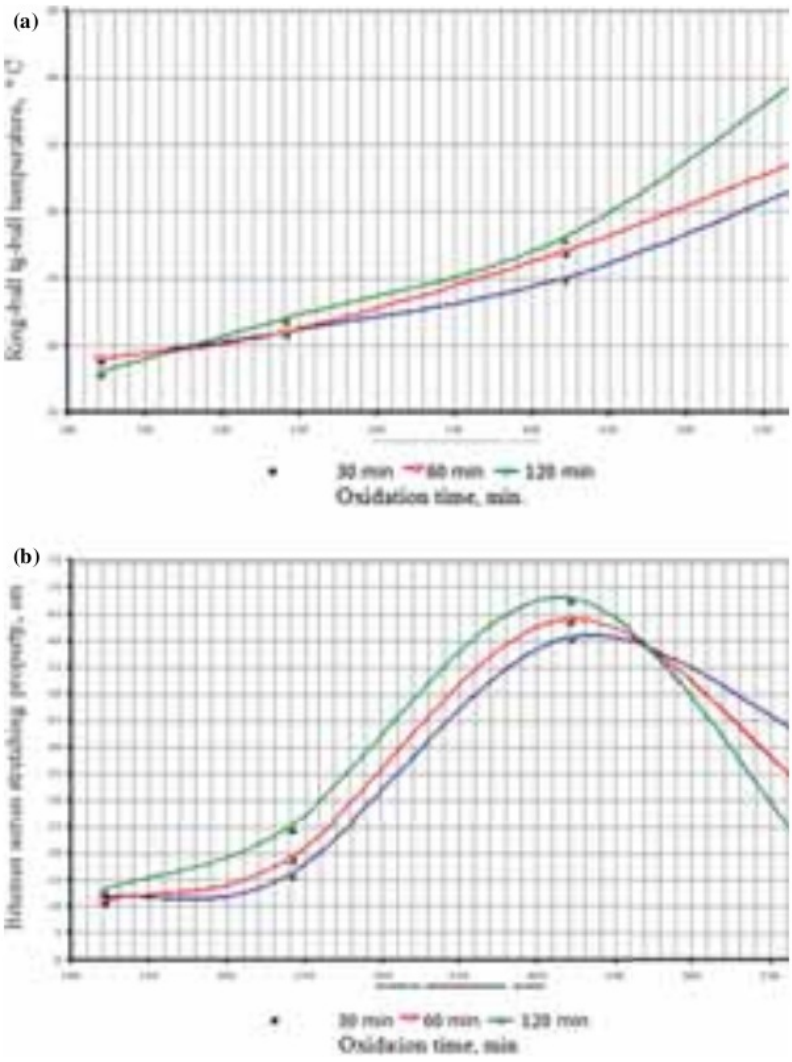

Fig. 1. The addiction of malacometric properties on oxidation time for vacuum residues product which was pre-activated by electromagnetic waves at temperature 150 °C.

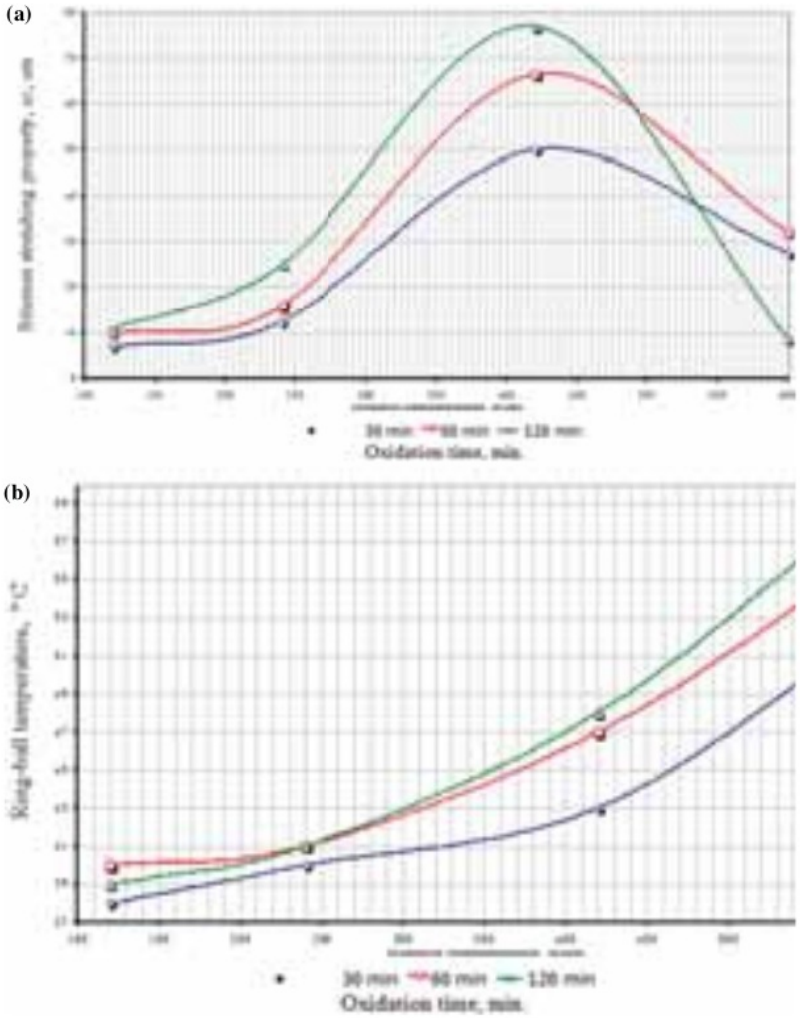

Fig. 2. The addiction of malacometric properties on oxidation time of vacuum residues product which was pre-activated by electromagnetic waves at temperature 210 °C.

intensification since the contact of oxygen with the feed improves; the solubility of gases with liquid increases. This leads to a reduction in the duration of oxidation and an improvement in the quality of oxidized bitumen. A decrease in pressure contributes to the occurrence of oxidation reactions, as they occur with a decrease in volume. By appropriate selection of pressure in the system, the composition and properties of the resulting bitumen can be controlled. During the oxidation process, the process temperature and airflow rate were maintained in the range of 240–260 °C and 3 l/min∗kg of feed, respectively. According to the data obtained as a result of the analysis of physicochemical properties (Table IV).

Relating the asphaltenes content, bitumen is a colloidal system having a sol, a sol–gel, and a gel structure, the destruction of which needs various energy. Thus, the asphaltenes percentage increases due to the decreasing of oils and resins percentage. Moreover, for the initial residual fuel oil, the content of asphaltenes increases due to the initial accumulation of resins. The relation of the malacometrical properties on the oxidation time of residual fuel oil previously activated by electromagnetic waves at a temperature of 150 and 210, is shown in Figures 1, 2.

The increase in the softening temperature in the first hours of oxidation is probably associated with the accumulation of resins, as evidenced by a sharp increase in

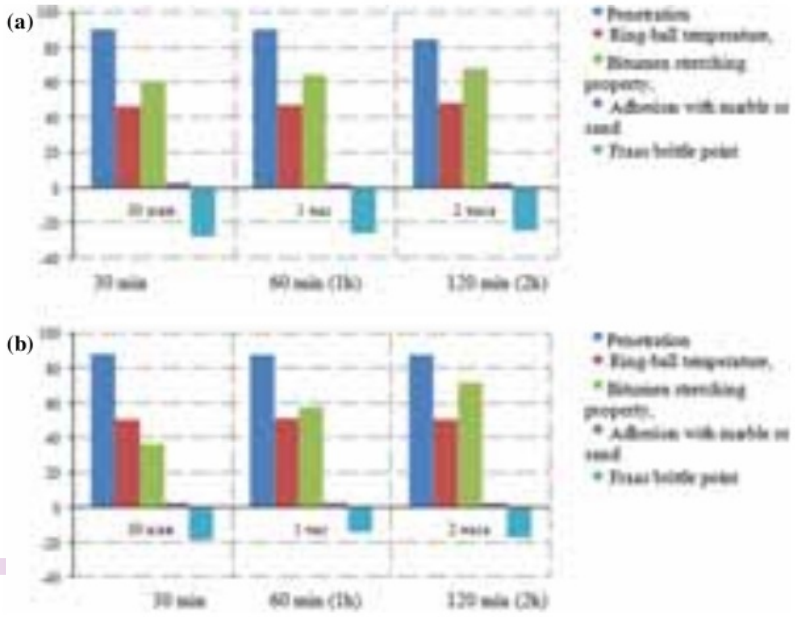

Fig. 3. The dependence of the physicochemical properties of oxidation products: (a) At temperature 150 °C; (b) at temperature 210 °C.

extensibility, while the concentration of asphaltenes does not change significantly, then the resin content remains constant throughout the entire oxidation process. The occurring changes in the properties of bitumen during the oxidation of 10 hours are caused, in our opinion, by structural changes that occur during the heavy oil oxidation residues [11]. The dependence of the physicochemical characteristics of bitumen gained via the oxidation of activated raw materials is shown in Figure 3.

The dependence of the brittleness and penetration temperature of oxidation products with the time of the process becomes more complicated since these indicators related more on the characteristics of the dispersion media: oils and resins. The brittleness temperature of oxidation products, as well as the softening temperature, excess with increasing content of asphaltenes and their sizes, which leads to the formation of a hard skeleton in bitumen, and its hardness increases. On the other hand, the brittleness temperature increases due to a decrease in the concentration of the dispersed medium, which increases the temperature of the bitumen transition into a solid-state. Penetration, which is a parameter of viscosity, also characterizes a change in the plasticity of bitumen depending on a change in its group chemical composition.

Table V. Quality indicators of the oxidized bitumen obtained.

Indicator name	GOST 22245-90 BND 60/90	EN 12591 Make 70/100	Value Sample number 1	2	3	4
1. Penetration (needle penetration depth), 0. 1 mm:			202	84	89	87
—at 25 °C;	61–90	70–100				
—at 0 °C	No less 20	–				
2. Ring-ball temperature, °C	Not less 47	43–51	42	48	48	48
3. Fraas brittle point, °C	Not higher -15	-ten	−21.8	−24.8	−18.3	−21.6
4. Flash temperature, °C	Not less 230	Not less 230	240	240	240	240
5. Bitumen stretching property, cm						
—at 25 °C;	No less 55	–	20	68	57	77
—at 0 °C	No less 3,5					
6. Adhesion with marble or sand, points	–	–	3	2.5	2	2

Softening point	Penetration
Dependence of the activation efficiency on temperature with electromagnetic exposure (30 min).	
$A = (53-44)/150 = 0.06$	$A = (90-50)/150 = 0.27$
$A = (53-44)/210 = 0.04$	$A = (90-60)/210 = 0.14$
The dependence of the activation effectiveness on temperature with electromagnetic exposure (120 min).	
$A = (62-44)/150 = 0.12$	$A = (90-25)/150 = 0.43$
$A = (60-44)/210 = 0.08$	$A = (90-40)/210 = 0.24$

When comparing activation efficiency depending on the temperature and time we can establish that the most suitable condition for activation of fuel oil is temperature 150 °C, duration −120 min. A comparative analysis of the operational properties of the oxidized bitumen obtained from fuel oil (sample 1) as initial raw material, as well as activated fuel oil (samples 2, 3 and 4, respectively), was carried out in accordance with the basic requirements for bitumen (Table V).

The regulatory requirements for road bitumen in Europe within the framework of a single standard EN 12591 are given in Table V. The same table shows the comparative characteristics of road bitumen obtained by the oxidation of activated residual fuel oil in accordance with GOST 22245-90.

4. CONCLUSION

As a result, samples of bitumen in their quality characteristics, namely, softening temperature, needle penetration depth fully comply with the standard, and for individual indicators, such as elongation, brittle temperature, exceed the requirements of the above standard. According to the data obtained, there is a general tendency to improve the properties of bitumen obtained by the oxidation of activated fuel oil. At the same values of the softening temperature, the penetration decreases, and the fragility temperature does not noticeably change. The resulting solvates and associates lower the total energy of the system, which leads to an increase in the softening temperature. On the one hand, the heat resistance of bitumen should not be less than the maximum operating temperature, the high softening temperature hampers their use as binders in asphalt mixtures (bitumens with a high softening point, and, therefore, the mineral filler surface is poorly enveloped by high viscosity). In our opinion, the activation of fuel oil allows the creation of conditions in the oxidation process under which mobile unpaired conduction electrons are almost completely localized in colloidal particles of bitumen, that results in their stabilization. Coagulation and precipitation of crystals of the asphaltene fraction during ageing, in this case, are mostly kinetically and sterically hindered and practically do not occur.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5254–5260, 2019

RESEARCH ARTICLE

Diagnostic Signal Informativeness Increase

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Modern requirements for the operation of cars lead to the need to improve the efficiency of their maintenance. Diagnosis as an element of the maintenance process allows you to provide information about the technical condition of a particular element, which allows you to respond in a timely manner to the technical condition change of a diagnostic object with minimal resources. In this paper, we consider the way improving the diagnostic signal quality. It is known that a diagnostic signal must meet several requirements. The most important requirement is informativeness, which shows the decrease of uncertainty about the technical condition of an object, represented by a priori entropy after information application from this diagnostic signal, measured during the diagnosis. There are the methods for a diagnostic signal conversion, which allow to get rid of the noise entering it to a different degree or present it in such a way to facilitate the signal analysis process. Three methods are considered in the work: direct spectrum obtaining, signal envelope spectrum obtaining, and adaptive filtering. The analysis of these methods led to the conclusion that adaptive filtering has the greatest efficiency potential. We have proposed the method that is based on adaptive filtering, but with additional operations. In the course of the diagnostic signal studies and the adaptive filtering algorithm, we found that it is possible to set the function to be detected as a variable, as well as several parameters that affect the result quality. Based on this, a new method for a useful signal extraction was proposed. The results of the work were checked on a signal simulating a car gearbox signal. The results showed that the method allows you to obtain the necessary knowledge about a defect, which can be used in the diagnosis. The developed method allows to increase the information content of the diagnostic signal by suppressing its other components. The results of the proposed method correlate with the results of other methods for general cases, i.e., when the ratio of the useful signal to noise is such that high sensitivity of the method is not required to identify the useful signal.

Keywords: Diagnostic Signal, Diagnostic System, Car Maintenance, Gearbox Fault Diagnosis, Diagnosis.

1. INTRODUCTION

Diagnosing of the car gearbox (GB) as an element of the power unit transmitting torque from the engine is an urgent task, because untimely detection of a malfunction in it leads to costly repairs. The control of GB technical condition by complete disassembly is not an effective way because of high labor costs. Therefore, maintenance is considered a promising area in terms of actual condition, where the resource of a part and its timely replacement is used to the maximum. Without developed diagnostic support (DS), this method is practically impossible. By developed DS, we mean the presence of a diagnostic signal (DS) that meets certain requirements; effective diagnostic methods with a high-quality diagnostic model, diagnostic algorithm and software; diagnostic tools to minimize labor costs for DS measuring, DS preliminary processing, fault detection, etc. In this paper, we consider the way to improve the quality of GB DS. It is known that DS must meet several requirements. The most important requirement is informativeness, which shows the decrease of uncertainty about the technical condition of an object, represented by a priori entropy after applying information from this DS measured during the diagnosis process. The level of controllability of modern gearboxes makes vibration acceleration of the housing walls the most effective diagnostic tool for bearing assemblies and gear diagnosing. But even in such a DS there are interferences that complicate its analysis. However, we have the opportunity to influence the measured DS, i.e., to improve its quality

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1546-1955/2019/16/5254/007 doi:10.1166/jctn.2019.8596

before use the information that it carries, applying various processing methods that reduce a priori entropy. If a DS is any function that contains a useful part and a noise one, then it is possible to transform it in such a way, influencing the operator, that the resulting function has a minimum noise component:

$$f^*_{DP} = A \cdot f_{DP} \quad (1)$$

where A is the transformation operator; f_{DP} is the diagnostic parameter undergoing conversion. In this case, the conversion suboperator is understood as the algorithm or a set of algorithms (processing methods) that comply the function to another function.

The development of such methods which allow to increase the information content of DS is one of the most important areas of technical diagnostics [1–5].

2. METHODS

2.1. Obtaining DS "Direct" Spectrum

The most common way of DS processing, but not in all cases informative, is the transition to the time-frequency function without additional operations. If you use this tool to analyze the technical condition of the gear, then it is quite effective. But during bearing assembly diagnosis, this method is applicable at the stages where a defect already has a strong development, while the overall level of the spectrum rises compared to the normal state. Most often, the operation of GB with such a level of defect development is unacceptable, therefore, the use of this method without additional operations is impractical. Let's consider the vibration spectrum of four-speed gearbox wall, where there is a crack on the gear tooth of the third gear. Measurement mode: 1500 rpm (25 Hz)—the frequency of input shaft rotation. DS from the sensor has the form shown on Figure 1.

Without a priori knowledge, it is extremely difficult to determine this defect by "direct" spectrum. Since this defect is very small on the scale of the entire system, the energy released during impact interaction of parts at the defect site is relatively small.

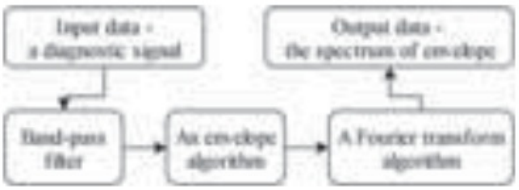

Fig. 2. The scheme for obtaining of the DS envelope spectrum.

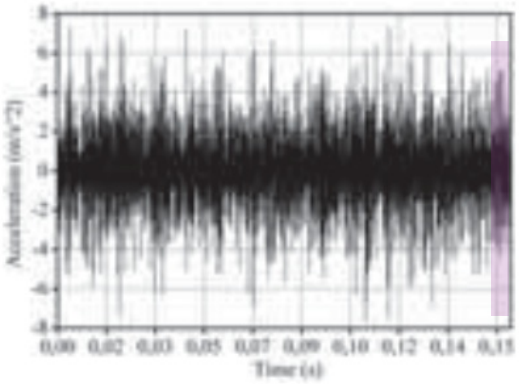

Fig. 3. DS after processing with a band-pass filter.

2.2. Obtaining the Spectrum of the DS Envelope

This method is quite effective to diagnose various defects of the GB, also during the early stages of development. Before receiving the DS envelope, it is necessary to pass it through the filter, which to some extent complicates this method, because you need to know the filter bandwidth limits. The scheme of this method is presented on Figure 2.

Knowing the frequency of the defect manifestation, we choose a band-pass filter with the boundaries of 2–4 kHz and let the DS pass through it. The processed DS is shown on Figure 3.

On the graph, you can notice the areas of the defect manifestation. However, it should be noted that in this form it is extremely difficult to analyze the DS, only the

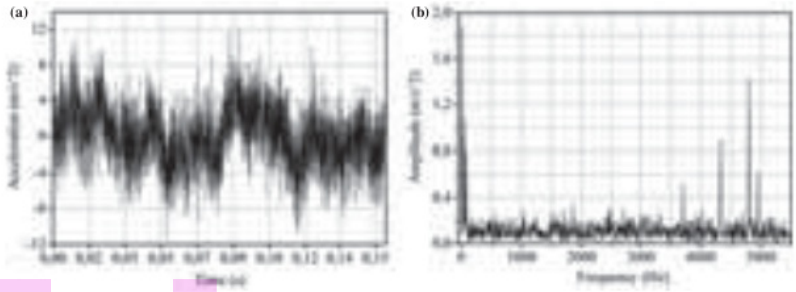

Fig. 1. DS in (a) time and (b) frequency representation.

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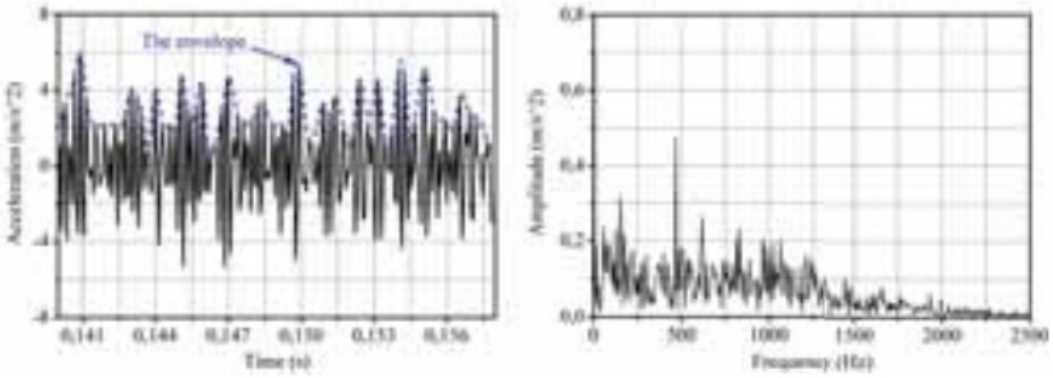

Fig. 4. DS envelope function and its spectrum.

presence of complete a priori knowledge allows us to give a qualitative assessment of the defect in this case. Therefore, the next step is to obtain DS envelope function and its spectrum (Fig. 4).

Knowing the design parameters of the bearing, it is possible to calculate the frequency of defect manifestation, which is of interest, and using this knowledge, to analyze the spectrum of the DS envelope (Fig. 4). However, there are the moments that make it difficult to use the method:
—selection of filter bandwidth;
—low sensitivity at low signal-to-noise ratios;
—the practical impossibility of the entire frequency band determination related to a defect;
—low automation of the process.

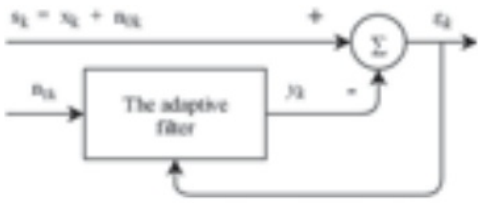

Fig. 5. DS processing scheme with adaptive filter.

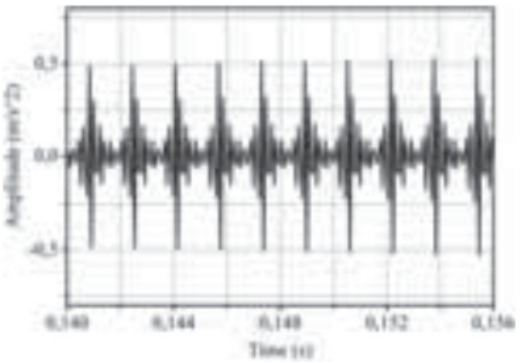

Fig. 6. The signal obtained after DS processing with adaptive filter.

2.3. DS Processing with Adaptive Filter

As we noted above, an important component of the processing method is the ability to give high-quality results with a small signal to noise ratio. An adaptive filter from this point of view is one of the most effective methods, due to the presence of a tunable filter core [6–8]. The DS processing scheme by an adaptive filter is shown on Figure 5. A DS consisting of a useful signal s and noise n_0, which is not correlated with x, is provided to input. The signal n_1, correlated with n_0, but not correlating with the useful signal, is also provided to input.

The output of the filter y is formed as follows [9]:

$$y(k) = \sum_{i=0}^{N-1} h_i(k) n_1(k-i) \tag{2}$$

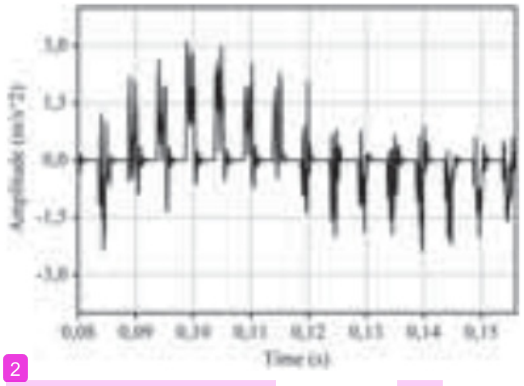

Fig. 7. The signal obtained after DS processing by an adaptive filter with a poorly correlated function n_1.

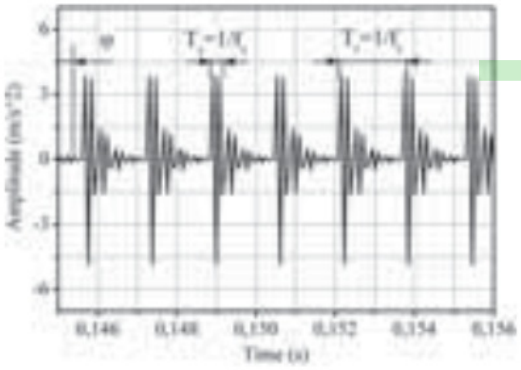

Fig. 8. The function n_1, supplied to adaptive filter input.

The filter coefficients are changed according to the formula [9]:

$$h_{k+1}(i) = h_k(i) + \mu \cdot e(k) n(k-i), \quad i = 0, 1, \ldots, N-1 \quad (3)$$

where μ is the parameter of the convergence step.

The output signal, which is the error function is equal to [9]:

$$e_k = s_k - y_k \quad (4)$$

where $s_k = x_k + n_{0k}$—the processed signal.

Let's apply the adaptive filter to the DS, which has already been analyzed by two other methods, and compare the results. As a correlated signal, we take the impulse function, because a priori, we know its appearance without exact characteristics. This function is selected in such a way that it correlates with the useful signal. As the result of processing in the DS, the noise component is suppressed to the maximum and only the useful component remains. Figure 6 shows the function obtained after DS processing by the adaptive filter.

As each iteration passes, the filter coefficients are adjusted. The output function allows the most effective assessment of a defect. But such qualitative results are obtained in the presence of the function n_1, which correlates as much as possible with the defect signal; however, in practice, we do not have such a qualitative function and the use of the standard algorithm leads to poor-quality results.

The result that is obtained when a poorly correlated function n_1 is fed to the input of the adaptive filter can be seen on Figure 7. This signal does not give any information about a defect, in some sense it can be misleading: we see repeated bursts that can be interpreted as shock pulses, but in fact the repetition frequency of these pulses does not correspond to the actual frequency of 618 Hz. We conducted the studies in the course of which they revealed important components that strongly affect the final result. Let's consider the first three, which directly relate to what

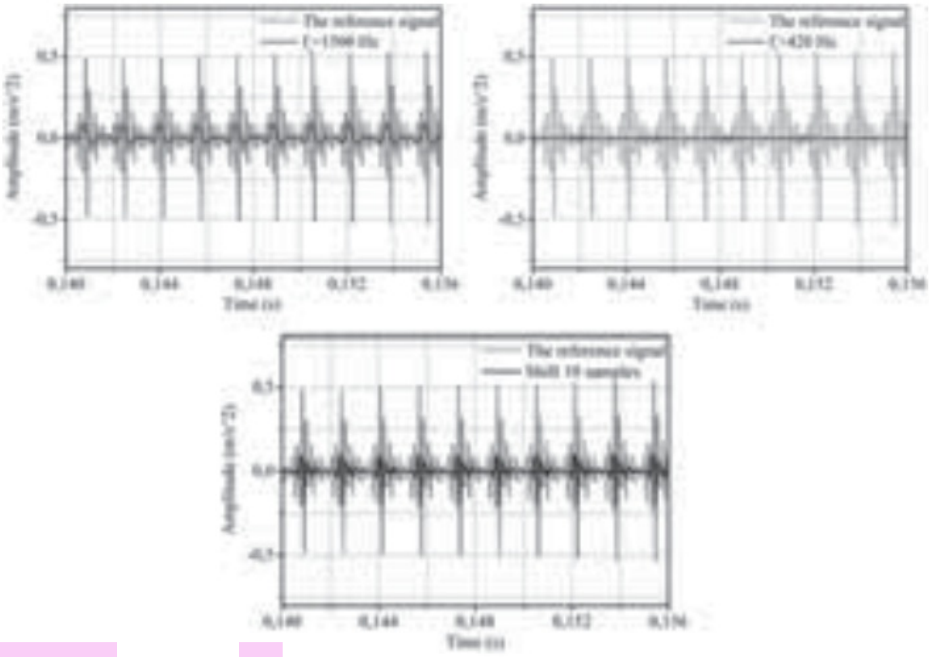

Fig. 9. The signals received at different parameter values of the function n_1.

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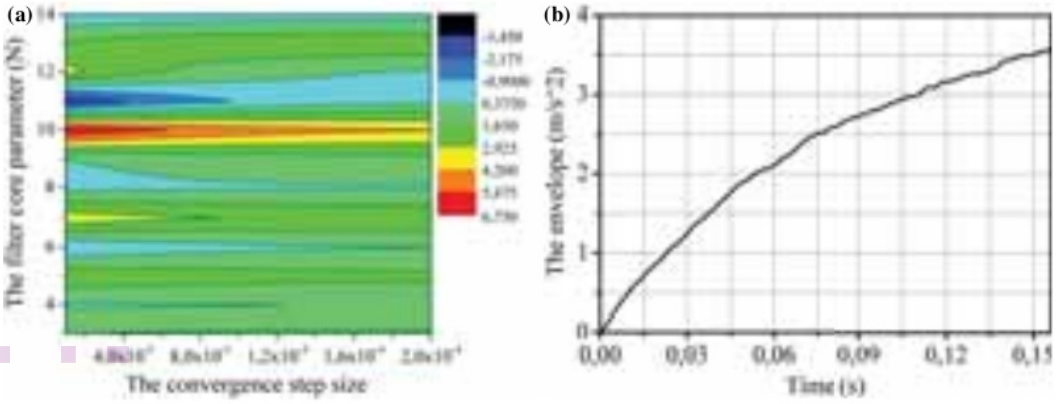

Fig. 10. The graph of (a) the function $\varepsilon(k)$ and (b) the output signal envelope.

kind of function n_1 will have—this is the frequency of its oscillations f_s, the pulse repetition frequency f_r and the shift φ (Fig. 8).

Let's consider the effect of each of these parameters on the output signal. We will compare with the reference signal presented on Figure 6. For the function n_1, we will successively change the value of the parameters $f_s = 1500$ Hz, $f_r = 420$ Hz, and $\varphi = 10$ samples. Figure 9 shows the results obtained during processing. In all cases, the deviation of the function n_1 parameters from the optimum leads to the loss of signal quality at the output of the adaptive filter. It should be noted that these results were obtained taking into account the fact that at a non-optimal value of one parameter the others were accepted as optimal, otherwise the results are extremely uninformative.

Let's consider some more important components, but now they affect not the input function n_1, but the adaptive processing algorithm itself. It is known that the order of the filter core and the convergence step parameter also affect the final result. Besides, the number of iterations also makes influence. Figure 10(a) shows the change of $\varepsilon(k)$ from the filter core parameter (N) and the convergence step value (μ). It can be seen that the graph of the function has differences and local maxima and minima, which means that the choice of these two indicators leads to different results.

Even during the selection of the remaining indicator optimal values considered by us, with an insufficient number of iterations, the output signal does not reach its maximum amplitude, and this can be observed on Figure 10(b). This means that it is necessary to choose the right number of iterations (n_{iter}). Based on the foregoing, we can conclude that the adaptive filter is a fairly effective tool for DS processing, but there are also the moments that limit its use. I.e., there are six components (parameters), controlling which you can control adaptive filter effectiveness [10–11].

3. PROPOSED METHOD

So, we have six parameters on which the output function of the adaptive DS processing algorithm depends,

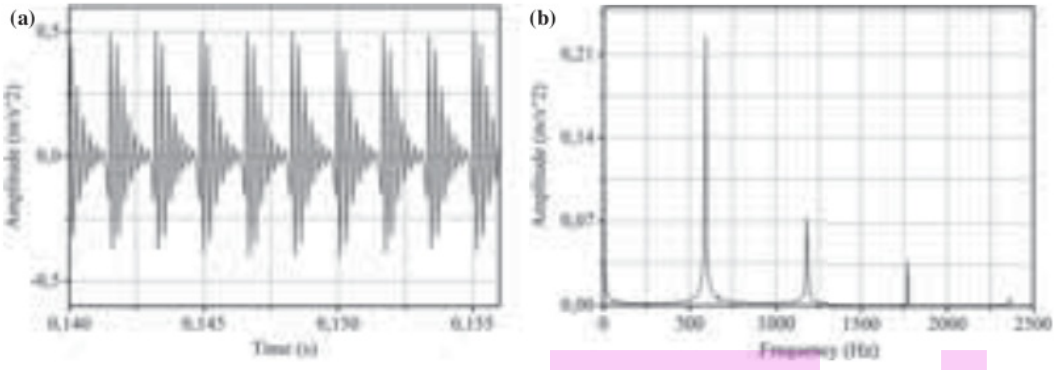

Fig. 11. The graphical view of the DS from the sensor after processing by the developed algorithm (a) and its spectrum (b).

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and if we consider it generally, they are the variables of the objective function $f^*_{DP} = \varepsilon = g(f_s, f_r, \varphi, N, \mu, n_{iter}) \rightarrow$ optim. However, you need to decide what to take as the optimal value. Since the above mapping is an operator, i.e., we get a function at the output, it's impossible to set a specific maximum or minimum directly, so you need to evaluate the output function. The peculiarity of this process is that the output function, in fact, is the DS. We made the decision to evaluate this function by DS information content parameter (I_{DP}) [10]. Thus, we can replace ε with its I_{DP} estimate. Thus, we obtain the following objective function:

$$I_{DP} = g(f_s, f_r, \varphi, N, \mu, n_{iter}) \rightarrow \max \quad (5)$$

The analytical form of THE expression (5) is not required due to the fact that all operations are performed by a machine in practice working with discrete quantities, and the objective function itself is specified in a table. The solution of the objective function (5) and finding the optimal value of the DS is based on formulas (6)–(8). Expression (6) represents the determination of the optimal parameters of the first group, the expression (7) includes the remaining parameters. Adaptive filter coefficients vary according to the expression (8).

$$F_S = \begin{bmatrix} (H_0 \otimes S_0) \otimes B \\ (H_1 \otimes S_1) \otimes B \\ \dots \\ (H_i \otimes Si) \otimes B \end{bmatrix}, \quad F_R = \begin{bmatrix} (H_0 \otimes R_{0FS}) \otimes B \\ (H_1 \otimes R_{1FS}) \otimes B \\ \dots \\ (H_i \otimes R_{iFS}) \otimes B \end{bmatrix} \quad (6)$$

$$F_\Phi = \begin{bmatrix} (H_0 \otimes \Phi_{0FSFR}) \otimes B \\ (H_1 \otimes \Phi_{1FSFR}) \otimes B \\ \dots \\ (H_i \otimes \Phi_{iFSFR}) \otimes B \end{bmatrix}$$

where F_S, F_R, F_Φ are the vectors of optimal parameters; H is the vector of filter coefficients until the optimal parameters μ and N are found; S is the vector of the processed signal; R_{iFS}–the vector of the processed signal with the optimal parameter f_s; Φ_{iFSFR}—the vector of the processed signal with the optimal parameter f_s and f_r, B—the vector for information content evaluation [12].

$$F^*_{DP} = \begin{bmatrix} W_0 \otimes S_{opt} \\ W_1 \otimes S_{opt} \\ \dots \\ W_i \otimes S_{opt} \end{bmatrix} \quad (7)$$

$$W_{(k+1)i} = W_k + 2M_i e_k N_k \quad (8)$$

where F^*_{DP}—diagnostic parameter vector; $M = [\mu_1 \mu_2 \dots \mu_i]$ the vector of the convergence rate parameter; W—the vector of filter coefficients during the search for optimal parameters μ and N.

4. RESULTS AND DISCUSSION

Let us evaluate the developed methodology by the example of the abovementioned DS processing, which was previously processed by other methods. The DS graph after processing is presented on Figure 11 in time (a) and frequency (b) implementation. It is similar to a signal that we could receive if we knew all the characteristics of the function n_1 (Fig. 6), i.e., correlating with the useful signal as much as possible, and the developed algorithm just allows you to find such a function n_1. In this case, this signal is better than the signal shown on Figure 6, due to the introduction of optimization with respect to the parameter of the filter core and the rate of convergence. If we analyze this DS, then we get the necessary knowledge about the defect, which can be used in the diagnosis.

The results of the proposed method correlate with the results of other methods for general cases, i.e., when the ratio of the useful signal to noise is such that high sensitivity of the method is not required to identify the useful signal.

5. CONCLUSIONS

The developed method allows to increase the information content of the DS by suppressing its other components. The key elements of this method are the use of an adaptive filter with optimal parameters and the search for the effective function n_1. Further research and opportunities may lie in the effective use of data that is provided by processing via the proposed method, for example, the development of a particular element or an algorithm diagnostic model for automatic identification of a defect.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5261–5264, 2019

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Removal of Petroleum Products from Water Surface by Chemically Modified Wood Waste

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In this work, they studied the possibility of woodwork waste use to remove oil products from the water surface by the sorption method. We used sawdust of ash (Fráxinus excélsior) and linden (Tília cordáta) as sorption materials, formed at the woodworking enterprises of the Republic of Tatarstan, as sorbates-fresh and used diesel engine oils, characterized by high boiling points and heavy fractional composition. To increase the sorption capacity of wood waste, they were chemically modified with the solutions of sulfuric, nitric, hydrochloric, perchloric, phosphoric and acetic acids with the concentration of 0.5, 1 and 3%. They determined the values of the maximum oil absorption of the initial and modified samples of sorption materials in relation to fresh and used motor oils. It was established that ash and linden sawdust modified with a 3% solution of nitric acid have the highest sorption properties. Determination of the sorption capacity by iodine and methylene blue showed that modified sawdust, in comparison with the initial samples, has a more highly developed surface, combining different types of pores: both micro- and mesopores. Experiments on modeling engine oil spills on water surface showed that chemically modified sawdust are effective sorbents of oil products, the degree of water purification reaches 99%.

Keywords: Acid Treatment, Oil Product, Oil Consumption, Wood Processing Waste, Sorption Capacity.

1. INTRODUCTION

Purification of surface and wastewater from oil products is currently one of the most significant environmental problems. Oil products get into the environment during accidental spills in pumping and transportation systems, in oil depots, in oil product storages, at gas station facilities and stations, as well as with sewage from industrial enterprises, storm and melt water. When oil products get into hydrosphere objects, they undergo various transformation processes under the influence of external factors, including the evaporation of volatile fractions, dissolution, precipitation, and photochemical oxidation of hydrocarbons under the action of sunlight, which leads to secondary pollution. Heavy oil products are particularly dangerous: fuel oil and mineral oils have low solubility in water and high boiling points. An effective and promising method for oil product extraction from aqueous media is the sorption processes using waste from agricultural, woodworking and other industries [1–10]. The use of vegetable raw material processing waste as sorption materials allows us to solve the dual problem in the field of environment protection: to ensure the use of waste accumulating in large volumes to obtain reagents for oil removal. To improve the sorption properties of cellulose-containing waste, chemical and physical modification methods are used: treatment with solutions of alkalis, acids, hydrogen peroxide, organic solvents, and the exposure to ultrasound [1, 2, 4–6, 8]. They studied the effect of chemical modification on the sorption properties of ash and linden woodworking waste products and the removal of oil products from the water surface by modified wood waste. The petroleum products with a high molecular weight and heavy fractional composition were used as a sorbate: motor oil of viscosity grade SAE 10W-40 and waste oil from a diesel engine.

2. METHODS

Chemical modification of sawdust was carried out with the solutions of sulfuric, nitric, hydrochloric, perchloric, phosphoric and acetic acids at the concentration of 0.5, 1 and 3%. For this, 10 g of initial sawdust was placed in flat-bottomed flasks of 250 cm^3 and 200 cm^3 of acid solution was poured, after which the contents of the flask were thoroughly mixed for 40–60 minutes at the temperature of (20 ± 2) °C. Then, the modified sawdust was washed with distilled water to a neutral pH value and

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dried at 70–75 °C to constant weight. The oil absorption of the initial and modified sawdust was determined similarly to the determination of oil absorption by the method described in Ref. [8]. The sorption activity of the samples was determined by the photocalorimetric method according to methylene blue via measuring the optical density of the clarified indicator solutions [11]. Iodine sorption activity was determined by titration of clarified iodine solutions with sodium thiosulfate solution [12]. The cellulose content in the sorption materials was determined by the nitrogen-alcohol method, for which a weighed portion of air-dried sawdust with the weight of 1 g was placed in the flask of 250 cm^3, 25 cm^3 of nitric acid solution in ethanol was added and boiled for one hour with a reflux condenser. The treatment was repeated three times with new portions of the nitrogen-alcohol mixture. After the last treatment, the cellulose was filtered on a glass porous filter, washed with 10 cm^3 of fresh nitrogen-alcohol mixture, and then with hot water until pH became neutral. Then the filter with cellulose was dried at the temperature of (103 ± 2) °C to constant weight and weighed. To simulate pollution of the water surface with oil products, a pre-weighed round brass sieve was placed in a Petri dish, then 50 cm^3 of distilled water and 3–9 cm^3 of the studied oil product (engine oil) were poured, after which 1 g of sawdust was applied to the surface of the oil film. After 15 minutes, the sawdust was removed and weighed on an analytical balance, the amount of oil remaining in the Petri dish was extracted with carbon tetrachloride. The optical density of the solutions was determined by the photocalorimetric method. Based on the mass difference, the amount of absorbed oil was initially calculated, then the amount of sorbed water was calculated.

3. RESULTS AND DISCUSSION

Since the studied woodworking waste has a different fractional composition, the sieve analysis of the samples was carried out, according to the results of which it was found that the most massive fraction was sawdust with a particle size of 1–2 mm. Under static conditions, the oil absorption of the initial sawdust of ash and linden was determined in relation to fresh and used motor oils. Figure 1 shows the graph of the initial sawdust of ash and linden oil intensity dependence on the contact time with respect to fresh semi-synthetic motor oil of SAE 10W-40 viscosity grade.

They showed that the main absorption of oil by sawdust occurs during the first 5 minutes of contacting. A further increase in exposure time does not contribute to a significant increase of the studied indicator. The maximum oil absorption for the initial sawdust of ash was 6.32 g/g for used oil and 5.88 g/g for fresh semi-synthetic oil, for the initial sawdust of linden −7.40 g/g and 6.85 g/g, respectively. In order to increase oil consumption, chemical modification of sawdust was carried out—the treatment with weakly concentrated solutions of sulfuric, nitric,

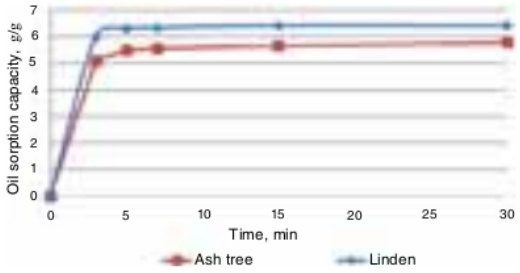

Fig. 1. The dependence of the oil intensity of the initial sawdust of linden and ash on the time of contact with the oil product.

hydrochloric, perchloric, phosphoric and acetic acids. The obtained values of maximum oil absorption depending on the type of oil product and acid concentration are presented in Table I for sawdust ash and in Table II for sawdust linden.

They showed that acid modification contributes to oil absorption increase of sawdust relative to fresh and used motor oils. At the same time, ash sawdust treated with a 3% solution of nitric acid has the highest oil consumption, the increase makes 25.2% with respect to used diesel oil and 17.8% with respect to fresh engine oil as compared to unmodified waste samples.

For linden sawdust, the highest oil absorption value was also noted for the samples treated with the 3% solution of nitric acid: 8.28 g/g in relation to fresh motor oil (increase by 20.8%) and 9.53 g/g in relation to used diesel oil (increase by 28.9%). Obviously, the interaction

Table I. The maximum oil absorption values of sawdust ash, depending on the type and concentration of acid.

	Maximum oil sorption capacity of sawdust ash when processing with acids concentration, g/g		
Modifying agent	0,5%	1%	3%
Sorbate-fresh engine oil			
Sulfuric acid	6,43±0,35	6,54±0,41	6,67±0,38
Nitric acid	6,63±0,39	6,79±0,33	6,92±0,45
Hydrochloric acid	6,39±0,44	6,49±0,49	6,57±0,35
Perchloric acid	6,41±0,36	6,51±0,39	6,58±0,44
Orthophosphoric acid	6,37±0,34	6,49±0,44	6,60±0,34
Acetic acid	6,31±0,45	6,40±0,41	6,49±0,39
Without treatment		5,88±0,18	
Sorbate-used diesel engine oil			
Sulfuric acid	7,37±0,38	7,57±0,33	7,66±0,45
Nitric acid	7,59±0,35	7,78±0,36	7,91±0,40
Hydrochloric acid	7,17±0,51	7,39±0,37	7,47±0,49
Perchloric acid	6,97±0,49	6,99±0,39	7,23±0,41
Orthophosphoric acid	7,11±0,46	7,22±0,45	7,44±0,52
Acetic acid	7,05±0,55	7,12±0,35	7,21±0,55
Without treatment		6,32±0,24	

Table II. Maximum oil absorption values of linden sawdust depending on acid type and concentration.

Modifying agent	Maximum oil sorption capacity of linden sawdust when processing with acids concentration, g/g		
	0,5%	1%	3%
Sorbate-fresh engine oil			
Sulfuric acid	7,23±0,45	7,48±0,52	7,81±0,50
Nitric acid	7,99±0,49	8,14±0,35	8,28±0,35
Hydrochloric acid	7,26±0,35	7,41±0,53	7,58±0,32
Perchloric acid	7,36±0,45	7,55±0,50	7,67±0,36
Orthophosphoric acid	7,09±0,38	7,13±0,45	7,33±0,39
Acetic acid	6,83±0,33	7,18±0,39	7,23±0,35
Without treatment		6,85±0,19	
Sorbate-used diesel engine oil			
Sulfuric acid	8,28±0,31	8,49±0,41	8,92±0,38
Nitric acid	8,61±0,36	9,11±0,50	9,53±0,32
Hydrochloric acid	8,02±0,35	8,17±0,35	8,27±0,29
Perchloric acid	7,99±0,33	8,14±0,33	8,36±0,35
Orthophosphoric acid	7,42±0,45	7,54±0,37	7,78±0,41
Acetic acid	7,99±0,43	7,43±0,39	7,72±0,32
Without treatment		7,40±0,25	

of the studied sorption materials with weak acid solutions leads to a slight increase of the maximum oil absorption. This fact is probably explained by the following: the acid treatment of wood waste contributes to the proportion of amorphous cellulose zone increase, which positively affects the increase of the specific surface and adsorption capacity of the material. The changes in the structure of wood biopolymer macromolecules under the action of acid solutions can contribute to the increase of the pore space and, accordingly, the oil absorption of wood sawdust. For both the original and modified sawdust, the oil absorption in relation to the used oil is higher than in the case of fresh oil. The reason is that the used diesel engine oil, unlike fresh, contains hydrocarbon oxidation products with polar chemical bonds, which leads to increased sorbate-sorbent interaction and increased sorption. In addition, the used oil has a slightly higher density than fresh oil at 20 °C and kinematic viscosity at 40 °C, which leads to increased adhesion interaction and, as a consequence, to oil absorption increase. One of the most important characteristics of sorption materials, which largely determines the possibilities of their practical application, is the sorption capacity, which is conditioned by the presence of a porous structure and a highly developed surface. To assess the effect of acid treatment on the sorption capacity of sawdust, iodine and methylene blue adsorption parameters were determined for the initial samples, as well as the samples subjected to treatment with 3% solutions of nitric and sulfuric acids. The data are presented in Table III. By the adsorption value of methylene blue, one can determine the presence of mesopores with the diameter of 1.5–200 nm in the sorption material, while the iodine

Table III. Sorption capacity for iodine and methylene blue sawdust of ash and linden.

The name of the sample of the sorbation material	Sorption capacity by methylene blue, mg/g	Sorption capacity by iodine, %
Ash native sawdust	8,75	15,87
Ash sawdust modified H_2SO_4, 3%	21,19	17,11
Ash sawdust modified HNO_3, 3%	26,32	20,36
Linden native sawdust	30,60	21,80
Linden sawdust modified H_2SO_4, 3%	58,25	25,43
Linden sawdust modified HNO_3, 3%	87,42	27,08

sorption activity characterizes the microporosity of the sorbents and the presence of pores with the diameter of less than 1.5 nm.

It is obvious that modified sawdust have a more highly developed surface, combining different types of pores: both micro- and mesopores, in comparison with the initial samples. The increase of sorption activity for methylene blue (by 200% for ash and 185% for linden) indicates a noticeable increase of mesopores, and sorption activity increase for iodine (by 28% for ash and 24% for linden) characterizes micropore volume increase in the structure of the sorbent as the result of treatment with nitric acid solution [13]. They also studied the effect of acid treatment on the composition of sawdust, in particular, on the content of cellulose, which is the main organic component of wood. The nitrogen-alcohol method was used to determine the cellulose content in the initial and chemically modified linden sawdust. It was shown that the mass fraction of cellulose in the initial samples makes 51.06%, and in sawdust treated with the 3% solution of nitric acid, its value decreases to 46.22%. The decrease of the cellulose content in wood as the result of acid treatment can be explained by the hydrolysis of cellulose and hemicellulose with the formation of simple sugars (glucose, xylose, etc.), which increases the porosity and sorption capacity of sawdust [14]. A special problem when oil products enter the hydrosphere is their removal from the surface of water, since the sorption materials used in this case, in addition to oil products, also absorb water. We have studied the sorption capacity of modified sawdust during the removal of used engine oil from water surface. The results obtained for sawdust linden treated with the 3% solution of nitric acid are presented in Table IV.

Table IV. The simulation results of oil film removal from water surface.

Volume/ weight of oil product, ml/g	Total oil and water-absorbing value, g/g	Oil absorption, g/g	Water absorption, g/g	The degree of removal of oil, %
3/2.616	4.215	2.615	1.604	99.81
5/4.360	5.218	4.349	0.869	99.75
7/6.104	6.680	6.340	0.234	98.26
9/7.848	7.312	7.266	0.046	96.05

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The simulation results show a high degree of water purification from oil product by modified linden sawdust. With a small amount of oil product spilled on water surface (3–5 cm^3), the cleaning efficiency exceeds 99%, with a larger film thickness of the oil product, the degree of removal is slightly reduced.

4. SUMMARY

Processing of ash and linden sawdust with weakly concentrated solutions of acids helps to increase their oil intensity in relation to fresh and used motor oils. In this case, the samples treated with a 3% solution of nitric acid have the highest sorption capacity in comparison with the initial waste. They noted the increase of mesopore volume (by 200% for ash and linden) and micropore volume (by 28% for ash and 24% for linden) in the structure of sorbents as the result of treatment with nitric acid solution. Modification of sawdust with weakly concentrated acid solutions helps to reduce the value of the mass fraction of cellulose in wood. The results of experiments modeling engine oil spills on water surface showed that modified sawdust of linden and ash are effective oil sorbents. With a small amount of oil product, the water treatment efficiency is more than 99%.

5. CONCLUSIONS

Chemically modified sawdust of ash and linden can be considered as effective, inexpensive, affordable, environmentally friendly sorption materials for heavy oil product removal from water surface. The studied materials can be recommended as a sorption in floating booms and other floating adsorbing elements.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5265–5276, 2019

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Balcony Effect on Thermal Performance of the Building and Its Climate Assessment in Local Houses in Mazandaran Province

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Utilization of natural ventilation in buildings has a long history. Architecture has been trying to response to weather conditions all the time. Wind catcher, mashrabiya, portico and iwan are some examples of climate designs in vernacular architecture which have shown the importance of natural ventilation since a long time ago. The efficiency scope of natural ventilation when used with other cooling techniques will be more widespread. Today, designing desirable buildings using natural ventilation requires knowing theoretical foundations and a detailed study based on new knowledge regarding the feasibility of the use of components design and equipment related to natural ventilation. The present research aims to offer architects some design solutions in order to take advantage of natural ventilation in buildings using the vernacular architecture. Through matching features of functional spaces in local houses with climatic characteristics of regions around the Caspian sea (Mazandaran province) and determining the pattern used in these spaces in housing areas, the present study seeks to answer this question: "Are types of local houses in regions with moderate and humid climate in Iran (Mazandaran) consistent with regional climate in terms of patterns applied in internal functional spaces? How do regional climate features affect physical form of houses?" The results show that there is a direct and consistent relationship between vernacular architectural features of Mazandaran province and climate classification and regional climate. It also enhances home comfort in summer and finally, it can be concluded that local houses are built based on the climate classification and environment context, and natural ventilation is the most important factor affecting the conditions which improve environmental comfort. The present research provides some guidelines for the architectural design of residential buildings in regions with moderate and humid climate with the aim of achieving maximum level of natural ventilation. Also, in order to exploit the potential of natural ventilation, the results of the research will help architect select optimal designing parameters in harmony with the regional climate.

Keywords: Natural Ventilation, Balcony, Local Houses Mazandaran Province.

1. INTRODUCTION

Formation of vernacular architectural elements is strongly influenced by environmental factors and the miracle of vernacular architecture in using regional materials and creating special techniques of construction as the best methods for meeting physical and spiritual needs of human being in terms of construction is obvious for everyone. Investigating local buildings is a short step to recognize indigenous techniques and knowledge of their creators when traditional tools and materials could provide only limited options for human. Today, the need for mechanical heating and cooling is minimized in buildings designed and built based on climate methods. In these buildings, in addition to exterior features, building plan is determined based on the use of climatic factors in terms of performance in different seasons. Therefore, the use of fossil energy is minimized and building energy is provided through renewable energy and comfort condition is achieved at higher level [1]. In the past, semi-open spaces in general and iwan in particular were considered as important spaces in traditional houses. Today's houses are built similarly in different climate and microclimate which this category leads to various problems caused by the indiscriminate use of

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fossil fuels. Mild and humid climate is observed in the southern coast of the Caspian Sea in Mazandaran. Paying attention to climatic factors as well as vernacular architecture in these regions can lead to patterns which not only save energy consumption but also provide a higher level of comfort. The present research seeks to answer this question: "can iwan as a main element in Persian architecture with some certain physical features enhance natural ventilation in buildings especially located in the Caspian coastal strip?" Therefore, the aim of this study is to evaluate the various types of ventilation patterns in indigenous housing in Mazandaran. This is a qualitative research and data is collected and analyzed through grounded theory.

Data is collected through case study. Case study provides an opportunity to gather precise and detailed information about the subject. In-depth and exact investigation, focusing on real events in real life content in limited time and space and a holistic attitude are all features of the present study. This kind of study is appropriate for making and testing theory [2]; therefore, it can be very efficient. Observing and reviewing documents are two main methods of collecting data in this study.

2. STAGES OF THE RESEARCH

A. First stage includes findings about climate, cities, houses, patterns and measurement standards. The results of this stage are as follows:

1. Stage leading to identification and selection of cities.
2. Stage leading to choosing houses in towns and villages to be studied in the present research.
3. The total typology of houses and identification of dimensions, directions, proportions and physical features of houses.

B. The second stage involves simultaneous analysis of research data. Image description of selected samples is shown.

C. The third stage involves results and conclusion which the findings of the study can be provided.

3. RELATED REVIEW OF THE LITERATURE

Related review of the literature is classified based on studies conducted in the field of A. Residential natural ventilation and B. Investigating and categorizes of balcony.

4. RESULTS OBTAINED FROM RELATED LITERATURE IWAN

Every house needs a semi-open space and this category shows iwan performance and importance in the Caspian area which despite enjoying high airflow, house can be protected against raining from time to time in this region. Iwan is a place used for relaxing, eating, sleeping, entertaining guests, drying cloths and dishes and more. Therefore, iwan is functionally similar to room. Due to this category that iwan is the most important element in indigenous houses of Mazandaran, it has an enormous impact on improving environmental comfort. Iwan refers to a seating place higher than surrounding area which is commonly built in the outer part of the residential buildings. Experts believe that the eastern part of Iran, especially Khorasan is the cradle of iwan and great iwans have remained from Parthian period in Iran. The most beautiful and wonderful iwans are observed in Persian-Islamic buildings and mosques and Iranian iwans are often long and have been built with interesting and various arcades. In Amid dictionary, iwan refers to open space in front of the room, saffe, and an open space in building with no windows and according to Dehkhoda, it refers to saffe, arch, a seating place higher than other areas with ceiling and doorway. According to professor Pirnia (R.I.P), saffe means an iwan and a hall which have been covered with arch. Iwan allows individual to define and delimit space and it is also the transitional space between earth and time factors. According to metaphysical perspective, iwan can be considered as a soul of house which is placed between garden and courtyard as soul and room as body [3]. Iwan can be considered both formally and conceptually as a point of transition from the earth to the sky [4]. Iwan refers to a semi-open space that is mostly covered and is located in front of living spaces and connects the open space of courtyard with the close space of inside. Iwan is a wide and rectangular space which is built in front of one of the sides of the building which involves most of openings. Iwan space is usually open from one or two sides. Iwan is deep enough to the extent that its interior walls do not receive sunlight [5]. Iwan is a connecting place and it appears in two forms (walled on three sides and open on one side). From exterior to interior perspective, since iwan is located in a place higher than other spaces in the building, it is considered as introducing and front space of building which validity of interior facades of courtyard depends on iwan value. From interior to exterior perspective, iwan refers to a determined wide space which is enclosed and considered as the main part of the house opened to small garden (yard) which means paradise. It is a symbol of perfection with its quadrilateral form and center (pool and water) and a symbol of the universe which is static with no direction in the most perfect yard that is a yard with four iwans. Four iwans represent four sides of the universe which look at the center of the small world. Therefore, a complete Mandel (the universe mapping) is formed in the heart of the smallest unit of the traditional city (house) [4].

4.1. Iwan Importance in Architectural Structure of the House

In the past, semi-open spaces in general and iwan in particular were considered as important spaces in traditional houses in Iran. These spaces influence overall organization of the building with two open and close spaces and are

considered as independent areas which have a variety of functions. Iwan is considered as the most important one among them because it has its own architectural structure in physical, functional and structural terms. It should be said that Iranian architecture respects various biological aspects of human being and responses them appropriately. That's why even the category of transition which might be less considered in today's architecture involves significant physical and spatial values in traditional architecture and becomes a successful architectural pattern. Therefore, semi-open spaces are considered as transition points connecting open and closed spaces with each other and in this way, closed spaces are connected to open spaces through semi-open spaces. These spaces, especially iwan have common features of both indoor and outdoor spaces and have functional and physical performance. Three groups of open, closed and semi-open spaces are not constructed separately but each of them is meaningful along with others in architectural structure of traditional houses. In other words, spaces lose the degree of openness and closeness gradually in the way that they become connected to each other. This conjunction in the composition of spaces makes consecutive spaces be an extension of each other [6]. Moreover, iwan is extensively used in warm seasons and many functions take place there including eating, sleeping, working and etc. It also adjusts room temperature located in the back of it in all seasons and has a lot of values in climatic terms [7]. Since similar patterns of living have role in forming iwan in different parts of the country, this space enjoys a particular unity. Climate and natural environment and subcultures are factors which make a difference in the number, position and shape and decoration of iwans in different regions of the country which first two factors are more important.

4.2. Iwan in Different Ecological Zones

Iwan has different and special shapes and forms in different parts of Iran. In the desert, it is vaulted and domed which is walled on three sides that connect to inside the building through a way. In the eccentric architecture of Gilan and Mazandaran, iwan is open on three sides and is placed outside the building. It has sloping roof on standing columns. In Abyaneh, a covered iwan which is open on three sides and located in the top floor is called Pachkem, pashkem, bashkem, bachkem. An iwan which is opened to miansara from one side is called saffe in Khorasan. Iwan which is settled behind the sun and used in summer is called hall in Yazd. A small iwan which can be seen in most of small houses is called hall in Masouleh. Iwan has flat cover in Tabriz which is walled on three sides. Iwas has been less used for sitting in cold weather; so that there is no space for sitting generally or the considered space for sitting is very small which was used in summer. Iwan was a place to prevent direct snowing on building facade and also it was a buffer space in front of the main spaces of the house to protect the house against cold weather. Table I summarizes the characteristics of iwan in different cities and indicates their local term.

Table I. Iwan in different ecological zones, Reference: Nejadebrahimi.

No.	City	Characteristics of Iwan	Local term
1	Yazd	Vaulted and domed, walled on three sides	Iwan which is settled behind the sun is called hall
2	Gilan and Mazandaran	Sloping roof with one end open	–
3	Masouleh	Flat roof, open on three sides	A small iwan found in most of houses is called hall
4	Khorasan	–	An iwan which is opened to miansara from one side is called saffe
5	Abyaneh	Covered, open on three sides	Pachkem, pashkem, bashkem, bachkem
6	Neyriz	Flat roof, walled on three sides	–

4.3. Relationship Between Building and Open Space in Houses

Usually, the composition and relationship of each building with open space are designed and constructed in the way that they become consistent with all phenomena affecting the formation and the way of using space, especially the phenomena related to natural and artificial environment in order to achieve the highest and best opportunity of using space. Study of traditional housing units in various cities and regions of the country shows that environmental phenomena have the most important role in the formation of building combination with open space because adjusting environmental conditions and building ventilation and lightening are of most important categories which have fundamental impact on the organization of the residential space. In general classification, types of housing units are categorized into two groups of unidirectional and bidirectional spaces in terms of combination of building with open space [8].

4.4. Iwan and Climatic Design

Protrusion of iwans prevents the interior spaces and iwans body from receiving sunlight and keeps the surrounding cool through prevention of transferring heat. Generally, iwans and protrusions of the building keep it cool during the day and warm at night. Some believe that enjoying shadowed, open and fresh space in summer is the reason of having iwan in houses. The side walls accelerate and help better ventilation of the space. Since the vertical walls can drive air flow to the internal part of the iwan, the use of protruded walls in building facade leads summer winds into the building. Iwan built on the southern part of the courtyard catches the wind and if iwan is facing favorable

winds, it can be widely used in warm seasons. Also, when there is no airflow, trapping cold air in the iwan back to the sun helps ventilation of the interior space.

4.5. Iwan in a Region with Mild and Humid Climate

Iwan and summer hall which are of the most important elements of housing units and the place for doing most of daily activities are considered as obvious layer surrounding the building and are constructed on foundations and positions higher than the ground to get rid of humidity of the ground. Floors are connected to the ground through one way stairs. Because of mentioned characteristics, residential architecture of these points is extrovert and outside space is more preferred to inside space most of the time. Connected iwans are an integral part in traditional houses because they have various functions such as living room, guestroom, bedroom, children's play room, a place for eating and cooking and whatever is necessary during day and night. Rooms are located behind the iwan which is mostly facing towards south. Unlike rooms of rural houses which have a single layer, rooms are connected to each other and have been made of two layers in many old houses in cities. Iwan is one of the important areas in house. This space has various functions and takes different forms according to the position of rooms. The simplest iwan has a protruded roof. Some beams and columns are used to keep beams used in the roof static. In this case, some columns are located in front of iwans from the simplest and smallest ones to the largest ones. In some buildings which have not elevated floor, horizontal beam separates iwan space from courtyard. In addition to this category that iwan is a place connecting outside space with inside space, it is considered as a place for sitting, sleeping and working in warm season. Another function of iwan is connecting rooms with each other in multi-room houses. Therefore, according to the type of room, the position of iwans differs.

4.6. Investigating the Role of Iwan in Houses Located in Areas with Mild and Humid Climate

Because of locating vernacular contexts in pure space and their interaction with the environment, iwan is considered as a most important element in houses located in areas with mild and humid climate. Therefore, the role of iwan is very significant in local housing in Mazandaran in following cases:

Iwan and human interaction with its nature and sense of localization, iwan and its hierarchies, multi-purpose space of it, its fluidity and sustainable architecture are separately analyzed in the following part:

A. Human interaction with the environment: it is an interaction created between human and natural and human environment which forms a physical environment including physical context, architecture form, elements and architectural details. Houses located in areas with mild and humid climate have been inextricably associated with their own natural context. In this kind of architecture, iwan is indeed the symbol of true and respectful interaction between human and natural environment. This semi-open space plays a significant role in creating visual qualities and development of living process from closed to open space. It gives people this opportunity to enjoy beautiful scenes and visual perspective when doing their daily activities.

B. Through an appropriate orientation towards important directions and beautiful landscapes, iwan and its sense of localization make human being have a proper understanding and strong sense of the place concept.

C. Iwan and its hierarchy are considered as connecting space, a transition point between internal and external space, private and public area and closed and open environment. In addition to this category that iwan has a certain identity and personality, it connects open space (courtyard) with open or semi-closed space (iwan) and finally closed area (home) elaborately. In other words, public space of yard, then semi-private space of iwan and finally the private space of house are consecutively located in building.

D. Iwan and spatial fluidity: iwan creates spatial fluidity. Moving is a means of understanding space, and fluidity is moving in space by visual character and not by physical displacement. Iwan gives an opportunity which the possibility of watching with no physical movement and displacement in space is provided. Spatial fluidity leads to comprehensibility of this kind of architecture and houses enjoy spatial dynamic, continuity and persistence. Spaces have fluidity and such fluidity has been provided through connective spaces such as iwan and it has created a certain attractive space in these simple dwellings.

E. Iwan as a multifunctional space: iwan is usually a carpeted place which its flexibility to cope with different functions makes it a multifunctional and multipurpose space. This place is very pleasant when it is used as place for sitting and collecting family members in the pleasant hours of a day. It is also used as a place for resting and night sleeping; therefore, it is called sleeping-porch in some areas. In some seasons, housewives use this space for doing their daily activities such as knitting during the day. Since iwan is a connecting space between closed space of home and open space of the yard, they can control and monitor both spaces appropriately. In some areas, iwan is used as a space for depot and temporary storage of products.

F. Iwan and sustainable architecture: iwan like other housing elements has pleasantly played its role as harmonious factors with climate. Through positive climatic performance and proper orientation towards the sun, iwans have provided optimal opportunities to make use of solar energy and natural ventilation. Proportions (depth and height) in iwan are in the way that absorption of solar energy becomes possible in winter and vice versa it prevents the

Table II. Different features and functions of Iwan.

No.	Different features and functions of Iwan
Physical and spatial	The space between inside and outside, flexibility and multi-functionality, a connecting space
Climatic	Air conditioning, keep the environment fresh and cool by shading, speed up air flow through the side walls, trapping cold air temperature when there is no air flow, dispersing the moisture accumulated around spaces walls, absorption of solar energy in winter and air conditioning in summer, reducing energy consumption at the entrance of the house
Economic activities of families	Depot and temporary storage of products, economic activities of women

absorption of light and heat in summer by shadowing the space. On the other hand, iwan which is a semi-open space between open space of yard and closed space of home minimizes energy dissipation caused by the opening and closing the entrance door and helps adjust environmental conditions. One of the distinctive features of Iranian architecture is using a connecting space between inside and outside. Iwans have been constructed because of climatic reasons. In the way that they have been designed consistent with the climate. Some changes have been observed in Iranian iwans by entering west-architecture in the middle of Qajar era into Persian architecture. In this way, iwan has lost its climatic function. Table II shows different features and functions of iwan based on physical, spatial, climate, and economical activities standards.

5. CLIMATE STUDIES

Previous studies conducted on consistency between climate and architecture show that according to experts, architectural features in regions with mild and humid climate are formed to modify climatic conditions and depend on climate components. The purpose is to achieve an appropriate strategy consistent with climate factors of that place. These strategies virtually make architectural features of the place. Due to relative humidity and relatively high temperature, heat and rain effects, it is the most important objective to adjust the level of heat and humidity and rain effects in the area under investigation.

6. STRATEGIES PROPOSED

A. Use of the normal flow of air and prevailing winds.
B. Local breeze and creating a shadowed space and prevention of receiving sunlight.

Climate strategies are achieved through features and physical components of architecture in one place.

6.1. The Sea Breeze

In another part of studies conducted, the greatest level of the sea breeze penetration along the beach was investigated. The results have indicated that the maximum rate of flowing the sea wind towards land is in the afternoon 10 m/s and maximum depth of breeze penetration into land is 20 km and the most optimal and effective depth is 10 km.

6.2. Ventilation and the Great Effect of Wind on Ventilation

Studies conducted on the relationship between design and natural ventilation can be divided into three large, medium and micro scales. The purpose of designing natural ventilation in large scale is to investigate the effects of natural ventilation in relation to urban blocks with different heights, design urban open space, orientation of various dimensions and how the streets are connected to each other. The purpose of designing natural ventilation in medium scale is to investigate designing effective natural ventilation in relation to a building or a complex. Micro scale relates to investigating function of certain parts such as solar chimneys, atrium and wind catcher. The architectural design of buildings with natural ventilation includes research conducted on two areas of medium and micro

Table III. Classifying stations based on climate and distance from sea.

No.	Station	Distance from the sea	Koppen-Trewartha	No.	Station	Distance from the sea	Koppen-Trewartha
1	Ramsar	10	Csa	12	Bi Kola research	20	Csa
2	Talarsar	10	Csa	13	Afrachal	20	Csa
3	Khoshkedaran	10	Csa	14	Tirtash	20	Csa
4	Khoramabad	10	Csa	15	Garm Rudabad	20	Csa
5	Nowshahr	10	Csa	16	Pol-e Zoghal	20	Csa
6	Rine Larijan	20	Dcb	17	Urimalek	20	Csa
7	Chamestan	10	Csa	18	Koresang	20	Csa
8	Babolsar	10	Csa	19	Soleiman Tange	20	Csa
9	Gharakhil ghaemshahr	20	Csa	20	Erikanour	20	Dcb-Bwks
10	Faculty of agriculture	20	Csa	21	Shirgah	20	Dcb-Bwks
11	Zardgol sorkhabad	20	Dob	22	Mahmoud Abad Sari	20	Csa

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Table IV. The baseline situation of houses.

No.	City	Climate	Number of houses	No.	City	Climate	Number of houses
1	Amol	csa	4	6	Sari	csa	3
2	Babol	csa	4	7	Savadkouh	csa	4
3	Tonekabon	csa	3	8	Qhaem Shahr	csa	2
4	Chalus	csa	3	9	Neka	csa	3
5	Ramsar	csa	4	10	Nowshahr	csa	5

scales. They have been extensively studied in the present research.

A. The medium scale which includes building shell, designing proportions, facade, openings, orientation, materials and thermal mass and ventilation patterns.

B. The micro scale includes ventilation components: the old ventilation elements such as central courtyard, atrium, wind catcher along with new elements such as side walls, ventilation ducts, double skin facades, and turbine ventilators are defined as ventilation components in climatic design. Balcony is the most important element in micro scale.

6.3. Climate Classification and Knowing Microclimate

Various methods of climatology have been studied in research conducted on climatology. The present research is based on the Koppen-Trewartha method.

Table VI. Classifying houses based on iwan classification.

No.	Iwan form	Number (house)	Percentage (house)	Common ratios	Common direction
1	Open on three sides and windows are perpendicular to the wind direction	4	11%	1:8–1:6–1:7	South
2	Iwan walled on three sides and windows are in wind direction and perpendicular to it	15	41%	1:6–1:3–1:2–1:4	South
3	Iwan walled on two sides and windows are in wind direction and perpendicular to it	9	26%	1:6–1:5–1:4–1:3	South
4	Iwan walled on two sides and windows are in wind direction and perpendicular to it	8	22%	1:6–1:4	South

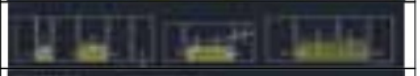
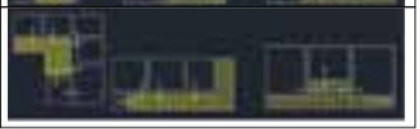
Table V. Analysis of houses under investigation.

No.	City	Village	North direction	General shape	Biosphere extension	Closed spaces	Open and semi-open spaces	Connecting spaces	Entrance
1	Neka	Chal mardi						Open in southwest direction	
2	Amol	Esku Mahalleh						Semi-open in south direction	
3	Savadkouh	Andar Koli						Semi-open in south direction	
4	Bobol	Pija Kola						Semi-open in south direction	
5	Sari	Pahne Kola						Semi-open in south direction	
6	Ghaem Shahr	Tir Kola						Semi-open in south direction	

Table VII. An introduction to six houses based on typology of iwan.

No.	City	Village	Living spaces and iwan position	Three-dimensional structure of house	Form classification	Iwan modulation	Connecting spaces
1	Neka	Chal mardi			Open on three sides and windows are perpendicular to the wind direction		Open in southwest direction
2	Amol	Esku Mahalleh			Iwan walled on two sides and windows are in wind direction and perpendicul ar to it		Semi-open in south direction
3	Savadkuh	Andar Koli			Iwan walled on two sides and windows are in wind direction and perpendicular to it		Semi-open in south direction
4	Bobol	Pija Kola			Iwan walled on three sides and windows are in wind direction and perpendicular to it		Semi-open in south direction
5	Sari	Pahne Kola			Iwan walled on two sides and windows are in wind direction and perpendicular to it		Semi-open in south direction
6	Ghaem Shahr	Tir Kola			Iwan walled on two sides and windows are in wind direction and perpendicular to it		Semi-open in south direction

Table VIII. General form of iwan based on iwan classification.

No.	Typology of iwan form	Common types
1	Iwan open on three sides and windows are perpendicular to the wind direction	
2	Iwan walled on three sides and windows are in wind direction and perpendicular to it	
3	Iwan walled on two sides and windows are in wind direction and perpendicular to it	
4	Iwan walled on combination of two and three sides and windows are in wind direction and perpendicular to it	

Koppen-Trewartha classification includes six major climate groups. Five groups based on the five main heating areas and the six one which is dry group disconnects four heating groups except polar-climate group in another direction and it is defined based on the amount of rainfall. Therefore, temperature distinguishes five main climate branches and rainfall just one branch. Five groups with thermal criteria have a certain position in the world which is not applied in dry group.

6.4. The Scope of the Study

Mazandaran is one of the provinces of Iran. The Caspian Sea has been located in the northern part of Mazandaran. It connects to Tehran, Semnan and Qazvin from the south. It is limited to Gilan from the west and to Golestan from the east. Its southern part is mountainous and northern part is coastal plain. It covers an area of 24091/3 km^2 and 1/46 percent of the total area of the country is dedicated to this province.

6.5. Analysis of the Cities and Distance from the Sea

According to previous studies, latest statistics reported in 2006 showed that Mazandaran has 16 counties, 44 districts, 51 cities and 113 villages. Since the sea breeze penetrates from the coast to the land in a distance of 10–20 km, it is required to investigate the distance between counties and the sea.

6.6. Climate Classification of Cities of Mazandaran

Since natural ventilation is one of the most important factors in creating environmental comfort and as wind and its speed and how deep it will penetrate into the land are important categories, penetration of the sea breeze which is effective on ventilation reported on a distance of 10 km from the sea after examining characteristics of the sea breeze and depth of its influence on the land. Therefore, cities were classified based on this category. Table III introduces stations and their distance from the sea and climate classification.

6.7. Case Studies (Selecting Cities and Houses)

According to studies conducted on research methodology, sampling should be continued to the extent that the data collected suffice to prove theories and conclusion. If there is no possibility to present a theory or give an appropriate answer to the research question, sampling should be continued to reach data saturation. Of course, it depends on examples related to the topic under investigation. Also, the sampling method should be selective and based on the theoretical foundations of the research.

In this part, Mazandaran houses and their physical characteristics are investigated. Then the plan of 36 houses in Mazandaran are shown based on the climate classification presented and some features and standards such as proportions of iwan, window sizes, the distance between building and wall, the number of windows, the distance between windows and side walls, form of windows and window-to-wall ratio are analyzed. This study is conducted on houses which are at least 50 years old with common climate of csa.

Based on the number of selected houses, first each house was drawn in AutoCAD and then they were statistically analyzed (see Table IV).

6.8. A Summary of Houses Characteristics

In this part, a summary of houses characteristics is investigated with the criteria for the north direction, overall shape, extension of bio-space, open, closed and semi-closed space, communicative space and entrance direction. In Table V, 36 case studies are investigated and compared. This study includes some components such as name of city and village, north direction, general shape, biosphere extension, closed spaces, open and semi-open spaces, connecting areas and entrance position.

Table IX. Introducing houses.

Architectural features of house			**Neka County**			**Chalmardi village**	**Owner: Gol Mohammad Shabani**					
Mazandaran province			Geographic longitude: 53119			Geographic latitude: 3639	Distance from the sea: 45					
			Total scale				Small scale					
group	Relation with the environment	percent	location	direction	form	Medium scale	ratios	window	Plan form	Access to closed living space	Main access	Proportions in living space
Closed space	close	84	Ground floor	East-West	Exterior, East-West direction, functional spaces at the same balance, direct relationship between rooms and outdoor, multiple wide openings	From yard to semi-open space From semi-open space to room From open space to room From room to room	1:3	southern	rectangle	south	south	
Semi-closed space	-	10	-	-								
connective	open		Ground floor	East-West								
subsidiary	close	6	Ground floor	East-West								

Table VI shows typology of iwan form and classification of houses in terms of number, percentage and common ratios and directions in this category.

36 houses are categorized in six tables according to the city name, village name, living spaces, iwan position, three-dimensional structure of house, form classification, iwan modulation and connecting spaces. Table VII shows the results of analysis of six houses investigated in the present study.

Table VIII shows typology of iwan form and its common types. Table IX introduces research statistical population which has been prepared for all houses.

7. RESULTS

The certain design of buildings shell in Mazandaran is considered as an important element influencing ventilation efficiency. According to previous studies, there are some factors affecting natural ventilation in local houses; factors tested in the present study are of most importance.

8. PROPORTIONS

In various studies, some standards have been proposed about building proportions to achieve optimal ventilation. The results show that when the width of the building increases, maximum air speed will increase and better potential will be provided for natural ventilation. The optimal ratio between length and width of the local house in Mazandaran is 1:3 from north to south and the highest percentage of window area is towards the south and a very small percentage is towards the west and east. According to the results, it is necessary to set the house with prevailing wind direction and it is more preferred to use rectangular houses than other forms of houses. House designing are mostly done in one floor. Open plan designing in the interior space, closing the opening of eastern and western walls and building extension is observed in the east-west direction in houses. The category of building proportions is one of the factors effective on selecting patterns.

8.1. Facade Design

Thermal behavior of facade components plays an important role in determining heat absorption in building and internal environment. Optimize ventilation for cooling a building can be created by reducing heat absorption. This category includes the way of using materials, thermal insulation of walls, colored glass and shadowing static components. In examining the potential of the natural ventilation in vernacular buildings of Mazandaran through medium scale and moderate climate, the role of openings and the location of building in distribution of indoor air velocity are studied. In addition to the proper orientation toward favorable wind, suitable interior design can increase ventilation capability in hot days. When the width of the building increases, maximum air speed will increase and better potential will be provided for natural ventilation. In this way, a rectangular building is proposed for houses located in regions with humid and moderate climate with ratio of 1:7, 1:4, 1:5 and 1:3; it seems to be an optimal choice for natural ventilation in moderate climate. Further studies are required by increasing the partition, the size of windows and inlet and outlet doors.

8.2. Building Form

Enjoying wind will lead to comfort in building in regions with moderate and humid climate. In moderate and humid climate, the sultry condition is reduced by removing moisture from the environment. Building acts like a barrier against air flow and building form is effective on driving wind appropriately inside it. Building form should be in the way that air can be flown in the best way inside it. The building should be designed in the way that air is entered the building in funnel form; therefore, the input amount can be increased. When the building is rectangular and wind direction parallels to the longitudinal side, better ventilation will be done.

8.3. Plan and Air Flow Direction

Frames, protrusions, shutters and other controlling elements of openings are effective on internal air flow. Protruded roofs are used in mentioned regions in order to prevent penetration of rain into the building and in this way driving air flow into the living environment will be more possible.

8.4. Air Flow in Plan

Factors such as designing protruded plan and creating beveled corners and angles against wind in order to increase the efficiency of wind energy, putting an opening in the place of entering air flow around the building just to drive wind into the building, use of protruded roof, partition and suitable furniture, proper position of the building which leads to driving air flow, and inserting an entrance space in a place of plan which has fallen back have great effect on ventilation by air flow.

8.5. Plan Form

Local buildings can make use of semi-enclosed spaces to reduce humidity level in the summer; therefore, driving air flow in the surface and higher layers of the building will be easily possible. The level of humidity and rainfall is very high; therefore, residential building should be constructed in the way that it decreases the humidity level exceeding human tolerance. Hence, the humidity and temperature will be favorable. Wind flowing will be possible to remove humidity from the covered transparent layers with many openings in outer wall so that sometimes, a semi-enclosed space of iwans with no sides in addition to establishing a relationship between housing units (rooms)

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has economical function and often is used as main space of living and in some cases as storage and servicing space.

8.6. Openings

Ventilation openings and windows are of main components in controlling the availability of daylight and ventilation. Ventilation efficiency can be improved by making changes in designing facade openings. In addition to openings' size, the location and orientation of windows define the distribution pattern of air flow in building. Type of window, size, opening location, and its angular feature are effective on making change in air velocity. The size of window is one of the most important elements affecting internal air velocity. When the wind direction parallels the opening direction, little air can enter into room. Wind velocity increases when its direction is oblique to the opening. Additionally, indoor air velocity does not always increase by increasing the level of window to wall. It depends on wind and building direction. In pattern selection based on the dominant percentage of window to the wall ratio, size, shape and location of window are investigated in buildings with the aim of achieving appropriate rate of air-conditioning and orientation and degree of building protection against wind in these rates. In the absence of a favorable wind, windows should be located in two sides of the building with different heights to create cross ventilation. Window is divided into two openings at different heights to improve one-way ventilation. When the window to the wall ratio increases, ventilation can be improved; however, heat absorption increases. This category determines the role of external awnings, especially for large windows. The overall distribution of opening size on the facade surface increases flexibility of different patterns of air flow and velocity. Better ventilation can be achieved through putting two groups of windows in opposite sides or perpendicular to each other. Based on previous studies, windows which are facing each other or are located in opposite sides and in north and south directions have the greatest impact on optimal ventilation.

8.7. Orientation

According to studies, orientation in different climates is determined based on radiation and heat received. In most of moderate and humid micro-climates, orientation is from north to south to make a balance between radiation and heat received.

8.8. Window Direction

Window direction is important in terms of ensuring equal distribution of air flow in space. In most of cases, when there is an axis between entrance and exit, if the entrance direction is perpendicular to the prevailing wind direction, air flow will be directly driven towards the exit and will have little effect on other spaces. When windows are located on opposite walls and prevailing wind is blowing with an angle of 45 degrees towards openings, higher speed air flows occur within the space. Studies about quadrilateral buildings which are dominant structures in Mazandarn have shown that wind shadows exist. Exact positioning of openings and placement of internal walls can alleviate this category. In this case, air flow is internally directed and it is flown as far as the pressure difference at the outlet changes its direction. In situations with two-way ventilation, windows' size has substantial impact on air velocity. In order for air to flow into a building, it is required to get out of it; increasing the size of the openings, when the inlet and outlet increase at the same time has great impact. It should be noted that even when the windows are large, the wind speed is reduced. The average speed of air flow directly depends on the size of the smaller openings.

8.9. Position of Window and Its Impact on Natural Ventilation

Studies showed that the best ventilation often occurs when the wind direction is oblique to the surface of the window. The favorite natural ventilation occurs when the air flow direction is changed inside the room rather than it gets out from the leeward window directly after entering the room from the window facing the wind. To use wind power in natural ventilation, the building must be built in a direction facing east or west. The best direction for placement of the building is incompatible in relation to wind blowing and sun shining. In areas where the favorable winds blow from the west or east, natural ventilation can be appropriately created inside the room through rotating the main facade of the building with the angle of 45 degrees toward south east or west direction.

8.10. Creating Air Flow in Rooms with Just One Window

Shallow awnings can prevent receiving direct sunlight by southeast and southwest windows. If the favorable winds blow from northwest, northeast or southwest and southeast, north-south direction can be an appropriate position for building to create desired natural ventilation. It is very suitable in terms of controlling sun shining upon southern windows.

8.11. Internal Separators

Position and orientation of internal separators can influence air flow and velocity inside a building. Generally, separators which are parallel to the air flow may contain minimal effect.

8.12. Balcony

Iwan is the most important element investigated in the present research. It affects natural ventilation. Balcony is

one of the significant elements in building which forms external façade and volumetric composition of the building. Obviously, balcony as an architectural element, in addition to functional role and impact on external façade of the building affects thermal behavior of building and has environmental effects through shadowing the space. Therefore, if the function of air conditioning improves, balcony can reduce thermal load of the building along with shadowing, otherwise it will reduce the influence of shadowing. The present research shows that in addition to visual delight, balcony improves ventilation, provides an opportunity and space for planting flowers, and reduces the intensity of radiation received from the sun through acting as an awning. In this research, balcony is recognized as a transition space to create and control natural ventilation and internal and external conflicts in buildings. This research considers corridors and balconies as means for channeling wind and driving air flow to the required area. It is said that this part can be defined as a connector between external open space and internal closed space of the building. Balcony increases pressure distribution on the walls facing the wind; however, it does not cause significant changes in the leeward walls. Ventilation powers of openings are reduced in all floors regarding winds which blow with the oblique or perpendicular angle. Pressure distribution in the building increases from middle floors of the building to upper ones. Balcony can improve ventilation process in all rooms from first floor to upper ones in spaces with one-sided opening facing the wind; however, air conditioning is reduced in all rooms of first floor and central rooms located in ground floor and upper ones. In case of oblique wind, ventilation caused by wind power on openings surface facing the wind reaches to its highest level in top floor. Balconies in other floors reduce ventilation and increase it in central part of the top floor.

According to the results of this research, balcony alters the external air flow significantly; however, it reduces the efficiency of ventilation caused by the wind in building with one-way ventilation. If the wind blows with an angle of 90 degrees towards the building, balcony will decrease the efficiency of external wind to create natural ventilation in one-sided buildings. The combination of balcony and opening has also an important role in creating internal air flow. Inappropriate combination of openings in balcony reduces mostly internal air flow. To optimize the internal flow, understanding changes in external air caused by balcony is required to make an optimal combination between opening and balcony. Internal air flow is significantly changed by changing altitude and block location. The present research recommends further studies to investigate the effect of balcony in various wind angles. According to the results, function of one-way ventilation can be improved through making use of facade components such as balcony in compared with flat building, although it is less desirable compared to two-way ventilation.

9. CONCLUSION

The results of the present study indicated that houses in cities and villages in Mazandaran province are located in an ultimate distance of 20 km from the sea. The common microclimate was coa. All vernacular buildings in climate plots emphasize on need for air conditioning. In most cities located in common microclimate, they can provide comfort condition in winter but it is not possible in days and nights of summer using climate pattern. The results show that although patterns of functional spaces cannot provide comfort condition in days and nights of summer in buildings under investigation, physical features of houses are key factors in providing such condition. In this research, balcony is recognized as a transition space to create and control natural ventilation and internal and external conflicts in buildings. This research considers corridors and balconies as means for channeling wind and driving air flow to the required area. It is said that this part can be defined as a connector between external open space and internal closed space of the building. Balcony increases pressure distribution on the walls facing the wind; however, it does not cause significant changes in the leeward walls. Ventilation powers of openings are reduced in all floors regarding winds which blow with the oblique or perpendicular angle. Pressure distribution in the building increases from middle floors of the building to upper ones. Balcony can improve ventilation process in all rooms from first floor to upper ones in spaces with one-sided opening facing the wind; however, air conditioning is reduced in all rooms of second and third floors and central rooms located in ground floor and upper ones. In case of oblique wind, ventilation caused by wind power on openings surface facing the wind reaches to its highest level in top floor. Balconies in other floors reduce ventilation and increase it in central part of the top floor.

A. Climate patterns of functional spaces in vernacular houses are consistent with microclimate features.

B. Due to patterns of prevailing and local winds, air flow patterns operate as static systems of natural ventilation.

C. Comparison of values related to space proportions in buildings under investigation shows a significant relationship.

D. The most important factors in vernacular short-height buildings in Mazandaran are proportions and window and house orientation and proportions and form of iwan which affect ventilation efficien

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Received: 1 January 2019. Accepted: 11 March 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5277–5281, 2019

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Development of the Concept of the Synthesis Methodology of Treatment Schemes of Complex Form Surfaces

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The article describes the development of the methodology concept for the synthesis of complex surface treatment schemes. The design of the technological equipment elements, namely, the machine, metal-cutting tools is currently performed individually. On the basis of the proposed concept of the methodology for the synthesis of machining diagrams for parts with double curvature surfaces, it is advisable to consider the synthesis process as a system of interrelated functional transformations: description of the processed surface; synthesis of initial structures; modification of initial structures; synthesis of tool-making surfaces; forming the space of project parameters of tools. In order to form the space of project parameters, within the framework of the transformation "Forming the space of project parameters of tools," it is advisable to build a complex of mathematical models, which will allow creating the space of the initial design parameters essential for a given project level in the early design stages, and establish analytical dependencies (dimensional relationships and material properties) between the design parameters and the main indicators of quality.

Keywords: Design Method, Metal-Cutting Tool, Accuracy, Complex-Shaped Surface.

1. INTRODUCTION

The design issues of technological equipment, have discussed and investigated in previous works [1–9]:

(1) Synthesis of variants of formative movements (formative system). The results of this stage are the variants of the coordinate, velocity codes of the shaping system (SS) and the corresponding shaping equation;

(2) Synthesis of the distribution variants of formative movements between the parts of the metal-cutting system (machine, tools, tools);

(3) Synthesis of the positions variants of the fixed link of the shaping system (bed), the results of which are many variants of the CC layout codes.

In the framework of the initial step, a zero-base variant of the structure of the metal-cutting procedure is built. On its basis, basic variants of the structure are formed by performing admissible transformations, as well as their combinations, which do not change the functionality of the CC. The following valid transformations exist [10]:

Transformation 1. Permutation of two neighboring links of the SS, making translational motion relative to the previous links.

Transformation 2. Rearrange the links that make up a cylindrical pair, i.e., two adjacent links, one of which makes translational, and the other—a rotational motion about one axis.

Transformation 3. The union of several links, making the same movement relative to the same axis, into one link.

Transformation 4. Breaking a link into several links performing the same movement.

2. MATERIALS AND METHODS

At the next step, the synthesis of layouts is conducted based on the consideration of the MS (A_Σ), matrix, which is included in the basic equation of MS formation

$$\bar{r}_0 = A_\Sigma \bar{e}^4 \quad (1)$$

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Table I. Variations of matrix modification A_m and A_t.

Option number	A_m	A_t
1.	$A^4(\varphi)A^2(-H_y)A^3(-H_z)A^4(-\varphi)$	$A^4(\varphi)A^2(H_y)A^3(H_z)A^4(-\varphi)A_t$
2.	$A^5(\varphi)A^1(-H_x)A^3(-H_z)A^5(-\varphi)$	$A^5(\varphi)A^1(H_x)A^3(H_z)A^5(-\varphi)A_t$
3.	$A^6(\varphi)A^1(-H_x)A^2(-H_y)A^6(-\varphi)$	$A^6(\varphi)A^1(H_x)A^2(H_y)A^6(-\varphi)A_t$
4.	$A^4(\varphi)A^2(H_y)A^3(H_z)A^3(p\varphi)$	$A^4(-\varphi)A^2(-H_y)A^3(-H_z)A^3(-p\varphi)A_t$
5.	$A^4(\varphi)A^2(H_y)A^3(H_z)A^2(p\varphi)$	$A^4(-\varphi)A^2(-H_y)A^3(-H_z)A^2(-p\varphi)A_t$
6.	$A^5(\varphi)A^1(H_x)A^3(H_z)A^3(p\varphi)$	$A^5(-\varphi)A^1(-H_x)A^3(-H_z)A^3(-p\varphi)A_t$
7.	$A^5(\varphi)A^1(H_x)A^3(H_z)A^1(p\varphi)$	$A^5(-\varphi)A^1(-H_x)A^3(-H_z)A^1(-p\varphi)A_t$
8.	$A^6(\varphi)A^1(H_x)A^2(H_y)A^1(p\varphi)$	$A^6(-\varphi)A^1(-H_x)A^2(-H_z)A^1(-p\varphi)A_t$
9.	$A^6(\varphi)A^1(H_x)A^2(H_y)A^2(p\varphi)$	$A^6(-\varphi)A^1(-H_x)A^2(-H_z)A^2(-p\varphi)A_t$

where $\vec{e}^4$—radius vector of origin $\vec{e}^4 = [0\ 0\ 0\ 1]^T$ и изменения структуры MC and changes in the structure of MS, by modifying the decomposition of the matrix A_Σ as

$$A_\Sigma = A_{a1}A_mA_{a2}A_t \tag{2}$$

where A_{a1}, A_{a2}—fixture coordinate transformation matrices; A_m—machine coordinate transformation matrix; A_t—tool coordinate transformation matrix.

Example. Let be

$$A_\Sigma = A^6(\theta)A^3(z)A^1(x) \tag{3}$$

where $A^6(\theta)$—matrix, taking into account the rotation of the workpiece around the Z axis at an angle θ

$$A^6(\theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{4}$$

$A^3(z)$—Z-axis transition matrix

$$A^3(z) = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & z \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{5}$$

$A^1(x)$—X-axis transition matrix

$$A^1(x) = \begin{bmatrix} 1 & 0 & 0 & x \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{6}$$

(1) at the firs step, the matrix A_Σ results in the form

$$A_\Sigma = A_mA_t \tag{7}$$

where $A_m = E$;

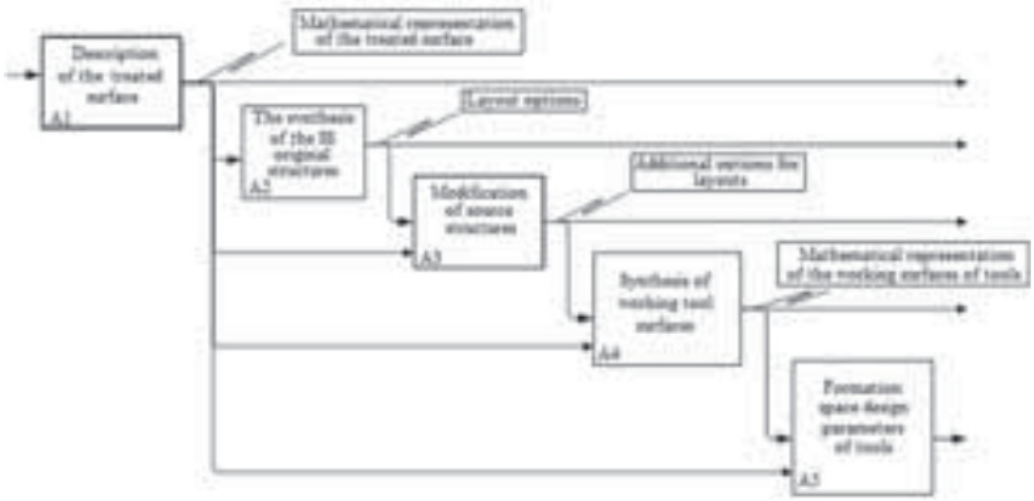

Fig. 1. Functional model of the synthesis process for machining parts with double curvature surfaces.

(2) modify the matrices A_m and A_j using the approaches, given in Table I.

In Table I adopted the following designation:

$A^4(\varphi)$, $A^5(\varphi)$, $A^6(\varphi)$—around the axes X, Y, Z;

$A^1(H_x)$, $A^2(H_y)$, $A^3(H_z)$—along the axes X, Y, Z;

φ—rotation parameter of the workpiece or tool;

H_x, H_y, H_z—parameters of the initial displacement of the tool relative to the workpiece, respectively, along the axes X, Y, Z;

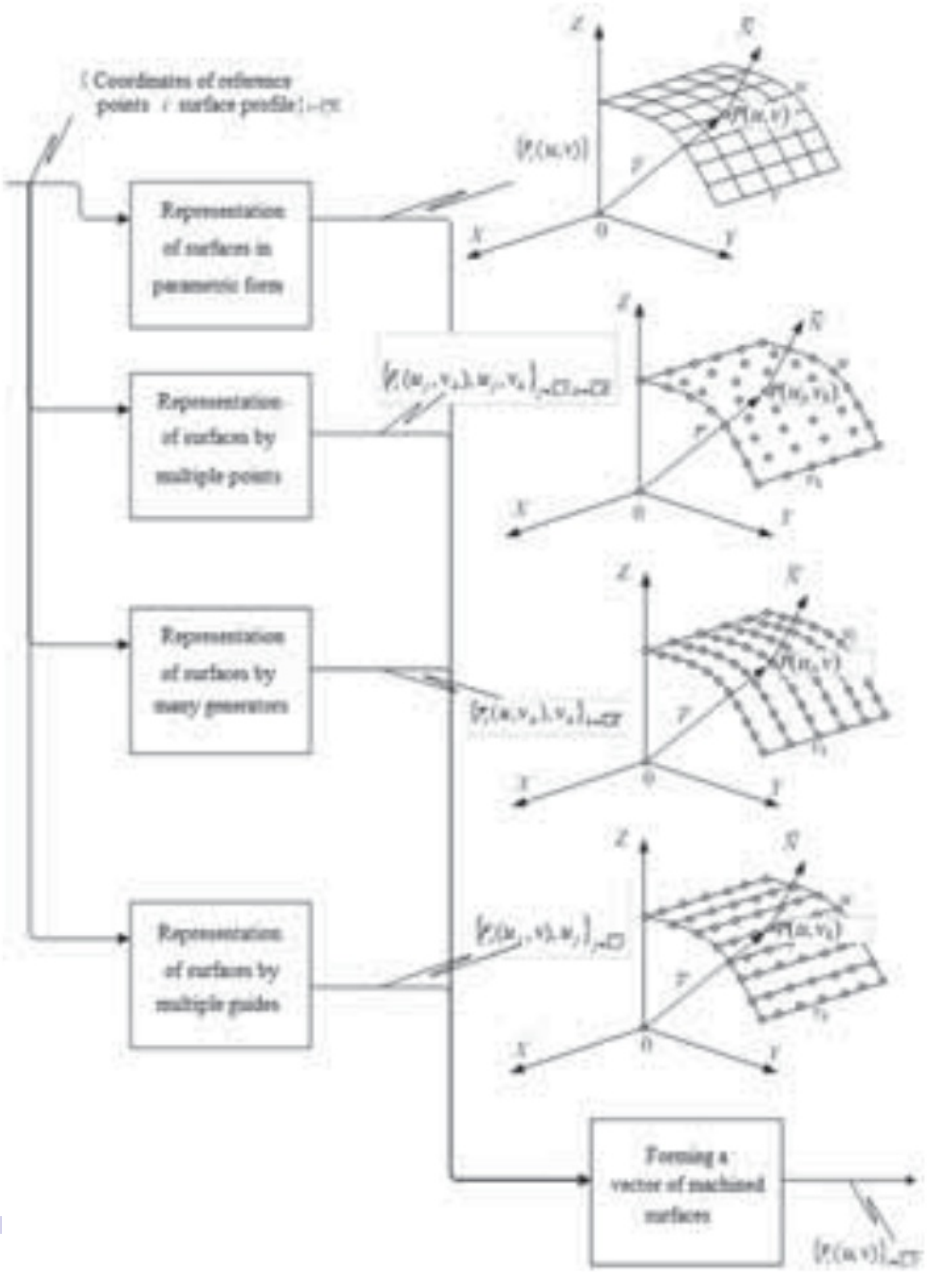

Fig. 2. Formation of the system of machined surfaces.

P—the rate of the linear movement of the tool to the parameter of the workpiece rotation [11].

3. RESULTS AND DISCUSSION

On the basis of the proposed concept of the methodology for the synthesis of processing circuits for parts with double curvature surfaces, it is advisable to consider the synthesis process as a system of interrelated functional transformations (Fig. 1): description of the processed surface; synthesis of initial structures of SS; modification of initial structures of SS; synthesis of tool-making surfaces; the formation of the space design parameters of tools.

The implementation of the transformation "Description of the machined surface" is connected with the need for a mathematical representation of this surface as a function and its parameters in homogeneous coordinates based on the vector of structural parameters of the machined surface and parameters determining its position relative to the part. In work [12], the question of the mathematical representation of the description of various surfaces was considered in detail; therefore, we consider only a few points. We will consider surfaces that allow four ways of presentation (Fig. 2).

Issues related to the implementation of the transformation "Synthesis of the initial structures of CC" were discussed in detail in works [1–8], where the structure of the shaping system was described as a model consisting of the coordinate code of the shaping system and the corresponding transformation (Fig. 3). Thus, the synthesis of CC structures should include three main stages: the formation of coordinate and velocity CC codes; distribution of formative movements between the machine, devices and tools; formation of layout codes CC. At this stage, the main dimensional chains are identified that correspond to the processing of specified surfaces.

As a result of such modeling, each element of the technical maintenance (machine, tool and tool) will have its own set of shaping movements. To implement the transformation "modification of the initial structures of the CC" in the framework of the developed concept, it is proposed to obtain additional variants of high-performance processing schemes that correspond to milling with a mill with a constructive radial feed and pull, perform additional transformations discussed earlier. To implement the transformation "Synthesis of producing surfaces of tools," it is vital to evaluate the nodes of the producing faces of the tool in its own coordinate system, under which all the shaping statuses will be fulfilled (which will be discussed later).

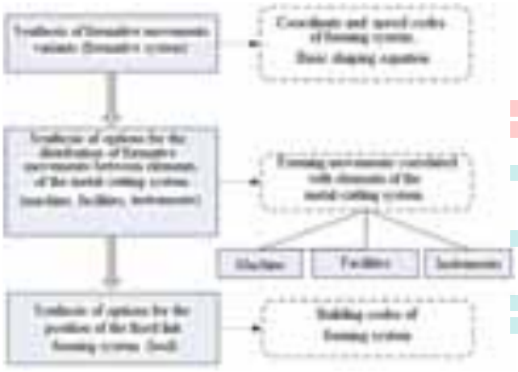

Fig. 3. Synthesis of variants of the structure-forming system.

4. CONCLUSION

In order to form the space of design factors, within the framework of the transformation "Forming the space of design parameters of tools," it is advisable to build a complex of mathematical models, which will allow creating the space of the initial design parameters essential for a given project level in the early design stages and establish analytical dependencies (dimensional relationships and material properties) between the design parameters and the main indicators of quality.

Acknowledgments: The work was supported by a scholarship of the President of the Russian Federation to young scientists and graduate students. Project number CII-2950.2019.1.

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Received: 1 January 2019. Accepted: 11 March 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5282–5286, 2019

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A Targeted Study on Simulation and Optimization of Shipping Systems

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Over the last four decades, containers have found their special place as suitable and necessary tool for packaging in maritime transportation. With growing increase in container manufacturing, numbers of container terminals and their competition become significant. This study aims to simulate the container terminal operation and its improvement. Simulation is carried out by Arena software. For this purpose, first base model with primary assumptions is simulated and results are obtained. At the end of first stage several scenarios are defined and using the software, the required results are obtained. Then, we seek a way to improve the existing model to obtain better results. There are several methods for this. Since in this system there are several main factors that affect performance of the entire system, decision making management, simulation and optimization methods in shipping systems based on design of experiment are used. Then the effect of the factors on evaluation function, intended by a decision maker, are determined. After simulation, the obtained results are examined by the Taguchi method to determine which level in each factor is the best state and which factor is more effective in the entire process. Results demonstrated that number of berths are the most important factor in the process improvement and it should receive more attention.

Keywords: Simulation and Optimization, International Transportation, Shipping Systems, Arena.

1. INTRODUCTION

Nowadays, without efficient use of information technology and optimization methods, it cannot be thought about shipping operation. Recently, in order to improve containers relocation, ports have encountered major challenges. Based on the charts presented by UNCTAD, trade through container transportation between 2003 to 2025 will have 5.32% average growth [1]. Today, most international shipments in maritime ports are located and displaced in containers. Recently, the intense competition between ports, especially in Asia and Europe, has led ports to move towards providing more facilities, improving operations and reducing costs [2]. Therefore, how to improve service efficiency and reduce costs is a fundamental issue in such ports. In general, there are two approaches to this: The first is the increase in the number of loading and unloading equipment, the second is to adopt the most effective operational program. It is very difficult to model complex systems such as manufacturing systems, supply chain and container terminals using algebraic equations. Discrete event simulation is a useful tool for evaluating the performance of these systems. Even though simulation only evaluates a given plan, it does not provide any optimization function. So it is necessary to integrate simulation and optimization. Optimization of simulation is the process of finding the best value of system decision variables whose performance is evaluated by simulation outputs [3]. Recently, most papers have used scheduling models to model the operation. But in such complex problems, the optimal answer cannot be obtained using mathematical models alone. Hence, the use of simulation and optimization has been increasing, Recently. In this study, a mathematical model and simulation was first developed for the problem, and then, simulation model was implemented using the software, and an initial answer would be used for the mathematical model. Then, using this solution and innovative techniques, the mathematical model is solved. At each step, the results are compared with those of previous steps, and if the answers were better the algorithm would stop, otherwise it would re-simulate the model this time with more recent solutions obtained from solving the mathematical model.

2. RESEARCH METHOD

The purpose of this study is to simulate the operation of container terminals and improve it. It is worth noting that in the container terminals, the ships first enter and after being placed in the berth, wait for operations by quay cranes. In this paper, the purpose is to simulate the first

1546-1955/2019/16/5282/005 doi:10.1166/jctn.2019.8600

part of the operation in the terminal, which leads to determination of the optimal number of berths and cranes. The simulation is done by the Arena software. First, the model was simulated with initial assumptions and its results were collected and to improve the model different modes of the system are simulated. Therefore, at the end of the first stage, several scenarios are defined and, with the help of the software, the required results are extracted. Then, it is looked for a way to improve the current model to extract better outcomes. There are several ways to do this. Because in this system there are several basic factors affecting the performance of the whole system, decision-making methods based on the design of experiments are used. In the following, we examine the effect of factors on the evaluation function considered by decision-makers.

3. METHODS FOR OPTIMIZATION OF SIMULATION

There are several ways to optimize the simulation. Thus, according to Carson and Maria (1997), several classes of optimization methods have been identified: gradient-based method, exploratory method, statistical methods, stochastic optimization and surface response method.

4. PROBLEM STATEMENT

In most terminals, there are usually three types of equipment for operation: quay cranes (QC), yard trailers (YT) and yard cranes (YC). Upon the arrival of a ship to the terminal, the QCs deploy containers from the ship or load them into the ship, and the YTs move containers from deck to storage and dock platforms [4]. In the storage, YTs do the work of loading and unloading the trailers. Planning the sequence of QC operations, dispatching trailer for containers, finding optimal location storage and YC allocation for trailers in the storage are important issues in optimizing terminal activities. Issues of container terminal are divided into several categories. The first category relates to the location of the harbor, which selects the best harbor location so that the ships are deployed regularly and in the least time in the first stage of their entrance to the terminal. Although the cost factor is also a decisive factor in this part [5]. The second category, which is discussed in this paper, is the issue of planning the operation of quay cranes. The goal is to determine the optimal number of cranes and provide a regular schedule for each crane so that the cost and time are minimized. In most articles that address this issue, because of the use of mathematical modeling and due to the limitations of mathematical models, only a work plan is found. Although the mathematical model has recently been used to determine the optimal number of cranes, it has not been able to apply for larger scale problems. Therefore, in this paper the simulation was used to do this, and it was observed that all of the previous restrictions were eliminated and the model could be used for even larger scale problems. Finally, in the final category of the container terminals problems, optimization of the operation in the terminal yard has been addressed. In this category, the goal is to determine the optimal location of the containers' storage, to determine the optimal number of equipment in the field, such as trucks, trailers and cranes in the storage. The whole process is that the ships first arrive at the port with an arrival rate that follows the exponential distribution. After the arrival, an action is done to prepare the ships and the ships are ready to enter the berth [6]. Each ship enters the berth with the lowest queue in it. Then they wait for a crane to enter this berth and do their work. Loading operations are performed according to a rectangular distribution. After this operation, the ship leaves the port and crane carries out the next container's work.

5. SIMULATION OF CONTAINER TERMINAL WITH ARENA SOFTWARE

At the container terminals, the ships first enter and, after being placed in the harbor, wait for operations by quay cranes. In this paper, the purpose is to simulate the first part of the operation in the terminal which leads to determination of the optimal number of berths and cranes. So the system environment is initially specified. Also the components of the system should be identified. The first entity in this system is ships that have arrival rates. The second entity is the cranes which carry out the loading and unloading of containers on ships. The cranes operate with a certain probable distribution, each of them located in a specific location according to the berth number [7]. Operations and displacements are also carried out in this system. For example, it includes loading and unloading operations, boarding, crane handling and etc. However, the key variables in this system are the waiting time and the number of cranes and berths. For this purpose, the simulation in the computer model Arena was used which is as follows.

The goal is to simulate a terminal with 2 cranes and 4 berths. In the first part, arrival of ships, time range for entering and other parameters related to the arrival of the ships should be inputted to model. Because the ships are entities and have a certain arrival rate, the Create module was initially used. In this module, the rate of ships arrival is also determined. Ships after arrival, must wait for terminal working hours to start and also the berth which ship to be deployed must be set, then the ship will be on the berth. In the figure below, the components of the Arena model related to the first part of the simulation are shown.

After determining that each ship should be on which berth, the ships are placed in the queue and wait for the operation. In the above example, there are 4 berths and 2 cranes. Also, the initial location of the cranes has been set primarily. The cranes do the work of the ships, in particular order. It is assumed that each crane will do the work of the closest ship to itself, and also the cranes should not

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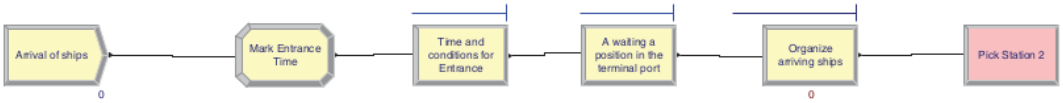

Fig. 1. Arena modules for entry and deployment of ships.

cut off each other. These assumptions should be applied in the Arena model. After the operation, the ships leave the terminal. The simulation related to this section is shown in the following figure.

The important part of the simulation with the Arena software is to define the variables and parameters by which the outputs are analyzed. In the case of container terminals and for quay cranes, the objective is to determine the optimal number of berths and cranes, so that the cost is minimized and income is maximized [8]. The costs of this section include the cost of crane purchase, the cost of building a berth and the penalty cost for delaying ships in the terminal. Terminal income is also obtained by leaving the ships. The following variables and parameters are defined to determine the cost, income and delay time and other outputs in the simulation.

First, simulation is performed and after identifying the factors, there will be several choices for each factor. Important factors in this section are: the number of cranes, the number of berths for ships to dock and the arrival rate of the ship. The levels of these factors are: For the first factor 1, 2 and 3 cranes, for the second factor 3, 4, 5, 6 and 7 berths, and for the last factor, the exponential distribution with parameters 3, 3.5, 4, 4.5 and 5 hours. Given these factors and levels of each factor, different scenarios are defined. Number of scenarios is obtained by multiplying the number of levels of each factor, which is equal to 75. For each scenario, simulation is performed five times and the average value of the income function is obtained. After simulation and obtaining the required answers, Taguchi method was used as follows.

Output of the simulation is reported by the software after each run. Obtained items from simulation by software include:

1. Waiting time for ships.
2. Duration of each crane operation.
3. Total delay costs: There would be a penalty cost if ships wait longer than a certain amount of time after entering the terminal. For this purpose, we assume in our model that if each ship waits in the port for more than 4 hours, delay cost will be 10,000 units per minute.
4. Income due to ship departure: It is evident that the income of container terminals is achieved by giving service to ships. In this model it is assumed that with the departure of each ship 1,000,000 units will be earned.
5. Net income: Is equal to the incomes from the departure of ships, minus the delay cost and the cost of purchasing a crane and building a berth. This is the evaluation function that the decision maker intends and wants to know what factors affect this function and how it can be controlled [9].

6. ANALYSIS OF SIMULATION OUTPUT

It was examined here that how changing the simulation results by altering the variables related to the model changes the other variables, as well as the income function. Inputs that are effective and considered as variables include:

1. Number of berths
2. Number of cranes
3. Ship arrival rate.

The output affected by these factors is the income function. The income is the deduction of the income from the service to each ship and its delay cost, the cost of purchasing a crane and the cost of construction of the berth. The income from the service to each ship is 100,000 units, for a waiting time of more than 4 hours, the delay cost of 1000 units per minute, the cost of buying a crane 1 million units and building a berth of 3,000,000 units were considered. These results are presented in the following graphs.

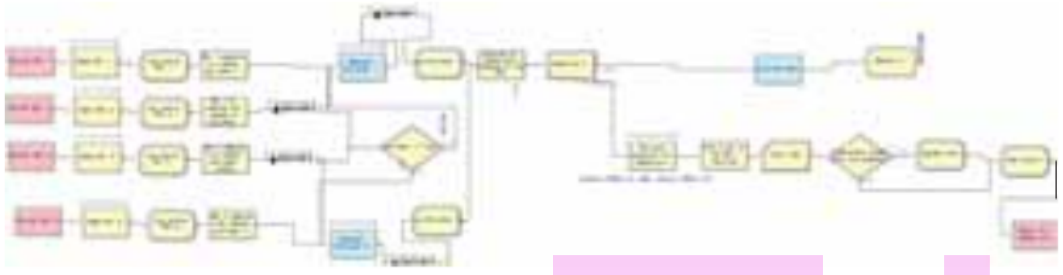

Fig. 2. Components of the arena model related to the second part of the simulation.

Table I. Defined variables in the simulation.

Variable name	Description
Mark_Entrance	Ship entry time
Pire	Berth number
Porteiner	Crane
Fine	Evaluation function, which is the result of subtracting income and expense

7. EFFECTS OF INCREASE IN CRANES NUMBER

By examining the results, it was found that in the one crane case, the increase in time between the arrivals, increases the income, because in this case the purchase cost is at its lowest level and due to the small number of equipments, the largest cost is the delay cost. As a result, the longer the time between arrivals is, the income becomes larger. However, in the cases with 2 and 3 cranes, this trend is the opposite, because in these situations response of the system is in its optimal state, therefore, the smaller the number of incoming ships, the income will decrease. On the whole, it can be seen that in the case of 2 cranes, more income is achieved.

8. EFFECT OF INCREASE IN NUMBER OF PLATFORMS

In this case, we examine the results for the case where the number of cranes is 2, as shown below.

It is clear from the graph that with increase in number of berths, the amount of income is reduced.

9. TAGUCHI'S DESIGN OF EXPERIMENTS

First, the goal is to identify the best level in each factor. For this, according to the Taguchi method, the S/N rate was first calculated for each level corresponding to each factor according to the following equation:

$$S/N = -10\log(MSD)$$

$$MSD = 1/n \sum y_i^2$$

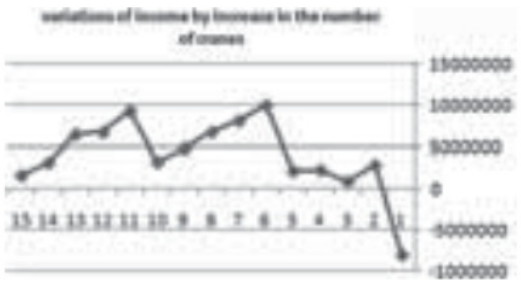

Fig. 3. The trend of changes in income by increasing the number of cranes.

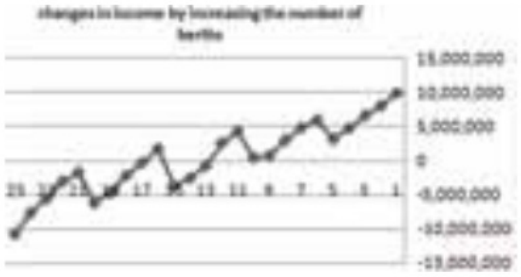

Fig. 4. The trend of income variations by increasing the number of berths.

Where MSD is the mean square of the deviations, y_i is the observed value at the desired level, and n is the number of observations per level. These results can be seen more clearly in the following graphs.

According to the graphs, the best levels for controlling factors are:

✓ The second level for the number of quay cranes with a value of 2.

✓ The first level for the number of berths with a value of 3.

✓ Finally, the second level for the factor of time between the arrivals is 3.5 time unit.

10. CALCULATIONS RESULTS

The problem that was addressed in this research is the planning and optimization of operations at the entrance of container terminal. At this part, ships are first entered, each arranged in berth or deck, in order. There are a number of cranes for ship unloading or loading operations that perform the work of each ship, in order. Following this, the factors affecting the terminal income in this section were identified and their impact was calculated. To do this,

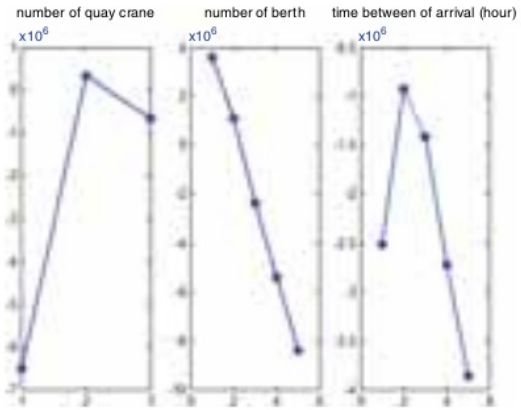

Fig. 5. S/N diagram for all three factors.

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a simulation model was first presented by the Arena software and after simulating in different states, the results were evaluated using the Taguchi's method for design of experiments. From the results, it is clear that the identified factors affect the income, and the most effective one is the number of berths. It was also found which level in each factor is the best.

11. CONCLUSION

Over the past four decades, containers as a necessary and suitable tool for packaging, have found a pivotal place in shipping internationally. With increase in containerization, the number of container terminals in maritime ports and the competition between them has become very significant. Today, without the efficient use of information technology and optimization methods, one cannot think of container operations. Recently, ports have faced major challenges in improving the efficiency of container handling. Therefore, how to improve service efficiency and reduce costs is a fundamental issue in such ports. It is very difficult to model complex systems such as manufacturing systems, supply chains, and container terminals using algebraic equations. Discrete event simulation is a useful tool for evaluating the performance of these systems. Although the simulation only evaluates a given plan, it does not provide any optimization function. So it is necessary to integrate simulation and optimization. Optimization of simulation is the process of finding the best value of system decision variables whose performance is evaluated by simulation outputs. The terminal planning problem involves different variables and constraints. So, in order to overcome the complexities of the problem, we need to consider non-deterministic and probabilistic factors. Recently, simulation has been widely used in such issues. Discrete event simulation (DES) models have superiority over mathematical optimization models, including: covering limitations of mathematical models, supporting computerization of policies and strategies, understanding and assisting decision-makers in daily decision making with the use of "What-if" approach. The purpose of this paper was to simulate the operation of container terminals and to improve it. The simulation was done by the Arena software. First, the model was simulated with initial assumptions and its results were collected. To improve the model, it was necessary to simulate different modes of the system. Therefore, at the end of the first stage, several scenarios were defined and, with the help of the software, the required results were extracted. Then, we sought a method to optimize the model to extract better results. There are several ways to do this. Because in this system there are several basic factors affecting the performance of the whole system, Decision-making methods based on the design of experiments were selected. Then, the effect of factors on the decision-maker's evaluation function was obtained. After simulation, the results were analyzed using the Taguchi method to determine which level in each factor is the best and which factor in the whole process is more effective. In the first case, the results are as follows:

✓ The second level for the number of quay cranes with a value of 2.

✓ The first level for the number of berths with a value of 3.

✓ Finally, the second level for the factor of time between the arrivals is 3.5 time unit.

In the next step, using ANOVA analysis and its related formulas, it is observed that the number of berths was the most important factor, and more attention should be paid to this factor in decision making for improving the operation.

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Received: 1 January 2019. Accepted: 11 March 2019.

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5287–5297, 2019

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Robots for a Detailed Study of Moon

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The problem of a detailed study of the Moon is considered—the phase of the study in which a person has either not yet begun manned flights, or makes them no more than once a year. At this phase, it is very important to conduct detailed studies of the substance in various regions of the moon, which should directly affect the pace, scale and scenarios of the exploration of the moon. The authors, relying on a list of scientific research on the moon that is relevant for the coming decades, offer the appropriate tools—automatic and semi-automatic (with elements of artificial intelligence) robots. It is shown that scientific tools and the necessary robotic systems can be unified and reduced to a relatively small list. Of particular interest is the reusable use of scientific equipment and related robotic systems. Reusable execution of robots, their maintenance on the lunar surface by robots themselves or on board a near-moon station can significantly reduce the time of exploration of the moon and go to the phase of its development—the pace of research can be increased by an order of magnitude. A key element in the proposed concept should be a reusable take-off and landing vehicle (MVPA). Its creation will ensure the reusability of the use of robots on the moon. In addition, the authors conclude that it is necessary to deploy an automatic lunar orbital station (LOS) in a low lunar orbit, the main task of which will be the maintenance of replaced equipment and the refueling of MVPA. Authors present configurations of promising robot platforms for scientific equipment for a detailed study of the moon. Features of the use of anthropomorphic robotics on the moon are considered separately. Recommendations are given on its use, implementation of elements of the artificial intelligence system. In combination with proposed MVPA concept and reusable scientific equipment, the use of anthropomorphic technology will ensure the telepresence of research scientists on the moon, regardless of the fact and speed of manned flights.

Keywords: Scientific Equipment, Drilling Rig, Deep Logging Tool, Reusable Take-Off Vehicle, Lunar Orbital Station, Anthropomorphic Robot, Low Lunar Orbit, Operator, Avatar, Partially Intelligent Control Mode, Signal Delay.

1. INTRODUCTION

For the exploration of the moon, as many space agencies today claim, it is necessary to know its substance. Much depends on the availability of certain local resources: the appearance of the lunar infrastructure, flight scenarios, the pace of launches, the scale of human presence. Actually, the natural resources of the moon and constitute the main object of exploration. The moon has been the subject of direct scientific research for more than 50 years. However, today it cannot be said that mankind has studied the Moon so well that it can begin the construction of inhabited (visited) settlements and begin to use the resources of the moon. To date, studies have been conducted using separate scientific missions with automatic spacecrafts (SC). In the late 1960s and early 1970s, six US manned expeditions visited the moon (Apollo program). Of course, manned flights gave a lot of valuable information. At the same time, the organization of manned flights to the moon is an extremely expensive task. So expensive that after 40 years, no one can repeat it yet. If we use automatic spacecrafts with the intensity of the missions that were up to now, then the stage of studying the moon will clearly exceed one or even two centuries. Of course, it is impossible to explore Moon for a millennium. Humanity has been exploring the Earth for its entire history. In this case, by the stage of research, we mean obtaining only that knowledge about the material of the Moon, its nature, which may be sufficient for manned missions—justifying these missions, this is knowledge's of the preparation of human presence. It is unlikely that the duration of the study phase in such a context for several centuries can be considered acceptable. This means that it is necessary to more carefully consider the capabilities and effectiveness of the missions performed by automatic spacecrafts. It is necessary to analyze

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the composition of the used scientific equipment, types of platforms for the placement of scientific equipment, flight scenarios. This is the part of the design and analytical work that defines the necessary lunar infrastructure, creating even before man will on Moon. This kind of work has already begun within the framework of the European Space Agency (ESA), the Japanese Space Agency (JAXA), the Canadian Space Agency (CSA) [1]. The HERACLES project was one of the first in this direction to be actively discussed in international society. However, the technical solutions laid down in the HERACLES project are largely related to another large-scale international project—LOP-G (Lunar Orbital Platform-Gateway) [2]. This article is devoted to the consideration of these issues without direct reference to any projects (international or national)—in a more general setting. In addition, it was proposed to more carefully consider the possibility of the telepresence of a human researcher (scientist) on the moon through the use of anthropomorphic technologies. This is the most important issue that can remove the need to complete entire missions with automatic spacecraft or even, in some cases, to perform manned flights.

2. ACTUAL SCIENTIFIC TASKS ON THE SURFACE OF MOON

Priority (topical for the next ten years) scientific tasks related to the need to land automatic spacecraft (SC) on the lunar surface can be systematized as follows.

1. Study of the composition and physicochemical properties of the regolith;
2. The study of the thermo physical properties of the regolith;
3. The study of the volatile components of the regolith: implanted, loosely coupled and frozen;
4. Study of the structure of the moon (study of the history of the formation of the regolith, the internal heat flow of the moon, seismic studies);
5. Study of the radiation situation and radiation anomalies on the moon;
6. The study of lunar rocks as a raw material for extraterrestrial construction;
7. The study of lunar rocks as raw materials for the production of extraterrestrial fuel;

Table I. Required scientific equipment at the initial stage of the Moon's exploration.

Scientific task on the moon surface	The content of the experiment	Necessary scientific equipment (SE)	Weight of SE, kg	The minimum number of experiments, pcs.
1.	2.	3.	4.	5.
1. Study of the composition and physicochemical properties of regolith	Taking samples of the regolith for delivery to Earth	Drilling rig (75 kg), container for placing a stratified column (25 kg)	100	6
2. Study of the thermal properties of regolith	Temperature measurement at depth and their annual dynamics	Deep thermal sensors, penetrator	8	6
3. The study of the volatile components of the regolith: Implanted, loosely coupled and frozen	Sampling in sealed containers for delivery to Earth, the study of volatile components during drilling	Drilling rig (75 kg), mass spectrometer (15 kg), hermetic container for placing a stratified column (25 kg)	115	6
4. Study of the structure of moon (study of the history of the Regolith's formation, the internal heat flow of Moon, seismic studies)	Study of the distribution of different layers of regolith in depth, Measurement of temperatures at depth and their annual dynamics	Deep logging probe, penetrator, seismometer	8–10	10
5. Study of the radiation conditions and radiation anomalies on the moon	Measurement of background radiation at the surface and at depth	Various types of ionizing radiation detectors, deep logging probe	1–2	12
6. The study of lunar rocks as a raw material for extraterrestrial construction	Delivery to Earth of samples for technological research	Drilling rig, hermetic container for delivering samples to Earth	100	12
7. The study of lunar rocks as raw materials for extraterrestrial fuel	Delivery to Earth of samples for technological research	Drilling rig, hermetic container for delivering samples to earth	100	12
8. The study of lunar rocks as a raw material for the production of extraterrestrial metallurgy	Delivery to Earth of samples for technological research	Drilling rig, chemical analytical module, hermetic container for the delivery of samples to earth	150	12

8. The study of lunar rocks as raw materials for the production of semi finished products of extraterrestrial metallurgy.

Each problem to be solved corresponds to a certain scientific equipment. Based on the experience of space flight, the existing scientific and technical groundwork, it is possible to form a table of scientific equipment, estimate its mass and the minimum number of experiments with this equipment on the lunar surface, which generally provides the initial stage of the lunar exploration, Table I.

As you can see, part of the nomenclature of scientific equipment (AT) for various scientific tasks is repeated, and the number of uses of this equipment in experiments on the lunar surface is dozens of times. Thus, the nomenclature of NA for research on the surface of the Moon can be systematized by highlighting the typical NA, the use of which will be required repeatedly. An important indicator is the number of required experiments. For example, the number of necessary landings on the surface of the moon, if we assume one-time flights under the scheme "one experiment—one mission," is more than 70 space missions. Of course, in this case, the process of exploring the moon could exceed 100 years, which is hardly consistent with the plans of many space agencies.

3. TYPING AND REUSING SCIENTIFIC EQUIPMENT ON MOON

How can the number of space missions be reduced without reducing the number of space experiments on the moon? In other words, how to shorten the duration of the first (exploratory) stage of the Moon exploration? The author suggests using two known methods:

Fig. 1. Reusable drilling rig (RDR).

Fig. 2. Reusable deep logging probe (RDLP).

The first method is thematic integration of scientific equipment on board.

The second way is to use the same scientific equipment many times.

If we combine the solutions of various tasks within one mission, then the mass of scientific equipment for the study of lunar matter will be from 100 to 162 kg Clusters (sets) of such equipment can be used many times, they can be repeatedly transported to new areas of the Moon, which shortens the duration of the moon exploration stage by a dozen times. In particular, the most important is the use of a reusable drilling rig (RDR, Fig. 1, Ref. [3]) and a reusable deep-well logging probe (RDLP, Fig. 2, Ref. [4]), having a total mass of about 160 kg. In addition, a sealed container for the delivery of samples to Earth, including a cassette with a stratified regolith column, is a necessary element (Fig. 3).

At the same time, the mass of the stratified regolith column for a single intake into a cassette is 3.4 kg. The depth of drilling can be up to 6 m. The mass of the container for one cassette will be about 25 kg. At each experiment of

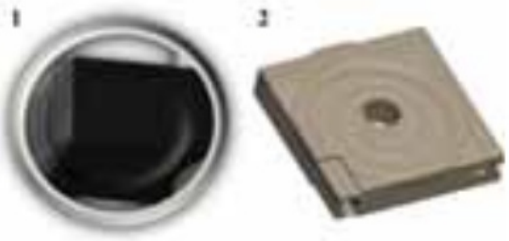

Fig. 3. Sealed container for delivery of samples to Earth (1). Cassette for storing a stratified regolith column (2).

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drilling the lunar surface, a replaceable (replaced) piece of equipment will be required. The mass of such "one-off" equipment is about 50 kg for each drilling.

4. ROBOTICS SERVING SCIENTIFIC EQUIPMENT

Not only before the start of manned missions to the moon in the 21st century, but also after that, robotics will be needed to service scientific equipment (SE) on the moon. Robotics is a very broad concept, so we will consider the part of it that is directly related to the maintenance of scientific equipment. Here it is important to distinguish three types of tasks that robotics will face.

The first type is transport tasks, i.e., transportation of SE from one region of the Moon to another;

The second type is the solution of standard manipulation problems in a deterministic environment;

Fig. 4. Lunokhod for transportation of reusable scientific equipment [5].

Fig. 5. Manipulator for working with cassettes, containers (for standard operations—overload, fixing, installation, removal) [6].

Fig. 6. Android robot for fine manipulations (studying stones, repairing equipment) and for working with an anthropic-like geological instrument [7].

The third type is the solution of manipulation problems (standard and non-standard) in a non-deterministic setting.

Accordingly, these three types of tasks can be used to formulate three types of robots that will be needed for maintenance of scientific equipment. It:

For the first type of tasks—the rover (moon rover), Figure 4;

For the second, a manipulator with 6 or 7 degrees of freedom, Figure 5;

For the third, there is an anthropomorphic type manipulation complex that includes two manipulators with several dozens of degrees of freedom, the torso part, the telepresence navigation system, Figure 6.

5. REUSABLE SCIENTIFIC EQUIPMENT DELIVERY VEHICLES

The use of reusable scientific equipment also involves the use of reusable means of delivery, namely, the reusable landing gear (MVPA), carrying out from circumlunar orbit to various regions of the Moon and delivering lunar matter samples to orbit for subsequent delivery of samples to Earth. This is the most important element of the entire infrastructure for scientific equipment, without which the idea of reusable scientific equipment (and, therefore, an active comprehensive study of the Moon) will not have such a meaningful perspective. As part of the research carried out by the author [8], flight scenarios where the landing of automatic spacecraft on the lunar surface is combined with the maintenance of these spacecraft in low lunar orbit have tremendous advantages in relation to single (one-time, maintenance-free) flights of spacecraft with similar volume of tasks, and in relation to manned missions to the surface of the moon. In Figure 7 shows one of such scenarios, when the spacecraft in the form of MVPA performs up to six landings in distant regions of the Moon. At the same time, the service is a refueling in a low lunar orbit from a tanker (space tug), waiting for MVPA in an orbit with an altitude of 100–200 km. Under this scenario, two variants of the IMPA were considered. The first version of MVPA is a two-stage, partially reusable MVPA,

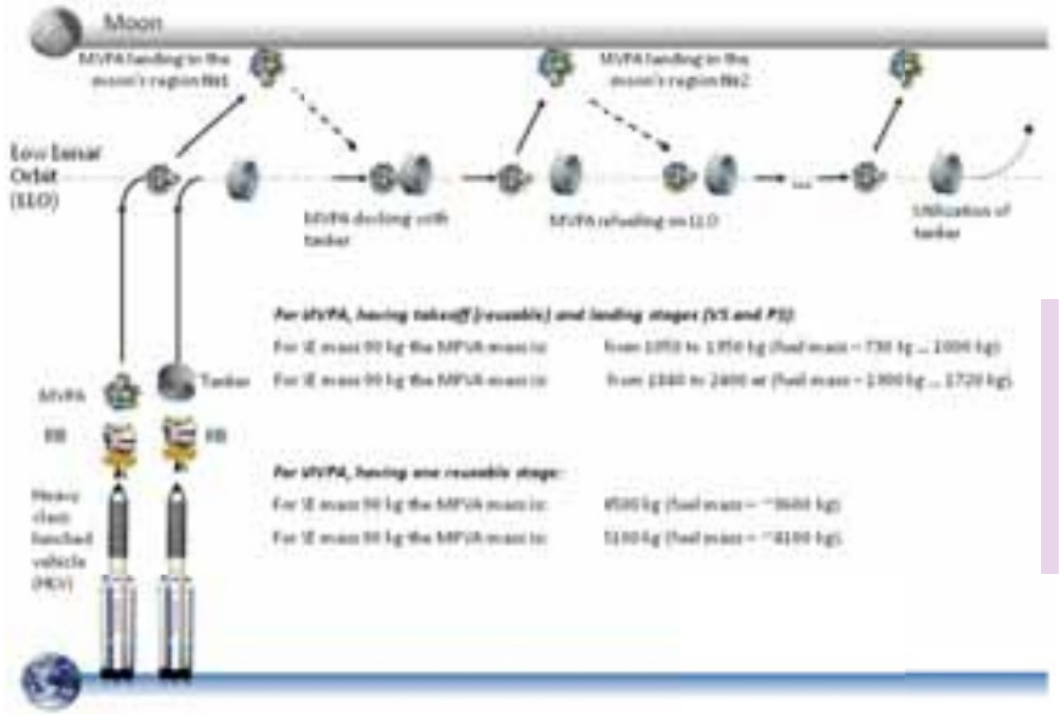

Fig. 7. The mission scenario of an automatic spacecraft in the MVPA variant, when up to six distant regions of the Moon are investigated and refueling is used in low lunar orbit.

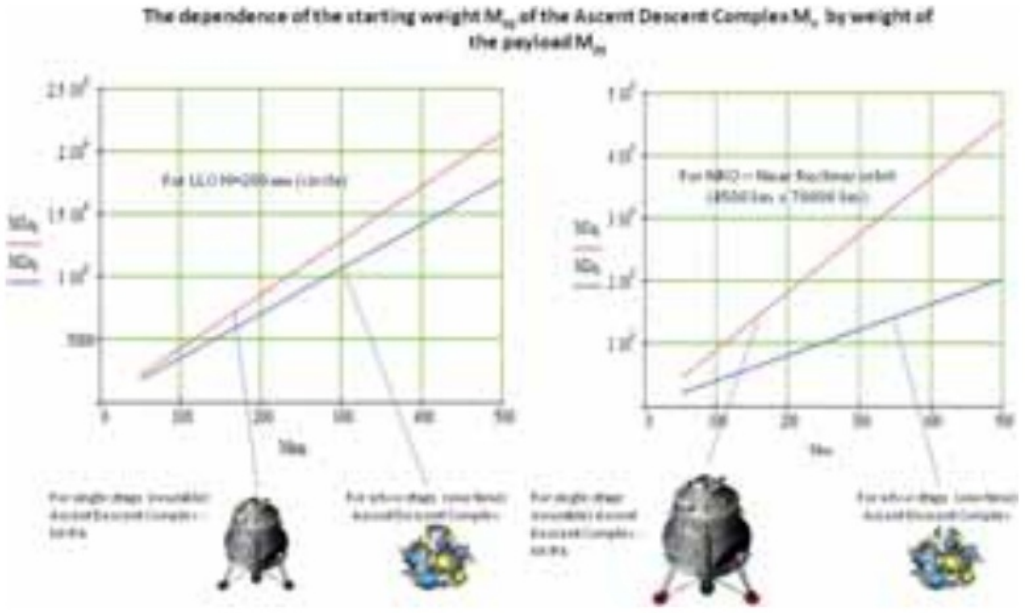

Fig. 8. Dependence of mass of MVPA on execution, mass of AN and on the height of the orbit of refueling.

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when the landing stage remains on the Moon after each landing (it is filled with a new one in orbit), and the take-off stage is reusable and refillable. The second version of the MVPA is a fully reusable, single-stage MVP, refu ing in orbit. The dimension of the complex of scientific equipment corresponds to the dimension of the space-craft "Luna-Resource-1 (PA)"—about 90 kg. Thus, two launches of heavy-class carrier missiles provide a solution to the tasks corresponding to six separate missions of the Luna-Resource-1 (PA) mission.

As we can see from the cited calculation results, a two-stage, partially reusable MVPA turns out to be of a lower dimension than a fully reusable one-stage one. However, in reality, in the first case, we must also deliver six filled landing stages together with the tug. This may be more complicated and more expensive than the delivery of only one fuel, albeit a larger mass. If we turn to the issue of optimizing the height of the orbit for refueling MVPA, here the results of ballistic calculations look quite clearly, Figure 8 [9].

In Figure 8, the left side shows the graphs of mass calculations of the MVPA for the refueling variant on a circular polar lunar orbit of 200 km in height, and on the right side are calculations for the variant of delivery of the MVPA to the high polar lunar orbit (Near Recliner orbit, NRO) with altitudes of 4000 km. . .70,000 km chosen as the base for the LOP-G project (Lunar Orbital Platform-Gateway) [2].

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Table II. Potential problems solved onboard the LOS and necessary means.

The potential problem it possible to solve on board of LOS	Necessary equipment	The necessity of human participation	Remark
1	2	3	4
1. The contact study of the lunar matter (regolith samples delivered by the WPA)	Chemical-analytical laboratory, thermal vacuum chamber, thermal oven, mass spectrometers, microscopes	Desirable	The effectiveness of a scientific survey is determined by the number of specialists involved in the work. With one or two specialists in orbit, only express analysis is possible, not replacing the need to deliver samples to earth
2. Remote study of the moon	Cameras, camcorders, spectrometers, IR and UV cameras	Not required	Crew participation is required only for conducting operational surveys, when shooting sites are difficult to predict and identify
3. Space astrophysics research	Telescopes, radio telescopes, magnetometers	Not required	Being on board the crew is undesirable with active equipment
4. Overloading samples of lunar matter from the WPA to the ship returning to earth	Robot arm	Not required	
5. Refueling of VPA	Refueling system	Not required	
6. Retrofit of WPA with replaceable scientific equipment	Robot arm	Not required	Subject to the modular manufacture of scientific equipment
7. Repair of VPA	Robot arm, Anthropomorphic robot	Not required	Subject to repairable manufacture of VPA
8. Development of new technological or technical solutions in deep space conditions	It is impossible to describe the necessary equipment in advance	Desirable	The frequency and scale of the formation of a package of such tasks is currently difficult to assess. It is expected that at the initial stage of the study of the moon such problems will be few
9. Logistic support for manned flights to the surface of the moon	Interfaces for docking of manned spacecraft and lunar modules. Life support systems for temporary stay of the crew	Determined by the mission scenario	For manned flights to the moon
10. Operational support for remote control of robots on the surface of the moon	Communication systems with orbital near-moon repeaters that set (control) the device robots	Is required	With manned flights to the moon and the deployment of robotics on the surface, working on flexible scenarios (requiring adjustment by the operator)

As we can see, first, the dimension of the MVPA is several times (an order of magnitude) in the variant of refueling in a low lunar orbit less than in the case of a high orbit NRO. Secondly, the differences in dimension between the two-stage and single-stage MOPA for low orbit refueling are not as significant as in the case of refueling in NRO orbit. The option of a fully reusable MVPA becomes irrational if we raise the altitude of the refueling orbit. In the case of using low orbit for refueling, fully reusable MVPA look quite competitive in relation to the two-stage (partially reusable) MVPA execution options.

6. LUNAR ORBITAL STATION

The consequence of the ideas and calculations outlined in the previous sections is the conclusion about the need to create a lunar orbital station—LOS. In particular, its tasks, localization in the lunar space, and dimensionality become obvious. Table II lists the main tasks that can be performed on board a LOS, the requirements for human presence arising from these tasks, the need for specific equipment.

As follows from the analysis of Table II, in the overwhelming number of cases, if this visit to LOS is not tied directly to a manned mission, it is not necessary to have a person on board. That is, LOS is a predominantly unmanned orbital object, significantly different from near-earth manned stations. What may be the approximate appearance of LOS, gives an idea of Figure 9.

Taking into account the listed tasks, the characteristics of this type of LOS could be as follows [9]:
Electric power of solar batteries 15 kW;
Marching Electro jet Engine Type SPD-230;
Electro jet control engine type SPD-50;
Xe—filling 300 kg;
The mass in the orbit of the moon—3777 kg.

An example of the inclusion of such LOS in the scenario of the implementation of the scientific mission is shown in Figure 10. The scenario shown in the figure provides for the interaction of automatic spacecraft with a station in high lunar orbit (for example, with the international project LOP-G). The meaning of the interaction in this case is the use of manned LOP-G related missions as cargo missions for the return of lunar matter samples (scientific results on the surface). Thus, the proposed version of the lunar infrastructure is organically consistent even with those projects whose direction is not directly related to the exploration of the moon. The lunar station in low orbit turns out to be the key object of the lunar infrastructure, since its task is to service the MVPA—their refueling, retrofitting with a spare tool of scientific equipment and radio engineering support of operations on the lunar surface.

7. THE APPEARANCE OF PROMISING SCIENTIFIC COMPLEXES

If we relate proposals for the tasks of scientific complexes, variants of robotic means of their maintenance, variants of delivery systems and variants of the lunar orbital station, then the following variants of scientific complexes most fully meet the goals of shortening the stage of scientific research on the Moon.

(1) MVPA with a drilling rig and a deep logging probe;
(2) a heavy lunar rover with a drilling rig, a deep logging probe, and others. For the study of regolith;
(3) lunar rover with the torso part of an anthropomorphic robot for research including stony, rocky rocks and with the possibility of repair (oneself and other lunar technology), Figure 11 [10, 11].

Fig. 9. LOS, preliminary conception.

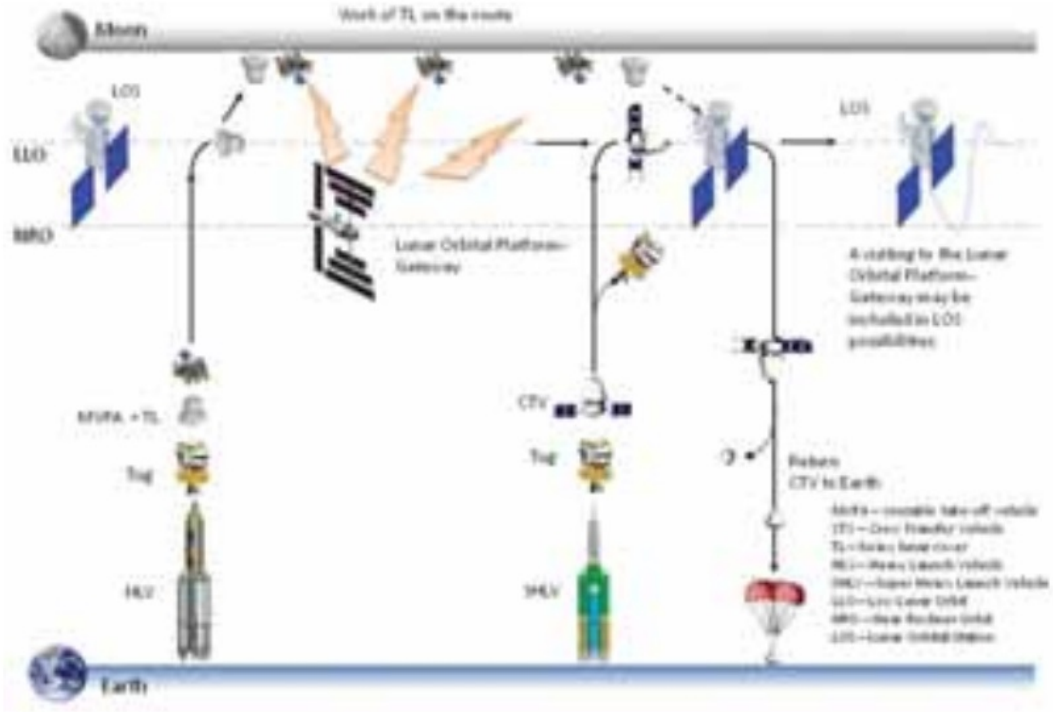

Fig. 10. Scenario of using LOS in scientific missions using reusable scientific equipment.

Fig. 11. Lunokhod with the torso part of an anthropomorphic robot for research of stony, rocky rocks and with the possibility of repair (of itself and other lunar technology).

Fig. 12. Automatic Soviet station "Luna-24," equipped with a drilling rig and a part that is rotated to the earth.

Fig. 13. Soviet lunokhod-2.

From the point of view of technical implementation, the first two types of platforms for scientific complexes have historical analogues. For example, MVPA with a drilling rig have analogues in the form of the Soviet stations "Luna-16," "Luna-20," "Luna-24" (Fig. 12).

The Soviet Lunokhod-1 and Lunokhod-2 are the analogue of a heavy lunar rover with a drilling rig. The mass of Lunokhod-2 was, for example, 840 kg, [12], Figure 13.

Let us consider in more detail a lunar rover with a torso part of an anthropomorphic robot, since there is no historical analogue here yet.

8. LUNOKHOD WITH A TORSO OF AN ANTHROPOMORPHIC ROBOT

This solution for the lunar scientific complex is a compromise between the desire to reproduce on the moon manipulators with the exact motor skills of hands, human hands in the form of an anthropomorphic robot, as well as the desire to create a reliable and relatively fast locomotion complex for alien conditions that ensures the movement of all scientific equipment. Thus, we are talking about creating a system of two interacting robotic complexes—manipulation and locomotion. In general, such a system can be called a "centaur" in honor of the mythical heroes of the ancient Greek epic [13], Figure 14. Tasks of such a system are focused on non-standard situations—to work in a non-deterministic environment. This also applies to the navigation of the locomotion complex, and the fine motor skills of the two arm manipulators. The Centaur should solve the following tasks:

—performing manipulations with efficiency comparable to the actions of an astronaut during extra-ship activity;

Fig. 14. The variant of the anthropomorphic robot of the Skybot f-850 project on a wheeled-walking chassis of moon rovers.

—high-precision navigation in the external environment both for the operation of manipulators and for moving the entire system in the environment;
—the ability to work with a standard (universal) tool adapted for human work;
—the ability to service (replace) the modules of the system itself, critical from the point of view of the resource;
—locomotion of the system over difficult cross-country terrain at distances of hundreds of kilometers;
—autonomous power supply system;
—temperature control of the system, including periods of moonlit night and active exposure to solar radiation.

When creating such a system there are many difficult tasks. Currently, the authors are studying the following tasks:
(1) Control of the system from the Earth under conditions of a signal delay of about 3 seconds.
(2) Creating a temperature control system for the temperature range from −180 to +190 degrees Celsius.
(3) Creation of a locomotion complex providing for the movement of the system hundreds of kilometers on the surface of Moon.

Without solving these problems, the value of the complex for the moon is greatly reduced. The delay of the control signal from the Earth to the Moon is about 3 seconds. This significantly complicates the performance of precision operations of fine motor skills by an anthropomorphic robot in the case of using the copy mode. Accordingly, the robot must have an intelligent manipulation control system that would allow it to operate to a certain extent independently. This means the possibility of sequential execution of typical movements with the brush and each individual finger within a certain scenario. Such a scenario may be the capture of a rock sample in the form of a stone of arbitrary shape or routine operation using a typical tool. To train and improve the performance of each individual movement within the framework

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of such a scenario, the creation and development of a virtual model of such a robot in a virtual environment, for example, the Unity product, is required [14]. During such testing, the vision system constantly supplies the control system with the current data on the relative position of the manipulation object and all the joints of the manipulator's hand. Based on multiple training solutions to the problem of inverse dynamics and performing manipulations in the copy mode, a knowledge base of the necessary sequences of atomic movements is formed. Such a base is formed in the form of a trained neural network of a certain architecture or a fuzzy controller. In the presence of a large verified base of such scenarios, the telepresence operator only starts the action and further controls its correctness. The robot then picks up the current action, choosing the most suitable scenario from the knowledge base and executing it. After completion of the script, there comes a time when you cannot perform new actions for several seconds, but control the correctness of the previous ones. In this way, a specific control mode is formed, which we will call *"partially intelligent" control mode*. About the development of a locomotion complex. The need to move it on stony and rocky rocks along inclined surfaces leads to the use of the so-called "Walking wheels." With this design option, the wheel is not mounted coaxially with the mounting bar on the apparatus. Thus, the chassis was implemented on Soviet moon rovers [15], as well as on American rovers (Spirit, Opportunity, Curiosity [16]). In particular, the authors consider the following design: the upper part of the wheel mounting rod is attached to the axis coming from the body, Figure 11. Inside the housing is an electric motor that can rotate the axis. In this case, the rod with the wheel also moves. When moving on a horizontal surface with small tilt angles, the robot moves only with wheels. When obstacles appear in the form of potholes or placers that cannot be avoided, the robot steps over them. To do this, the design provides for additional retractable bearings (not shown in Fig. 11). The same supports can be extended to increase stability when the robot begins to manipulate. Also, to facilitate pacing, the use of moving the center of mass of the structure by changing the position of the torso is provided. The combination of the walking and rolling functions should ensure high road qualities of the system. For example, walking can also be applied if the angle of elevation of the surface is large and/or the coefficient of adhesion to the surface is reduced. The torso can lean forward to capture objects on the surface of the moon. If it is necessary to unload one of the front wheels for walking, the torso should be thrown back, while the case with the manipulators should be turned at a right angle from the initial position to the side opposite to the unloaded wheel. Manipulators are also brought to the required position. To unload the rear wheels for walking, the procedure is similar, but the torso part leans forward.

About the development of a robot temperature control system. Specialists of the Android Technology company

Fig. 15. Thermal vacuum tests of the prototype manipulator of the anthropomorphic robot in the pressure chamber of JSC "ISS named after Reshetneva," manufactured by the company "Android technology."

and the I.Kant Baltic Federal University conducted thermal vacuum tests of the torso part of the anthropomorphic robot in a thermal pressure chamber of JSC "ISS named after Reshetneva" [17, 18], Figure 15. Under conditions of maximum heat generation in the manipulator's engines while simulating the maximum external heat fluxes, the manipulator worked for 1.5 hours before reaching the critical temperature. In the absence of external heat fluxes, when heat was released by radiation onto cryoscreens simulating the surrounding space, it took about 10 W of heat in the manipulator electric motors to maintain temperatures over them in a comfortable range. Thus, the circuit design of the torso part was confirmed, in which the manipulators were not covered by screen-vacuum thermal insulation, and the body was covered. A similar solution is proposed for the lunar variant.

In addition to temperature control at the drive level, the option of temperature control of the entire anthropomorphic torso of the robot for the period of the "moonlit night" is also being considered. In this case, the locomotion complex has a container in the upper part corresponding to the dimensions of the folded torso of the robot. Before the start of the "moonlit night" the container opens, and the torso of the robot folds into the locomotion complex. After that, the container closes. With this embodiment, heat loss during a moonlit night can be minimized. Thus, the solution to the problems of creating an anthropomorphic lunar explorer created by the formula "operator + avatar" seems possible.

9. CONCLUSIONS

(1) The stage of researching the substance of the Moon when using reusable means (MVPA equipped with reusable RDR and RDLP) can be reduced by almost ten times compared with the period of implementation of one-time scientific missions to the lunar surface with a similar volume of scientific tasks and a similar mass of lunar returned to Earth substances.

(2) It is necessary to deploy in the low lunar orbit an automatic lunar orbital station (LOS), whose main task is

to maintain the MVPA—to refuel them, to equip scientific equipment with spare parts and radio engineering support for operations on the lunar surface.

(3) Currently, the tasks of creating reusable tools for scientific research (RDR, RDLP, MVPA) and remotely controlled robotics placed onboard the MVPA, moon rovers and LOS (in particular, cargo manipulators for transferring containers, as well as manipulators for preventive maintenance and repair MVPA).

(4) Particularly relevant is the creation of tanker tankers for MVPA.

(5) Promising platforms for scientific equipment, which cover the list of topical scientific tasks for the coming decades for a detailed study of the Moon, are:

—MVPA with reusable drilling rig and reusable deep logging probe;

—heavy lunar rover with reusable drilling rig, deep logging probe, etc. science equipment to study the regolith;

—lunar rover with the torso part of an anthropomorphic robot.

(6) The proposed concept can be developed both in support of the upcoming manned expeditions to the Moon, and independently of them, providing flexibility and continuity in the implementation of a comprehensive scientific program.

(7) It seems relevant to develop an anthropomorphic lunar robot based on a wheeled-walking locomotion platform. Such a combined system can largely replace a human researcher on the moon, giving the researcher on Earth the possibility of telepresence and control in a mode close to that of direct copying.

Acknowledgments: The work was supported by Ministry of Education and Science of the Russian Federation under the agreement No.14.578.21.0141 2019-05-576-0001 (unique project identification number RFMEFI57815X0141 2019-05-576-0001-0486).

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of Computational and Theoretical Nanoscience
Vol. 16, 5298–5302, 2019

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Reallocated Sectors Count Parameter for Analysing Hard Disk Drive Reliability

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The dependence of the SMART parameter 5 Reallocated sectors count value change on the operating time characterising the number of reallocated sectors is considered. This parameter is critical in the sense that if the attribute value increases, this may indicate deterioration in the state of the disk surface. The scientific task of the study is to establish relationships in the failed hard drives between the specified parameter and the values of other reliability parameters for information stores of various manufacturers. In the course of the study, the drives of the HGST, Hitachi, Samsung, ST, Toshiba, WDC trademarks operated in the Backblaze largest commercial data centre were analysed. The analysis revealed a relationship between the specified parameter and the parameters 1 Read error rate (frequency of errors (when reading data from the disk), the origin of which is due to the hardware of the disk), 196 Reallocation event count (number of reallocation operations), 197 Current pending sector count (number of sectors that are candidates for reallocation). It is shown that the nature of the change in the values of the considered parameters depends on the manufacturer of information storage devices. It is proposed to perform an individual assessment of the reliability of hard drives using the parameters identified as a result of the study.

Keywords: Reallocated Sector, Hard Drive, Reliability, Information, Security, Drive.

1. INTRODUCTION

In order to confirm the safety of data, it is vital to timely and completely copy data from an un-safe drives to another safe one. For this purpose, they usually use SMART technology [1] for internal assessment of the computer's hard drive, as well as a way to predict its possible failure. The paper considers the dependence of the change on the operating time of the parameter 5 Reallocated sectors count, which characterizes the number of reallocated sectors. This parameter is critical in the sense that if the value of this attribute increases, this may indicate deterioration in the state of the disk surface. The scientific task of the study is to establish for failed hard drives a connection of the specified parameter with the values of other reliability parameters of information storage devices from various manufacturers. In the course of the study, the parameters of failed drives of the HGST, Hitachi, Samsung, ST, Toshiba, WDC brands operated in the Backblaze largest commercial data centre were analysed. The analysis revealed a connection between parameter 5 Reallocated sectors count and parameters 1 Read error rate (frequency of errors when reading data from the disk, the origin of which is due to the hardware of the disk), 196 Reallocation event count (the number of reallocation operations), 197 Current pending sector count (number of sectors that are candidates for reallocation). It is shown that the nature of the change in the values of the considered parameters depending on the operating time of the information storage devices depends on the manufacturer. It is proposed to perform an individual assessment of the reliability of hard drives using the parameters identified as a result of the study.

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2. METHODS

To analyse the dependence of the parameter values on the operating time of information storage devices on hard magnetic disks that have failed, we studied the SMART data provided on the Backblaze website [2]. 45 parameters of SMART 92530 type were examined for 93 drives and 6 brands.

The group which values accumulate (of the "count" type), the values of which reflect the rate of change (of the "rate" type or similar in meaning), the group which values

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are associated with other parameters (also of the "count" type or similar). According to another classification, three groups of parameters can also be identified: those associated with the state of the memory space, or the surface of the disks; those associated with the positioning of the write/read heads; and those associated with the mechanical part of the hard drive design. Data storage defects can also be divided into two large groups: physical and logical. Physical defects include surface defects, servo errors, and bad hardware sectors. Surface defects occur due to mechanical damage to the magnetic coating inside the sector space, for example, due to scratches caused by dust, ageing of disk plates or careless handling of a hard disk. Such a sector should be marked as unusable and excluded from circulation. All modern drives use a system called "moving coil" to move the heads, which, unlike a stepper motor, does not have any discreteness of movement. For an accurate hit of the heads on the tracks, a feedback system is used; it is guided by special magnetic servos applied to the disk. Servo tags are available on each side of each drive. They are evenly spaced along all tracks forming a servo format. It does not belong to the lower level format, but it is available for all modern hard drives and plays a crucial role. According to servo marks, the engine speed is stabilised and the head is held on a given track regardless of external influences and thermal deformation of the elements. However, during the operation of drives, some servo tags may be destroyed. If there are too many faulty servo tags, failures will occur at these points when accessing the information track: the head, instead of taking the position it needs and reading the data, will begin to move from side to side. It will look like a bad sector or even a group of them. The elimination of such defects is possible only with special programs, by disabling defective tracks, and sometimes the entire disk surface. For these purposes, some drives have a defect list that stores information about bad servo marks. The servo-defect list is not used by the translator, but by the entire firmware of the hard drive. Sectors with defective servo tags are blocked even by physical parameters; this helps to avoid knocks and breakdowns when accessing them. A hard drive cannot restore the servo format on its own; it is done only at the factory.

Hardware bad sectors appear due to a malfunction in the mechanics or electronics of the drive. Such problems include breakage of the heads, displacement of the disks or a bent shaft as a result of an impact, dusting of the hermetic zone, as well as various interruptions in the operation of electronics. Errors of this type are usually catastrophic and cannot be corrected programmatically.

Logical defects arise not because of surface damage, but because of violations of the logic of the sector. They can be divided into correctable and uncorrectable. Logical defects have the same external manifestations as physical ones, and they can be distinguished only indirectly, according to the results of various tests.

The essence of the research method is to compare changes in the values of SMART parameters for failed storage media and to identify coincidences in time.

3. RESULTS AND DISCUSSION

The parameter 5 Reallocated sectors count is the best option for displaying the surface state of hard drives. It is always used for all drives and is equally interpreted by all manufacturers. Also, its changes coincide with changes in parameters 1, 196, 197. The example of such coincidence for the failed hard drive brand HGST is shown in Figure 1. A similar coincidence is observed for failed drives of the Hitachi brands (Fig. 2), Toshiba (Fig. 3), WDC (Fig. 4). For the only Samsung manufacturer that lost its working capacity, parameters 5 and 196 are equal to zero. Nevertheless, there is still a coincidence of the change in parameters 1 and 197 (Fig. 5). Parameters 13 and 183 are additionally shown here in order to indicate another reason for the failure of the drive. There is a coincidence for failed drives of the ST brand, which is similar to the previous ones, but without parameter 196, which is absent in all Seagate drives, and with the chaotic nature of parameter 1 change (Fig. 6). As can be seen from Figures 1–6, usually parameter 1 changes earlier than all the others. Here, it characterizes the appearance of the very first write/read errors. Then, parameter 197 changes; it shows the number of sectors in which these write/read difficulties are

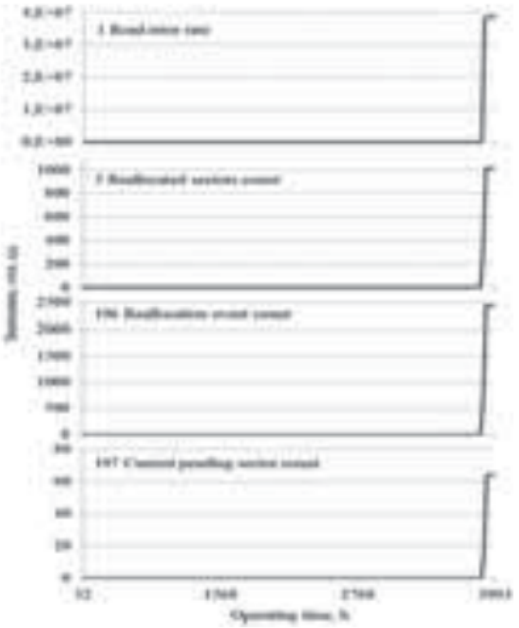

Fig. 1. Parameter 1, 5, 196, 197 values depending on the operating time for a failed hard drive of model HGST HMS5C4040ALE640 with the number PL1331LAGRTU8H and with a capacity of 4 TB.

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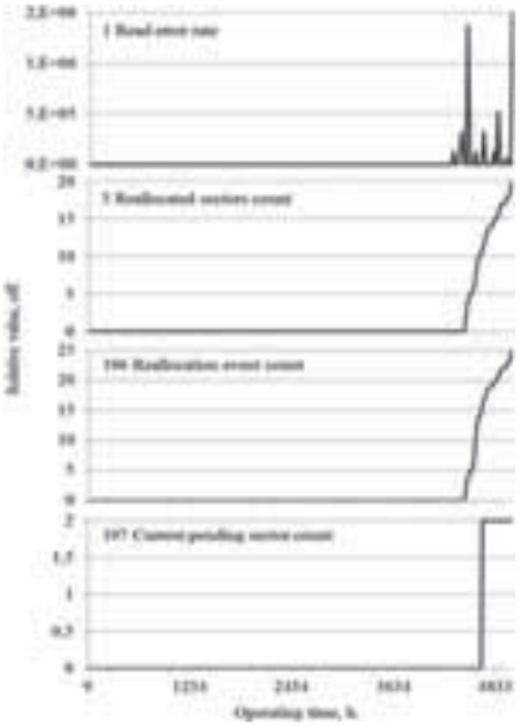

Fig. 2. Parameter 1, 5, 196, 197 values depending on the operating time for the failed Hitachi HDS5C3030ALA630 model hard drive with the number MJ1311YNG6EH8A and with a capacity of 3 TB.

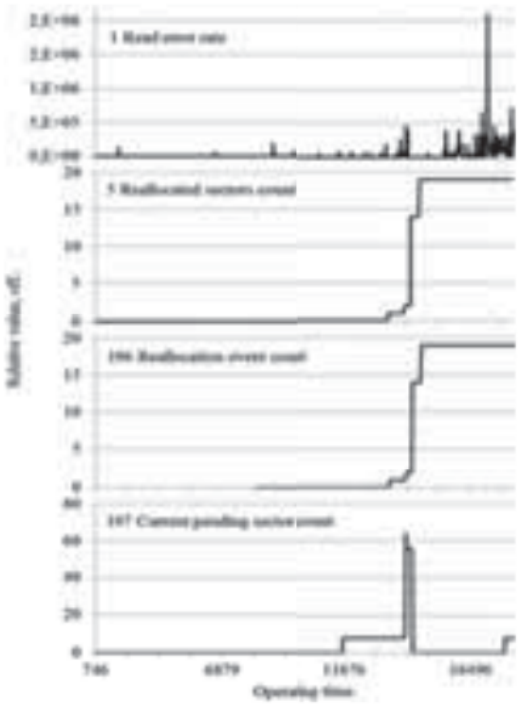

Fig. 3. Parameter 1, 5, 196, 197 values depending on the operating time, in hours, for the failed Toshiba DT01ACA300 model hard drive with the number Z262EBNAS and with a capacity of 3 TB.

observed. Further, parameters 196 and 5 are changed with all or only successful reallocation attempts. Taking these circumstances into account when analysing relative [3] or absolute [4] values allows one to predict the failure of a hard disk.

Here, parameter 1 Read error rate characterizes the frequency of errors, the origin of which is due to the hardware of the disk when reading data from a disk. This is the number of internal data corrections made before being issued to the interface. Frighteningly huge numbers may come up [5–7]. Parameter 5 Reallocated sectors count characterizes the number of reallocated sectors. When a disk detects a read/write error, it marks the sector as "reallocated" and transfers the data to a dedicated backup area. An increase in the value of this attribute may indicate deterioration in the surface of the disk platters. Parameter 196 Reallocation event count shows the number of reallocation operations. The attribute characterizes the total number of attempts to transfer information from reallocated sectors to the backup area. Both successful and unsuccessful attempts are taken into account. Parameter 197 Current pending sector count shows the number of sectors that are candidates for reallocation [6, 8, 9]. They have not yet been identified as bad, but reading from them is different from reading a stable sector, these are the so-called suspicious or unstable sectors. In case of successful subsequent reading of the sector, it is excluded from the list of candidates. In the case of repeated erroneous readings, the drive tries to restore it and performs a reallocation operation [8–11]. An increase in the value of this attribute may indicate physical degradation of the hard drive. A feature of parameters 1, 5, 197 (as well as 9 Power-on hours, which forms the horizontal time axis in the figures, and 194 Temperature, which characterizes the case temperature, but not yet used in the analysis) is that they are available for all drives of all manufacturers. Moreover, they can all be used to evaluate the reliability of hard drives. Therefore, this group of parameters is the most important and mandatory for use in the analysis. As can be seen from Figures 1–6, parameters 5 and 196 are cumulative; their values only grow depending on the operating time [12]. Although parameter 197 is cumulative, however, if a sector moves from the category of candidates for reallocation to reallocated sectors, then its value decreases. Parameter 1 characterizes the rate of change in the values of other parameters and has the character of a derivative. As can be seen from the above figures, failures associated with the surface state of the disks can be of both types.

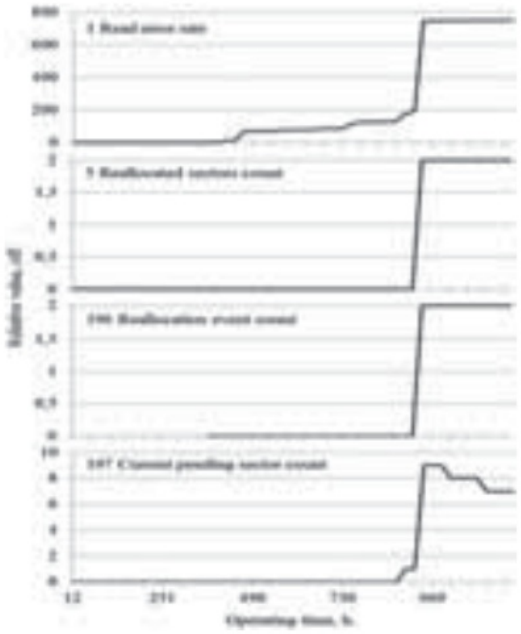

Fig. 4. Parameter 1, 5, 196, 197 values depending on the operating time for a failed hard drive model WDC WD30EFRX with the number WD-WCC4N0299367 and with a capacity of 3 TB.

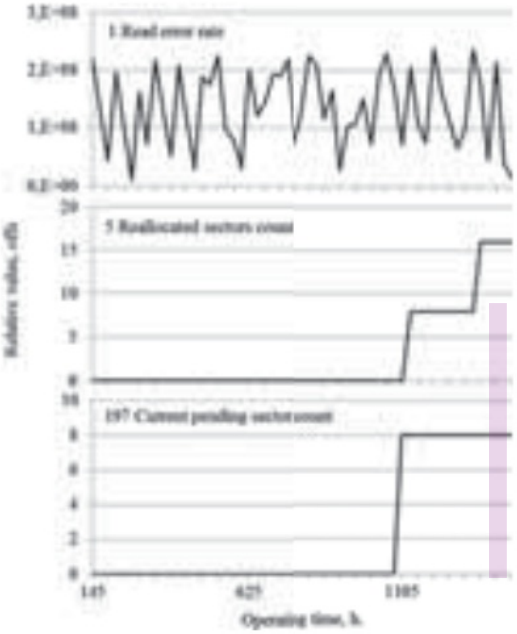

Fig. 6. Parameter 1, 5, 197 values depending on the operating time for a failed hard drive model ST4000DM000 with the number Z300X6Y6 and with a capacity of 4 TB.

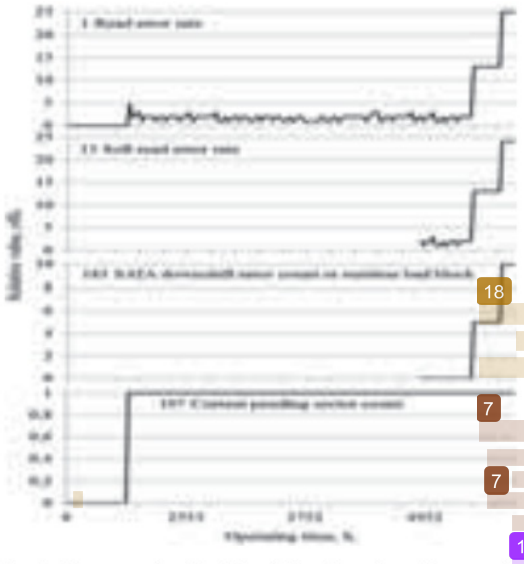

Fig. 5. Parameter 1, 13, 183, 197 values depending on the operating time for the failed SAMSUNG HD154UI model hard drive with the number S2CHJR0Z900286 and with a capacity of 1.5 TB.

4. CONCLUSION

Based on the obtained findings in the current paper, it was enhanced that four SMART parameters have time-coinciding changes in values of parameters for failed hard drives. These are parameters with numbers 1, 5, 196, and 197. Some of them, namely, parameters 5, 196, 197, characterize the total number of reallocated sectors, attempts to reallocate them, and candidates for reallocation. Parameter 1 characterizes the rate of change of these parameters. The novelty of the findings is that we can develop standard for the risk of drive failures based on the identified parameters characterizing the state of the surface of the hard drives. The justification of these criteria is based on the fact of coincidence in time of the change in the values of the specified parameters identify as a result of the analysis.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5303–5306, 2019

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Spin Retry Count Relation with Other hdd Parameters

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The change of the SMART parameter 10 Spin retry count values depending on the operating time is considered; this parameter characterizes the number of repeated attempts to spin the disks up to operating speed if the first attempt was unsuccessful. This parameter is critical in the sense that if the value of the attribute increases, then the likelihood of malfunctions in the mechanical part of the hard disk drives is high. The scientific task of the study is to establish the relationship between this parameter in failed hard drives and the values of other reliability parameters for information stores from various manufacturers. In the course of the study, the drives of the HGST, Hitachi, Samsung, ST, Toshiba, WDC trademarks operated in the Backblaze largest commercial data centre were analysed. As a result of the analysis, the relationship between the specified parameter and such parameters as 3 Spin-up time (time of spinning the disk package from standstill to operating speed), 4 Start/stop count (counting the spindle start/stop cycles), 12 Power cycle count (number of full drive switching on/off cycles), 192 Power-off retract count (the number of shutdown cycles, including emergency), 193 Load cycle count (the number of magnetic head block moves in the parking zone/in working position cycles). It is shown that the nature of the change in the values of the considered parameters depends on the manufacturer of the hard drives. It is proposed to carry out an individual assessment of the information storage device rotation mechanism reliability using the parameters identified as a result of the study.

Keywords: Rotation Mechanism, Hard Drive, Reliability, Information, Security, Drive.

1. INTRODUCTION

To ensure information security, it is necessary to timely and completely copy data from an unreliable drive to a new safe one. For this purpose, SMART technology [1] is usually used for internal assessment of the state of a computer's hard drive, as well as a way of predicting its possible failure. The paper considers the change from the operating time of the parameter 10 Spin retry count which characterizes the number of repeated attempts to spin up the disks to the operating speed if the first attempt was unsuccessful. This parameter is critical in the sense that if the value of the attribute increases, then the likelihood of malfunctions with the mechanical part of the hard disk drives is high. The scientific task of the study is to establish the relationship between this parameter in failed hard drives with the values of other reliability parameters for information stores of various manufacturers. In the course of the study, the parameters of failed drives of brands such as HGST, Hitachi, Samsung, ST, Toshiba, and WDC operated in the largest commercial data centre Backblaze were analysed. As a result of the analysis, the relationship between the parameter 10 Spin retry count and parameters 3 Spin-up time (time to spin a disk package from standstill to operating speed), 4 Start/stop count (counting spindle start/stop cycles), 12 Power cycle count (number of full disk on/off cycles), 192 Power-off retract count (the number of shutdown cycles, including emergency cycles), 193 Load cycle count (the number of cycles for moving the block of magnetic heads to the parking zone/to the working position). It is shown that the very existence of the values of the considered parameters and the nature of their change depending on the operating time of the information storage devices depend on the manufacturer. An individual assessment of the hard drive rotation mechanism reliability is proposed to be performed using the parameters identified as a result of the study.

2. METHODS

To analyse the dependence of the parameter values on the operating time of the failed information storage devices on hard magnetic disks, the SMART data listed on the

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Backblaze website [2] was studied. 45 parameters SMART 92530 were examined for 93 drive models of 6 brands HGST, Hitachi, Samsung, ST, Toshiba, WDC for the duration from April 10, 2013, to December 31, 2016. It was deduced that at the end of the study period, 79.58% of drives continued to work normally, 14.74% were prematurely decommissioned, and 5.68% failed. Therefore, Backblaze specialists created only 40 of them in 2013–2015, and since 2015, there were recorded 45 with numbers 1–5, 7–13, 15, 22, 183, 184, 187–201, 220, 222–226, 240–242, 250–252, 254, 255 (in 2015, 22, 220, 222, 224, 226 were added). Among these parameters, three groups can be distinguished: which values are being accumulated (of the "count" type), which values reflect the rate of change (of the "rate" type or similar in meaning), and which values are associated with other parameters (also of the "count" type or similar). According to another classification, three groups of parameters can also be identified: those related to the state of the memory space—the surface of the disks, the positioning of the write/read heads, and the hard drive mechanics. Storage defects can also be divided into two large groups: physical and logical. Physical defects include surface defects, servo errors, and bad hardware sectors. The latter arise due to malfunctioning mechanics or electronics drives. Such problems include breakage of the heads, displacement of the disks or a bent shaft as a result of an impact, dusting off the hermetic zone, as well as various interruptions in the operation of electronics. Errors of this type are usually catastrophic and cannot be corrected programmatically. Logical defects arise not because of surface damage, but because of violations of the logic of the sector. They can be divided into correctable and uncorrectable. Logical defects have the same external manifestations as physical ones, and they can be distinguished only indirectly according to the results of various tests. Thus, the essence of the research method is to compare the changes in the value of the SMART parameters of the failed information storage devices and to identify time coincidences in them.

3. RESULTS AND DISCUSSION

When analysing the 10 Spin-up retry count parameter which characterises the state of the rotation mechanism, it was detected that a failed hard drive of the HGST trademark has a coincidence in time of changes with the parameters 3, 4, 12, 192, 193 (Fig. 1). Moreover, an increase in the value of parameter 10 coincides with a decrease in the value of parameter 3, although this behaviour is not always observed. Nevertheless, taking into account this circumstance when selecting for relative [3] or absolute [4, 5] values, will allow us not to lose sight of the necessary parameters. In other words, the requirement of a monotonic change in the values in the series of "normal," "taken ahead of schedule," "failed" ones, can be replaced by

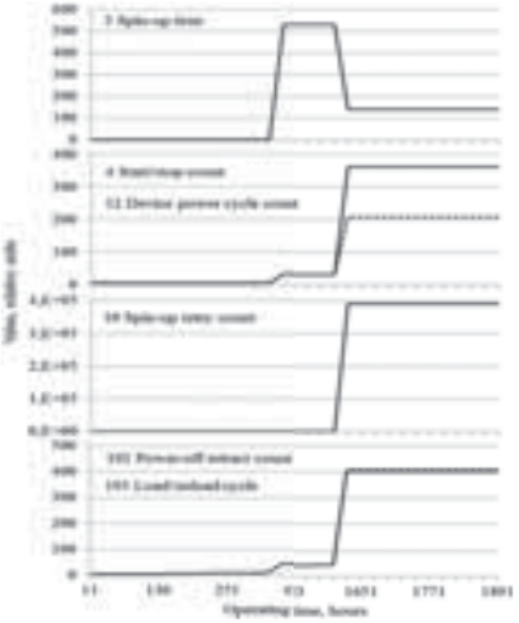

Fig. 1. Parameter values 3, 4, 10, 192 (solid lines), 12, 193 (dotted lines) versus the operating time for a failed hard drive model HGST HMS5C4040BLE640 with number PL2331LAGGW6UJ and with a capacity of 4 TB.

a simultaneous increase (decrease) in the values "taken ahead of schedule" and "failed" drives compared to normal devices. A similar coincidence was observed for other failed drives of the HGST brand (Fig. 2) (total of 3 pieces),

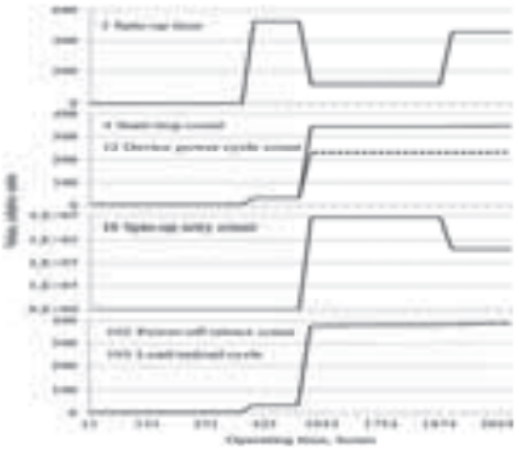

Fig. 2. Parameter values 3, 4, 10, 192 (solid lines), 12, 193 (dotted lines) versus the operating time for a failed hard drive model HGST HMS5C4040BLE640 with number PL1331LAGLXLEH and with a capacity of 4 TB.

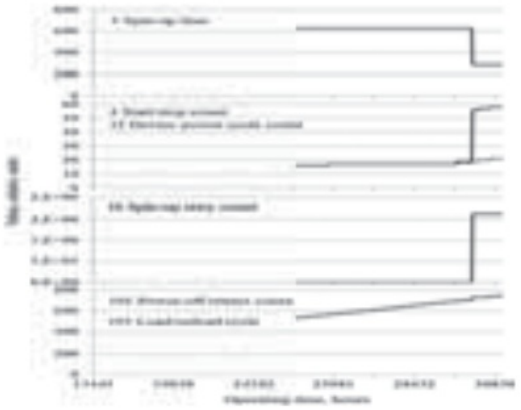

Fig. 3. Parameter values 3, 4, 10, 192 (solid lines), 12, 193 (dotted lines) versus the operating time for the failed Hitachi HDS722020ALA330 model hard drive with a 2 TB and number JK11A4B8J22ZNW.

Hitachi (Figs. 3, 4) (total of 5 pieces), Toshiba (Fig. 5) (1 piece), for which parameter 10 had nonzero values. For disks of other manufacturers that lost working capacity, it was equal to zero or completely absent.

Here, the parameter 3 Spin-up time characterizes the time of spin-up of a disk pack from the idle state to the operating speed. Its value increases due to wear and tear of mechanics, increased friction in the bearing, and may also indicate poor power supply (for example, a voltage drop at the start of the disk). Parameter 4 Start/stop count

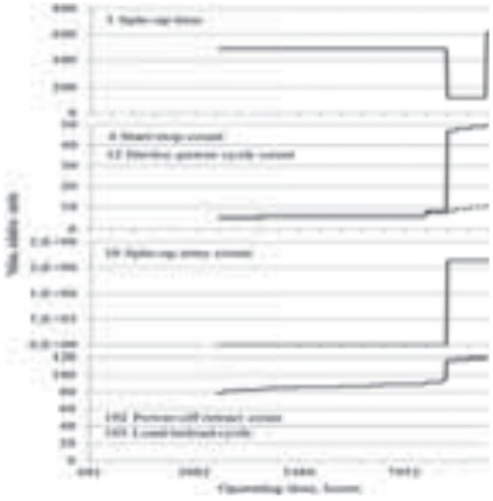

Fig. 4. Parameter values 3, 4, 10, 192 (solid lines), 12, 193 (dotted lines) versus the operating time for the failed Hitachi HDS722020ALA330 model hard drive with a 2 TB and number JK11A5B8KK8Z2X.

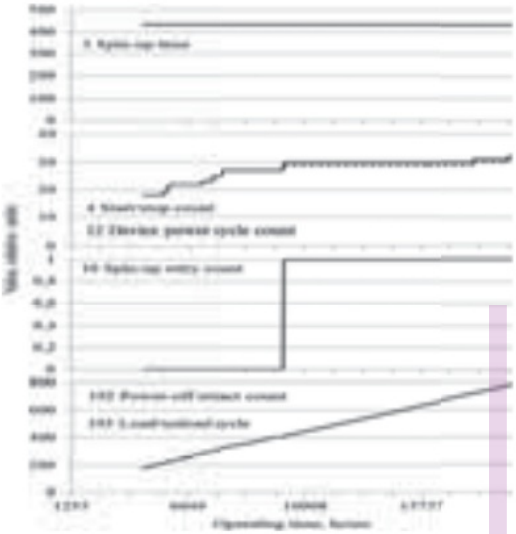

Fig. 5. Parameter values 3, 4, 10, 192 (solid lines), 12, 193 (dotted lines) versus the operating time for the failed Toshiba DT01ACA300 model hard drive with the number 13H883WAS and a capacity of 3 TB.

characterizes the total number of starts/stops of the disk. Parameter 10 Spin retry count characterizes the total number of attempts starting rotation in order to achieve full working speed (provided that the first attempt failed). An increase in the value of this attribute is a sign of problems in the mechanical subsystem of the hard drive. Parameter 12 Power cycle count shows the number of complete power on/off cycles of the hard drive. Parameter 192 Power-off retract count shows the number of shutdown cycles or emergency failures (drive power on/off). Parameter 193 Load cycle count shows the number of magnetic head block movement cycles in the parking zone/in the working position. As can be seen from Figures 1–5, parameters 4, 12, 192, 193 are cumulative; their values only increase with increasing operating time. But they are not very convenient to assess the mechanical reliability of drives, because they depend not only on the state of the disk drives. Instead, the parameters 3 and 10 which turned out to be interconnected could well be used to assess reliability. Moreover, it is precisely the changes in values, and mainly its absolute values, that are important in parameter 3, and in parameter 10, respectively. In addition, 74 HGST drives have non-zero values of parameter 3 (out of a total of 167 failed); this correlation is 409 out of 510 for Hitachi, 1 out of 1 for Samsung, 16 out of 4156 for ST, 10 out of 12 for Toshiba, and 290 out of 404 for WDC. As can be seen from the above figures, failures associated with the mechanics of disk drives can be of both types.

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4. SUMMARY

We found in this research that six SMART parameters have coincident changes in parameter values for failed hard drives. These are parameters with numbers 3, 4, 10, 12, 192, 193. However, some of them, namely parameters 4, 12, 192, 193, characterise the total number of starts/stops of the disk with slight semantic nuances. Of course, their sharp increase may be due, inter alia, to problems in the mechanical subsystem, but only parameters 3 and 10 are intended and really directly speak about errors in the mechanical part of hard drives. The scientific novelty of the obtained results lies in the fact that on the basis of the identified parameters characterizing the mechanical subsystem of the hard drives, it is possible to develop criteria for the danger of drive failures. They are justified due to the existence of the fact that, as a result of the analysis, the coincidence in time of changes in the values of these parameters exists.

5. CONCLUSIONS

Similar investigations on the same data with heterogeneous disk teams are done in Ref. [6], as a research is made for universal predictors of disk failures that can be employed to disks of all makes and patterns. The important issue was a clear number of SMART factors, data for which were not available for most brands and models of disks. The authors were enforced to discard features that are absent in at least 90 percent of the disks, after that only 21 features remained. In Refs. [7–12], the SMART parameters of the specified data set of the Backblaze data centre were also used to determine the intensity and predict failures of disk information storage devices. So, the issue of evaluating the information reliability storage devices by the values of SMART features is really dominant for ensuring data safety in any system. Based on the detected coincidence in time of the change in the parameter values of failed hard drives, it is presented to ovecome the issue of individual assessing the reliability of information storage devices in relation to the mechanical part using the identified parameters.

Acknowledgments: The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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Received: 1 January 2019. Accepted: 11 March 2019.

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5307–5312, 2019

RESEARCH ARTICLE

Co Evolution of Information Society and Online Community: Concepts and Communication Practices

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The impact of the Internet on the life of society is growing on a global scale, while it remains an uncontrolled area of interaction for various online communities, which requires further investigation. The purpose of the article is to conceptualize the notion of "co evolution of information society and online community" based on the theories of information society and analysis of communication practices. The objectives are to establish the factors of successful development and assess the prospects of this type of co evolution. The research uses both theoretical and practical approaches. A dialectical method was the main method of philosophical reflection. Community informatics is another scientific approach (M. Gurstein, D. Loader). To explain the phenomenon of integrity of technology and social networks in complex socio-technical systems, the actor-network theory (ANT) of Bruno Latour was used. This article gives a definition of co evolution as joint commensurate development of non-identical information processes and online communities. In the course of co evolution, "junction points" and "bifurcation points" were revealed and its social effects and prospects were assessed. The factors in successful development of the process of the information society and the online community co evolution were assessed: knowledge, technology, and information management. The conclusion about a common pace of the information society and the online community development not having been set was substantiated. The growing influence of online communities on society and a simultaneous trend towards secrecy and transformation into a new kind of social groups is a megatrend in the information society development. The results obtained are of practical importance in studying the problems of information management in the global network and regulating the activities of online communities.

Keywords: Online Communities, Co Evolution, Information Society, Communication Technology, Information Management.

1. INTRODUCTION

Currently, in the first quarter of the twenty-first century, the development of information technology continues to ramp up its potential. In real time across the globe, new technical and software products are being introduced in the production and social spheres, and citizens are changing from the space of industrial life arrangement over to the information space. The changes are multidimensional in nature, from education and upbringing to a transformation of social structure and social values. The analysis of contributions of such information society theorists as R. Iris, D. Bell, M. Castells, J. Fourastié, Y. Masuda, A. Toffler and a number of other authors allows for the conclusion that the conceptual framework of the information society has not yet fully formed. Thus, there actually has been no universally accepted name for the society in succession to the industrial (post-industrial, information, network, etc.) society. For example, when describing the features of the information society, Y. Masuda characterizes it as part of the post-industrial one [1]. The concepts of "information" and "network" society are perceived both as identical and different, and the interpretations of the "online community" concept are also diverse. The research hypothesis is based on the idea of the information society and the online community as procedural unity within the framework of the identity of opposites. The concept of "co evolution" was used as a temporal criterion for this systemic integrity. The goal of this research was to conceptualize the notion of the information society and the online

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community co evolution, based on the information society theories and the analysis of communication practices. The research objectives were to assess the factors of successful development and prospects for their co evolution process.

2. LITERATURE REVIEW

The term "co evolution" was widely adopted at the end of the twentieth century and refers to the process of interdependent changes in the elements that make up a developing integral system. The problem of co evolution of the information society and online communities in this formulation has not been considered in the research literature, whereby it is particularly attractive and productive for modern understanding of the prospects for society developing as a socio-technical system. The co evolution concept proposed as a theoretical framework can be formulated on the basis of the information society theories of A. Toffler, D. Bell, A. Touraine, J. Fourastié, M. McLuhan, M. Castells, and A. Etzioni in so far as it describes evolutionary processes. A number of theories contain reflections of the problems of virtual reality and the activity of online communities [2–7], but the major part of the conclusions can be validated on the basis of analysis of online communication practices with a subsequent conceptualization of the online community and information society co evolution concept. Among the variety of theories, the network society theory of M. Castells that substantiates the impact of online communication on social development and the actor-network theory of B. Latour that combines the material with the social and the temporal with the spatial are of principal interest in the online community studies. According to Castells, each new social structure has its own genesis, depending on the spatio-temporal contexts [8]. Castells argues that the technological foundation of the information society has a complex integrative structure. One of the aspects of this integrity is the developed information technology, including the universal process of knowledge reproduction, from its emergence to technological implementation. The information society concept of M. Castells is a synthesis of the information technology [9], the media [10], information innovations [11], and network relationships. The Internet is considered as a network space that simultaneously acts as a condition for the existence and development of people and a result of their collective activity. The "reference point" indicating the beginning of formation and development of structures, systems, and practices is of paramount importance in the study of evolutionary and co evolutionary processes. Thus, F. Websterasks: "Has the information society already emerged or not yet?" There has no absolute answer to this question so far. The problem of interpreting information processes gains not only academic but also practical importance. To acknowledge that the information society has emerged would mean awareness of the need to fill the global population's needs that comply with the higher standards of the information society. F. Webster also raises the issue of the need to clarify the criteria traditionally used to describe the information society: technological, economic, professional, spatial, and cultural [12]. With reference to the information society evolution in his Theories of the Information Society (fourth edition), F. Webster updates the main scientific approaches to information development, taking into account new research and social and technological changes, such as "Twitter Revolution" in North Africa and the emergence of social media and blogs [13]. This paper construes the information society as such a system of social relations whereby a permanent transformation of knowledge into technology is the base pattern. Accordingly, the previous configuration of industrial society is a system based on reproducing technologies in which knowledge is implemented. These configurations are a co evolutionary pair. In single events, such as acts of labor, it is often difficult to distinguish between them. These configurations are diametrically opposed. Thus, in the industrial pattern a personality is formed by an external influence, while in the postindustrial one—due to internal becoming that modifies their cultural and educational experience. It follows from this context that the post-industrial society acts as a specific modification of the information society and, at the same time, a stage of its formation. Most authors distinguish the most reputable researchers of information processes into two main groups. The first group includes supporters of the idea of new society emergence: D. Bell and his supporters (post-industrialism), J. Baudrillard, M. Poster (postmodernism); M. Piore, C. Sabel (flexible specialization concepts); and M. Castells (information method of development). These thinkers are distinguished by conceptual thinking and a sufficient degree of dissociation from the empirical basis. As a result, the information society as a category acquires metaphorical certainty. The second group includes social continuity supporters, such as theorists of Neo-Marxism (H. Schiller); regulation theory (M. Aglietta, A. Lipietz); flexible accumulation (D. Harvey); reflexive modernization (A. Giddens); and public sphere (J. Habermas, N. Garnham). These approaches single out a particular basic property of the post-modern society and build social interests thereon in the determinist paradigm. Online communities (Internet communities, virtual communities) based on associations of users with the same interests and communication via the internet began to appear on a massive scale at the turn of the twentieth century, which coincided with the present stage of information society. This stage is characterized by mainstreaming of information systems and new types of information and communication technologies that open up the potential for front-line creation and adjustment of information resources, such as Web 3.0, a global hypertext information system, one of the Internet services. In Web 3.0, users do not only create online content but

also independently evaluate and systematize it, that is, indicate what is worth noticing by fellow thinkers in the communities they belong to. The new technologies have made it possible to create a communication environment for the formation and virtual interaction of online communities. These include peer-to-peer networks and communities (P2P) and file-sharing networks; social media: professional networks, dating networks, and some types of blogospheres [14]. Carole Agres Dana Edberg Magid Igbaria conceptualizes the notion of virtual communities as a new social form that has its own structure and an increasing impact on society and largely determines its development prospects [15]. According to H. Knyazeva & S.P. Kurdyumov, "the present-day theory of complex systems self-organization provides insight into possible coexistence forms of heterogeneous social structures at different development stages in terms of various ways of their sustainable co evolutionary development. According to the theory, the evolution channel is extremely narrow, and only certain discrete spectra of relatively stable self-organizing structures are possible in complex systems. There is a limited set of ways to compose a complex evolutionary whole from different parts. The law of nonlinear synthesis of complex structures states that structures are combined into more complex ones through setting a common pace of their evolution. Based on the theory, one can see not only the desired, but also the attainable futu[18][16].

3. METHODS

The work is interdisciplinary in nature and based on the use of both theoretical and practical approaches. The main method of philosophical reflection was dialectics that is bifurcation of the unity into opposites, the study of contradiction, its resolution, and ascent to a new level. Another scientific approach with an interdisciplinary nature, which emerged in the mid-1990s, is community informatics [17, 18] that allows one to explore communication in different communities both in the virtual and in the social space as a method of research [19]. To explain the unity of action of the technical and social networks in the development of complex socio-technical systems, the actor-network theory (ANT) of Bruno Latour [20] was used that sees a network as a connected series of actions, each participant of which is considered to be a full-fledged mediator, including the technical network, which is the Internet. At the same time, an "actor" is not perceived as a source of meaningful action; it is a mediator that encourages other actors to act.

4. RESULTS

Conceptualization of the notion of the information society and online community co evolution was the result of the study. Co evolution of the information society and online communities is joint commensurate development of non-identical information processes and the processes of online community development. Also, the paces of co evolution were compared and social effects of its societal impact were identified; it has translated into the following. A fixation on the emergence of a fundamentally new configuration of the social system that would have information as a basic pattern is formed. Such a transformation of sociality would lead to conflict resolution through the use of information and communication technologies and self-organization of online communities. Their co evolution allows information to turn into a source of resources for online community members. The online community itself will act as a source of virtual and other innovations that can be implemented by any network actor who has realized this need and is able to meet it directly or indirectly. It can be said that two formats of information reproduction have arisen: instrumental and network. The instrumental algorithm of information reproduction involves local networks of both legal and illegal type, confidentiality of some data, privacy zones in the information network, etc. The network method of reproduction, in turn, is based on the needs of users: respect for law, openness and free access to information, and adherence to the chosen values. To summarize, we can draw the following conclusion: the information society began to take shape much earlier than online communities, for which reason a common pace of development of information technologies and online communities has not been set, since the latter are still in the formative stage. The concept of co evolution has made it possible to establish temporal criteria for factors of successful development and prospects for the information society and online communities: knowledge, technology, and information management. In the process of co evolution, "junction points" and "bifurcation points" of development trends were identified. The co evolution of individual and collective knowledge, the process of blurring the differences between the public and private spheres of network activity is a significant phenomenon in the field of network formation of knowledge. In the future, the development of technology will allow for the emergence of closed network structures with their own group identities that would have their own information goals. The innovative area is becoming a productive area of technology co evolution; digital technologies are launching a stream of creative production and convert information consumers into collaborators. Another notable trend is the attempts made by public authorities to influence network users.

5. DISCUSSION

Summarizing the debate in the scientific community, we can name the theses for which consensus was reached and those about which there are disagreements on the development of online communities and the information society. Daphne Ruth Raban, Avishag Gordon & Dorit Geifman revealed a nonconformance between the information society implementation in everyday life and the

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state of the art in the area that is at quite an early stage of evolving into a mature research discipline [21]. David Karpf points out that many of the most reliable empirical research methods do not apply to the online environment [22]. Leah A. Lievrouw identifies three groups of problems around which research has been conducted: the practice of human interaction and exchange of information and meaning; tools, devices or artifacts that people create and use to do this; and social mechanisms or institutional forms that proceed from and develop around these methods and tools [23]. Brian d. Loader & William H. Dutton critically assess online social research and thereby determine the line of interdisciplinary research for the short-term: research is required in the field of law, ethics and science, technology and computer science, and art and the humanities [24]. Thus far, a certain consensus has been reached on the information society concept as a characteristic of socio-economic systems. The term 'information society' has been used to describe socio economic systems that exhibit high employment of information-related occupations and wide diffusion of information technologies [25]; however, there are differences of opinion regarding its development stages. One can identify with the periodization proposed [26], which helps determine the pace of the information society development and the content of its evolutionary forms. The first stage of Information Society (1960–1970s) is focused on the production and use of information through the development of information technology and telecommunications. The second stage of Information Society (1980s–1990s) is characterized by globalization and specialization. The third stage of Information Society (1990s–2000s) is distinctive in the fact that information becomes a key item, culture, and product. Web 2.0 service appears, whereby the individual user becomes a creator of online content for the Internet resources. Online communities got widespread use only at the present stage, at the beginning of the twenty-first century. The main co evolution factors are knowledge (its development, acquisition, and distribution), technology (its design), and information management (controlling and manipulating information).

5.1. Knowledge

A significant phenomenon in the field of network development of knowledge is the co evolution of individual and collective knowledge. J. Kimmerle, J. Moskaliuk, A. Harrer & U. Cressoffer illuminating insights into this, using the case study of the empirical model of Wikipedia, an online encyclopedia, which allows one to graphically visualize co evolutionary processes and take into account dynamic changes [27]. The evolution of public networks, or Free Nets, is presented by JAY WESTON as a lengthy process of blurring the distinction between public and private areas, destroying the dichotomy largely created by the media [28]. Another notable trend is the attempts to influence the knowledge development in network users. A series of network analysis contributions prove that the agents with established network relationships between each other have a strong mutual influence and change their views in consensus with their partners [29]. In the scientific literature, the effect of echo chambers that are an obstacle to the reception of knowledge has been studied well enough. Refs. [30], [31] are among those researchers who believe that people and organizations tend to receive information from those whose beliefs are similar to their own, thereby forming "echo chambers" with their own network connections. In the future, Web 4.0 will enable users to create new social groups with their own group identity. Drawing on Melucci's ideas, Stefania Milan explores the evolution of collective network identity, a new phenomenon inherent in online communities, the social effect of which is the possibility to organize collective actions. Social networks play a mediating role in the activists' meaning construction processes, thereby enhancing "interactive and shared" collective identity elements [32]. Milan points out to the peculiarities of cloud protesting: in communities, a "community" is perceived through an "individual," while the group is a means of collective action rather than its goal [33].

5.2. Technology

The process of co evolution of information, communication and media technologies is based on the assumption of their importance as actors equal to online communities of people. Using Latour's theory, W. Lance Bennett & Alexandra Segerberg [34] investigated "the organizational structure of people and social technologies" and proposed to recognize the mechanisms of digital networks (for example, a variety of social networks and devices that control them) as potential networking agents along with people (for example, individuals and organizations). Such digital mechanisms can include: organizational connectors (for example, web links), event coordination (for example, protest calendars), information sharing (for example, YouTube and Facebook), and multifunctional networking platforms with other networks embedded into them (for example, links in Twitter and Facebook messages). The innovative co evolutionary trend is considered promising. The Journal of Community Informatics dedicated a special issue to study the online community user involvement into the technological innovation development, using information and communication technologies, for example, the creation of civil virtual laboratories [35]. A whole range of articles in the journal Information, Communication & Society has been dedicated to the phenomenon of new, or social, media. Clay Shirky shows how new digital technologies are launching a stream of creative production and turn information consumers into co-authors, collaborators. For the first time, people are using new media that allow them to pool their efforts at incredibly low cost [36].

Drawing on the system approach, Jan-Felix Schrape states that "meso media" (many to many) gain popularity with the advent of the Internet, which had a significant impact on society, determining its evolution towards the empowerment of media users [37]. Rapid changes are occurring in computer-mediated communication, as shown [38, 39].

5.3. Information Management

The most promising area of interdisciplinary research on the study of a whole range of problems related to managing network relationships, whereby several trends can be distinguished:

R. Srinivasan proves the importance of involving communities in developing and setting their own information goals, which would provide insight into the cultural, political and economic development processes [40]. M.Gurstein points out to another aspect of information management, considering the network communications infrastructure as a way to deliver "innovative" information from one community to another, such information that would really contribute to social change and social adjustment [41]. The Internet management infrastructure issues are discussed: for example, the use of the Internet domain name system to protect intellectual property rights or the kill-switch approaches to limit the flow of information [42]. Jeremy Rose & ØysteinSæbø show how government agencies put in place and operate specialized discussion systems (information systems designed to support discourse) and forums designed to encourage civic engagement [43].

6. CONCLUSION

The common pace of the information society and online community development has not yet been set; there are indications of a uniform pace of development of the co-evolutionary pair only in a few areas, such as innovation. At the same time, the megatrend of the information society development is the growing influence of online communities on the life of society and their quest for secrecy and transformation into a new kind of social groups at the same time. In the process of the information society and online community co evolution, the "junction points" were identified: the co evolution of individual and collective knowledge, the process of blurring the differences between the public and private areas of network activity, and the transformation of information consumers into collaborators. The "bifurcation points" may include the ambition of online communities to become network structures with their own group identity and informational purposes that would further special interests. Another notable trend is the attempts to exert influence on network users by the public authorities imposing control, both regulatory, through the adoption of necessary laws, and in the form of information censorship and manipulation. The most promising area of interdisciplinary research on the information society evolution is the study of a whole range of problems related to the information and network relationship management.

Acknowledgments: The study has been funded; the publication was funded by the Southern Federal University in Rostov-on-Don.

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Received: 1 January 2019. Accepted: 11 March 2019.

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5313–5326, 2019

RESEARCH ARTICLE

Creating Happiness at Workplace: Work Team Contributions and Concerns

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Upon start of the century, a developing assemblage of research has foundationally inspected the factors incident for the happiness in the work environment. When all is said in done, the relative group of research conducted in the area has contributed some effective contributions to advocate for factors for happiness at the work environment, which in turn has created a helpful effect for projects and the people. However some proof is blended. To help further studies in the area, the study address these points in two dimensions of happiness. The critical point is to audit the available past research on happiness in the existing work place environment and to differentiate the critical points to give guidance for further studies. The subsequent studies is to provide a hypothetical structure which clarifies the manner people will decipher happiness in the work environment. Later to address how it might be generally advantageous. Drawing on the thought that enjoyment in the working environment is subjective depending on each person's preferences, our proposed system gives a more nuanced comprehension of the worldly procedures and logical variables that clarify how people evaluate and eventually advantage from happiness.

Keywords: Work Place Environment, Happiness, Job Satisfaction.

1. INTRODUCTION

Over 20 years, happiness at work environment was contended to be an ideology for fixing as association achievement. The study carried out In the book Built to Last, Ref. [1] explains that two extraordinary organizations, Marriott and Walt Disney World, have solid developmental societies which underscore happiness in every working environment. Marriott's center philosophy proclamation namely "buckle down, yet keep it happiness," while Disney World's yearly report contained words, namely, "happiness, energy, and euphoria." Generally popular for the positive work environment, Google pioneers accept the characterizing characteristic of happiness in any working environment is that "happiness originates from all over the place" as explained in the above primary statement [2]. Truth be told, as opposed to attempting to produce happiness in working conditions around specific happiness exercises, Google fuses happiness in work environment in multiple manners. As an example the observation of April Fool's Day every year at times, enable workers to play shoreline volleyball and ping pong during off times, and fuses happiness into its working system. The basic conviction that penetrates organizations, for example, these is that enjoyment in the work environment is a focal way to advance commitment, firm connections, innovativeness, and better worker wellbeing [3]. In studies conducted by Caccamese it contends that albeit taking part for entertainment only in the working environment does not really make an incredible work environment, it helps to support worker brotherhood, fabricate trust, and rouse individuals to act naturally. Expanding on these contentions, a developing assemblage of research, which has basically centered around the individual degree of investigation, has risen to approve the generalizability of the estimation of happiness in the working environment. For instance, Karl and partners exhibited that enjoyment in the work environment is decidedly identified with employment fulfillment [4–6] believe in administrators and collaborators and impression of quality administration [6], just adversely identified with enthusiastic fatigue [4] and goal turnovers [7]. Besides, Tews and associates explains that enjoyment in the working environment affects candidate fascination [8], work execution [9], as well as representative maintenance [10]. It can be seen that the essential methods by which happiness in the working environment can possibly favorably affect people is by expanding constructive effect, which is upheld by the feeling hypothesis and an assemble hypothesis. As indicated

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[in Ref. [11]] full of feeling occasions hypothesis, occasions that individuals involvement with work are proximal reasons for emotional responses to those occasions. Happiness in the working environment can inspire enthusiastic responses from people. At the point when people experience happiness in the work environment positively, they might be bound to encounter constructive as opposed to pessimistic feelings to such occasions. Fredrickson's expand and construct hypothesis to be utilized to clarify for encountering a better effect from taking part for the sake of entertainment in the working environment can have long haul benefits. The expand and-construct hypothesis recommends that encountering constructive effect after some time widens the idea activity propensities of individuals, which benefits towards advancement of scholarly, mental, physical and social assets. Along these lines, encountering positive effect from happiness in the work environment may enable people to think all the more inventively, approach circumstances all the more hopefully, create more grounded connections, and obtain better methods for dealing with stress to enable people to perform better, participate in additionally learning, and experience larger amounts of prosperity. In spite of multifarious potential advantages, happiness in working situation does not seem, by all accounts, to be all around acknowledged by administrators or representatives, and the reactions against happiness in the work environment needs to show some legitimacy. The contentions opposing happiness at work environment is reflected in the above statement by Roosevelt who explains that work needs to discuss much about work and not much about rest or relaxation. In help of this conviction, an overview led by the HRM Society recognized that a few supervisors enquire the general adequacy of happiness in working environment. Eighty-eight percent enquiries demonstrated time imperatives will shield directors from embracing happiness in the work environment. Multiple reasons referenced for incredulity incorporate expenses, detailed results, absence of the top management support, and a verifiable burden to worker profitability. Reference [12] explained that numerous representatives' despised organization supported happiness, thinking of it as inauthentic and phony. Additionally, Sturdy and Ref. [13] explained that a few people were impervious to support external social exercises and just pretended intrigue. The core of all the contentions is that work that needs to be perform. Based on the studies, the propel for the enjoyment in the work environment, it is contended that additional work is expected not just to simply inspect that, whether happiness in working environment is useful, however all the more completely comprehend the situations based on which it is esteemed and adds prompts to attract results. Toward this end, the essential objectives of this paper are two-overlap. One, we direct an orderly audit of the observational research on happiness in the working environment and distinguish holes in the enjoyment in the work environment writing. Two, to propel hypothesis and research around there, we build up a hypothetically grounded system that gives a more nuanced model of the worldly procedures and relevant and individual explicit elements that clarify how people may translate happiness in the working environment and how this can be most valuable over the time bound haul. While concluding on the evaluation writing [14], alongside full of feeling occasions and widen and construct hypotheses, the proposed structure will explain how happiness in the working environment is entirely subjective [15]. This system will delineate how people make examinations previously, during, and in the wake of taking part for the sake of entertainment in the work environment and how relevant and individual explicit components reinforce (or debilitate) the positivity of these evaluations. Eventually, we believe that the study will provide a more explicit point of view on the estimation of happiness based on the work environment, which will invigorate further research in this area.

2. OBSERVATIONS

- There exists no specific theoretical evidences to substantiate the variable evidences which contributes to the happiness at work environment. It is currently observed that most of the happiness at workplace literature never constitutes any grounded theoretical evidences.
- The diversified studies done by individuals have made cognitive and emotional appraisals related to the various benefits from happiness at workplace.
- The observations in this study is related to the factors on happiness at work place, aimed to review the gap in factors related to work place happiness.
- Specific appraisal and contextual observations of happiness at work place is looked up on and developed in the study.

3. WHAT IS HAPPINESS IN THE WORKPLACE?

It is essential to explain what is implied by joy in the working environment. In the current collection of writing, bliss in the work environment is portrayed as angles or highlights of the workplace that can possibly advance positive passionate responses, for example, satisfaction, beguilement, and happy joy in people. In a recent study on bliss in working environment, Ford et al. [16] characterize satisfaction at working environment as "workplace that deliberately energizes, starts, and supports an assortment of charming and pleasurable exercises." Reference [17] contends the joy at work environment includes exercises that are "not explicitly identified with the activity that are charming, entertaining, or perky." To give more extensive reality and its conceptualization of happiness in the working environment, Ref. [18] characterized this as "any social, relational, or task exercises at work of an energetic or comical nature which furnish a person with diversion, delight, or joy" (p. 15). McDowell as well as

Fluegge incorporates related exercises in another manner by through which people enjoy the working environment. In spite of the fact that these definitions investigate bliss in the work environment as one of the agenda that advanced deliberately by the association. Reference [15] articulate that all joy is not hierarchically supported and it is essential to recognize "bundled joy" and "natural satisfaction," the last mirroring an "inborn and innate piece of authoritative life" (p. 557). Based on the past studies, we characterize satisfaction at the working environment based on qualities and even highlights of the workplace for a social, lively, as well as hilarious in nature. This can possibly trigger positive sentiments of happiness, beguilement, and cheerful joy in people. Research that has concentrated on satisfaction as an element of the workplace have concentrated on various degrees of explicitness and points of view. A few analysts have concentrated on a worldwide all-encompassing assessment of satisfaction. For instance, Karl and associates have inspected the effect of experienced bliss, which alludes to whether people see that satisfaction for the most of it is existing in the work environment [5, 6]. Correspondingly, Ref. [17] analyzed worldwide bliss in the work place, in a way can allude to the general assessment of people concerning the association has happiness at work atmosphere. Different scientists concentrated on explicit highlights at workplace which possibly increment a person's certain effect, which incorporate joy exercises, individual flexibilities, supervisor support for joy, colleague mingling, and bliss work obligations. Joy exercises explains social exercises which are composed of as well as supported by the association intended to encourage a feeling of happiness and duty [5, 14, 16], for example, trips, team-building games, and open festivals of relief as well as individual achievements. Individual flexibilities identify with whether the working environment energizes, allows and enables people to have joy in the working environment [17], and director support for satisfaction alludes to the degree to which administrators explicitly enable people to do as such [14]. Altogether individual flexibilities and chief help for joy reflect strong working environment rehearses for bliss in the work environment. Thusly, collaborator mingling alludes to amicable social associations among colleagues, which can incorporate discussing individual stories, sharing jokes, as well as offering nourishment to each other [14, 17, 18]. At long last, joy work duties are undertakings that are by and by pleasant, important, and a solid match to the individual's advantages [8]. It ought to be noticed that satisfaction work obligations might be at outskirts of what establishes bliss in the work environment, in accordance with Ref. [17] contention that joy includes parts of the work environment that are past the activity itself, however are significant in any case. Satisfaction in the work environment is identified with, yet particular from, other working environment develops and surges of studies including humor [19] and group activities [20] at work. Further to the satisfaction in the working environment, funniness and play are explicit strategies for cultivating bliss and are all the more barely centered develops, which can likely be subsumed inside kinds of joy in work environment. In common sense, happiness is any verbal and nonverbal correspondence that delivers a "positive subjective or emotional reaction from audience members" [21]. Diversion is utilized by community oriented chiefs and colleagues to upgrade political co-operations, give a support favoring pressure, and to benefit weaker one's economic wellbeing for to appear to be progressively receptive [22]. Incorporating the details with the various sorts of satisfaction recommends silliness from coworkers is a sub-part based on associate mingling measurement of joy and the funniness from other's director is a segment of chief benefit for joy. Games were characterized as "a movement or conduct that (an) is done with the objective of entertainment and bliss, (b) includes an excited and in-the-minute attitude or approach, and (c) is profoundly intelligent among play accomplices or with the action itself" [23]. Similar to joy, play is an action that advances beguilement, satisfaction, as well as joy. Nonetheless, similar to laughter, we contend that games are a sub-segment of happiness in working environment. Following that, games include cooperation for members or with their action itself, we contend that games are subsegments of satisfaction exercises. As an instance, few joy exercises literally incorporate parts of games, for example, some team-building activities. Besides, game is likewise a part of collaborator mingling for e.g., people having breaks to make amusements, (for example, ping pong or baseball). At long last, working in a team or for an administrator who co-operates bliss based on the working environment will probably give more chances to participate in games at work. This is critical to explain, in any case, that not a wide range of happiness in the working environment depends upon diversion or games. Upon silliness and games are parts of bliss in the work environment, satisfaction at job involves more extensive scope for exercises as well as cooperation. This ought to be stressed that happiness in work environment that is unique in relation to having bliss. Bliss in the working environment reflects highlights or parts of the workplace. Interestingly, having satisfaction mirrors a state inner to a person, that is, the genuine encounter of happiness, entertainment, and joy. At the end of the day, having happiness is usually as an the experience with positive effect, a condition of "high vitality, full focus, and pleasurable commitment" [24]. In this effort, Ref. [25] characterize having joy as "the delight you experience while you are engaged with some activity, for example, accomplishing something, seeing something, or notwithstanding unwinding." This is, having happiness alludes to the genuine encounter of constructive feelings that individuals expertise, when occupied with bliss in the working environment. In help of this refinement, contemplates by Refs. [26, 27] showed the members who

viewed clever video clasps expertise more positive effect than those viewed a non-diverting video based science. Essentially, explained members that showed kid's shows expertise increasingly positive influence contrasted with a control gathering. Besides, explore has likewise shown that different sorts of positive occasions additionally increment positive effect. \ exhibited much directive connection for understudy commitment in get-togethers, for example, going for supper with others, going to programs, and positive exercises, and diversified feeling. Thus, Asher, Reis found that understudies had better positive feeling when they occupied with get-togethers like going out with friends or open accomplishments namely excelling in course work etc. These discoveries give proof that advanced influence is a result of satisfaction qualities or highlights of the workplace instead of any component towards happiness in the work environment [18].

4. PRIOR HAPPINESS AT WORKPLACE

Surviving collection of research towards happiness in the working environment commonly centered around three area of request. One stream of research, which is to a great extent graphic in nature, has endeavored to figure out what sorts of working environment exercises are joy or not. Another stream of research that has been to a great extent been quantitative has centered on approving the effect of satisfaction in the work environment by inspecting its associations with employment frames of mind, execution, and benefits. In the further region of research, which has to a great extent been subjective, has analyzed joy in the work environment from a progressively basic point of view. Every one of these will be depicted with detail in the accompanying discussions.

5. DESCRIPTIVE RESEARCH TOWARDS HAPPINESS IN THE WORKPLACE

The research on happiness in the work environment concentrated on satisfaction exercises. One of the most recent punctual examinations on bliss in the working environment. Reference [16] overviewed 471 human asset supervisors to decide whether HR chiefs felt it is significant for people to get satisfaction in the work environment and inspected the recurrence which distinctive conceivably bliss exercises happen in the working environment. Passage et al. discovered from their studies says HR chiefs favored advancing a satisfaction workplace and accepted that it was a significant administration practice and not a prevailing fashion. Their information demonstrated that of the ten exercises inspected, the most as often as possible happening were acknowledgment of individual achievements, get-togethers, and open festivals of individual accomplishments. Rivalries among people, open doors for self-improvement, and excitement were the least. In another investigation, Ref. [5] additionally inspected

Fig. 1. Seven reasons to provide a happy work place.

what people thought about satisfaction or not. Utilizing the individual reactions from diversified assortment of associations, Karl et al. discovered that most people favored exercises including sustenance at work, festivities of individual achievements, and working environment excursions. As of today, Chan explained to subjective contextual analysis with basic hypothesis approach and identified four classes of bliss experiments—(1) employee oriented exercises, (2) socially arranged exercises, (3) administrator situated experiments and (4) methodologically arranged experiments. Employee oriented experiments are utilized to commend worker achievements and commitments of representatives and incorporate the festival of birthday celebrations, business commemorations and representative thankfulness weeks. Socially situated experiments are utilized to construct social connections at work and incorporate get-togethers, buffet snacks, occasion gatherings, and authoritatively supported trips. Manager situated exercises are started by chiefs to make a joy domain and incorporate dining with the administrator, employer-employee social affairs after work, as well as party time with the director. At last, technique based experiments incorporate facilitation approaches and procedures benefitted to help joy at job as well as incorporating casual dress days, association provided relaxation and refreshments, or even family-fun activities. Chan explained that the more that persons participate in these programs, the more beneficial in their involvement.

6. VALIDATING THE IMPACT OF HAPPINESS IN THE WORKPLACE—QUANTITATIVE RESEARCH APPROACH

Many studies have concentrated on approving the direct effect of happiness related to in the working environment

has on occupation mentalities, execution, practice and maintenance (Fig. 1). In a progression of discussions, Karl associates examined the connections with experienced happiness and worker demeanors. Reference [5] explains that representatives' frames of mind in regards to the fittingness, striking nature, and results of a satisfaction workplace were emphatically identified with trust in the individual's observer as well as associates. This recommends that by building trustworthy connections could be a precondition for happiness in the work environment. In a related investigation, Ref. [6] observed that inspirational dispositions in regards to the propriety, remarkable quality, and outcomes of bliss in the working environment were decidedly identified with occupation fulfillment in an example of human services specialists. Additionally, in a medicinal services setting, Ref. [6] explained that encountering joy in the work environment diminished the unethical connection between enthusiastic depletion and employment fulfillment, and Ref. [6] found that accomplished bliss was contrarily identified with passionate weariness and enthusiastic discord and emphatically identified with employment fulfillment. With an example of college understudies utilized in administration facilities, Ref. [7] identified that accomplished joy was emphatically identified with employment fulfillment, particularly for the individuals who set a high incentive on bliss in the work environment. Besides, these creators likewise discovered that fulfilled representatives saw that it gave much positive administration importance to clients. Ultimately, Karl recognized that inspirational frames of mind toward experienced bliss was decidedly identified with occupation fulfillment and contrarily identified with turnover aims in an example of volunteers. A different line of study analyzed joy in present work environment as a multi-dimensional, higher request develop. Reference [17] built up a multi-dimensional structure of happiness in work environment which incorporated the recently depicted dimensions of associate mingling, joy exercises, individual flexibilities, and worldwide bliss. Collecting these measurements into a general measure, Ref. [17] showed that bliss in the work environment was essentially identified with occupation fulfillment, authoritative responsibility, and turnover expectations with an example of oil organization representatives. In another examination, which analyzed similar measurements, Ref. [18] explained that joy in working environment needed a positive approach with occupation execution, including project execution, imaginative execution, as well as authoritative citizenship practices (OCBs) as an example of working college understudies. In addition, she showed that the connection between bliss in the work environment and assignment execution was intervened by representative positive effect and that the connection between joy in the work environment and imaginative execution was interceded by work commitment. Nonetheless, neither productive influence nor job commitment intervened the connection related to satisfaction in the work environment as well as OCBs. Despite the fact that these two investigations gave introductory proof to the significance of different components of joy in the working environment, they didn't figure out which parts of bliss in the working environment were most compelling in light of the fact that all measurements were collected into a solitary measure. To decide the general significance of various parts of joy in the working environment, Tews and associates directed a few investigations concentrated on the overall significance of various parts of bliss in the work environment. With an example of university work searchers, Tews showed that satisfaction in the work environment was a more grounded indicator of candidate fascination than remuneration and open doors for progression, while associate mingling and bliss work obligations were more grounded indicators of candidate fascination than joy exercises. Reference [9] analyzed effect of satisfaction exercises and administrator collaboration for bliss on worker execution and turnover with an example of café servers. The consequences of this examination showed that bliss exercises were decidedly identified with execution and supervisor support for satisfaction was adversely identified with turnover, in this manner advancing maintenance. In any case, supervisor support for satisfaction adverse affected execution. The creators estimated that supervisor support for bliss may prompt lower execution since workers were permitted to "slack off." Reference [10] found the connection related to three types of satisfaction in the work environment related to turnover—bliss exercises, associate mingling, and supervisor respect for happiness based on another example of café vendors. The aftereffects of the examination demonstrated that collaborator mingling as well as director requirement for satisfaction were fundamentally identified with turnover, and that constituent connection intervened the connection between every one of the three types of bliss in the working environment and turnover. Michel, secured that bliss position duties were the most overwhelming indicator of embedness pursued by apparent vocation openings, recognition and prizes, chief help for joy, colleague mingling, and satisfaction exercises. At last, with an example of easygoing eating eatery supervisors, Tews showed that joy exercises were identified with casual adapting, yet administrator support for bliss was definitely not. Nonetheless, administrator support for satisfaction was decidedly identified with a sub-measurement of casual getting the hang of, gaining from oneself. Further, joy exercises were decidedly identified with the sub-measurements of gaining from others and gaining from non-relational sources. Generally speaking, these examinations feature that not all satisfaction in the working environment is essentially equivalent.

RESEARCH ARTICLE

7. HAPPINESS IN THE WORKPLACE—A QUALITATIVE RESEARCH EXAMINING FROM A MORE CRITICAL PERSPECTIVE

A few subjective examinations have scrutinized the estimation of bliss in the working environment. Taylor showed that chief endeavors to support bliss in the work environment may now and again be counterproductive. People that occupied with parody and jokes created countercultures that conflicted with the objectives and needs of two call focuses. Baptiste found that open division ranking directors were impervious to satisfaction in the work environment since it would speak to a weight when stood up to with related work requests as well as stressors. Besides, Mathews explained that a few people saw formal satisfaction exercises negatively, and Ref. [12] found that a few people disliked formal bliss exercises since they thought of them as inauthentic and phony. Fineman recommended that utilization of earlier satisfaction exercises adapts the association and improve representative demeanors and practices, yet overseeing bliss in the work environment also firmly can be hazardous as joy fundamentally "gains its 'happiness' from its suddenness, shock, and frequently disruption" (p. 280). Reference [13] exhibited that some people created enthusiasm for organization supported satisfaction exercises and accordingly opposed interest in such exercises, particularly when commitment was energized. At long last, Hutchison led a specific and ethnographic investigation to look at the connection between different kinds of bliss related to the working environment—oversaw satisfaction, natural joy and joy work obligations—and working environment commitment. They found that for certain people, bliss in the working environment offers a "reviving break" that outcomes in more prominent work environment commitment. Be that as it may, for other people, satisfaction in the work environment can result in withdrawal on the off chance that it bring diversions from people's relative work assignments.

8. HAPPINESS IN THE WORKPLACE LITERATURE—A SUMMARY

Based on the earlier research (see Fig. 2), few ends can be drawn on happiness in the work environment. In general, happiness in the working environment seems to provide a predictable ideal association related to frames of mind, yet bliss' associations with worker execution and maintenance is blended. Besides, albeit worldwide bliss estimates have prescient worth, extra worth can be picked up by concentrating on various elements of satisfaction in the working environment. When all is said in done, associate mingling, administrator support for bliss, and satisfaction work duties display more grounded associations with significant results than joy exercises. In any case, not all discoveries are as strong of bliss in the working environment. At long last, a subject that has been reverberated through the subjective examinations is that bliss in the working environment may not generally be satisfaction and that whether joy in the work environment is "joy" is setting subordinate. We battle that joy in the work environment is to a great extent subjective depending on each person's preferences and more work is expected to deliberately see how people figure out what is joy or not. To achieve this objective, we will draw on the evaluation, full of feeling occasions, and widen and-assemble written works to build up a hypothetically grounded structure for understanding transient procedures and relevant and individual explicit elements that clarify why, how as well as in what conditions joy in the working environment is generally useful. Dialog in this system seems as the focal point for the accompanying segment.

9. HAPPINESS@WORKPLACE: WHEN, HOW, AND UNDER WHAT CONDITIONS?

At the point when people take part in bliss in the work environment, they may encounter responses that, thusly, impact their frames of mind and practices. What needs to be clarified is that when as well as in what conditions a few people's expertise profits by taking part in bliss occasions and under what conditions they don't. Regardless of whether people encounters constructive advantages relies upon the intellectual and passionate evaluations made about the joy occasion. At the end of the day, regardless of whether satisfaction in the work environment is "bliss" is subjective depending on each person's preferences. Comprehensively considered, examination hypothesis can be utilized to clarify why a few people experience constructive feelings from satisfaction in the work environment, while others experience antagonistic feelings. As indicated by Ref. [14] basic hypothesis of examinations, people's passionate responses to occasions are dictated by their elucidations of an occasion. As explained by full of feeling occasions in hypothesis, occasions that people involvement with work are proximal reasons for emotional responses to those occasions, which impact their frames of mind and practices [11]. Cropanzano and Weiss depict an occasion as "an adjustment in conditions, an adjustment in what one is right now encountering" (p. 31). Regardless of whether momentary or continuous, work occasions inspire positive or negative enthusiastic responses in people dependent on how an occasion is evaluated, instead of the occasion itself. Albeit a few occasions, for example, encountering something profoundly upsetting are increasingly basic and evoke more grounded passionate responses, different occasions are less critical and cause progressively transient enthusiastic responses. Notwithstanding whether the occasion is profoundly huge or less critical, the more constructive occasions that are encountered, the larger amounts of constructive feeling the individual should feel. With regards to satisfaction in the working environment, we

Fig. 2. Employer contribution to create a good work environment.

battle that it is essential to consider people's psychological and passionate evaluations preceding an occasion, now and before. The model gives a hypothetically explained structure based on worldly procedures as well as relevant and individual explicit components that clarify how people may translate joy in the working environment and how satisfaction may prompt attractive present moment and long haul benefits. Fundamental to the model are the expectant, head, and review evaluations. The expectant examination happens preceding a satisfaction occasion; the chief evaluation happens during the joy occasion itself; and the review examination happens at some point after bliss occasion happens. Analyzing whether bliss is useful or not, requires a fl ing focal point. We fight that every one of these examination procedures offers a one of a kind of vantage point based on how bliss in the working environment affect worker dispositions, practices, and convictions.

As f the expectant evaluation, people survey whether they choose to take part in a bliss occasion and their degree of commitment. In such manner, preceding a particular episode of satisfaction in the working environment, people think about whether they plan to resolve to (connect completely with eagerness), agree to (draw in, however with disregard and insignificant exertion), or oppose coop- tion (maintain a strategic distance from on account of opposition). Individuals are probably going to resolve to take part in joy occasions when their expectant evaluation of the expertise is good as well as they accept the expertise that could be happy and advantageous. Consistence is required when people are uncertain if the occasion is charming or advantageous or on the off chance that they feel constrained to take an interest by others. People will probably oppose when different due dates or obligations come first or when the occasion is compulsory and not apparently pleasant. Regarding the vital examination, in the event that people participate in a joy occasion, they at that point make a constant evaluation dependent on the feelings they experience from the occasion. On the off chance that people experience constructive feelings, for example, happiness, entertainment, or joy, they will have a great head examination of the occasion. In any case, if people experience antagonistic feelings, for example, disturbance, disappointment, or bothering, they will have a horrible head examination of the oc ion. At the point when people make good head evaluations from encountering constructive feelings, they will be bound to increase present moment and long haul profits by the occasion. In any case, if people make troublesome head evaluations from encountering contrary feelings, they will be bound to separate from the occasion. Transient advantages could incorporate making another association with a partner, gaining some new useful knowledge, or "winning focuses" with their chief by taking part in occasions supported by the board. Long haul advantages are created after some time in any event somewhat related to widen and-assemble process as explained by Fredrickson which is portrayed in later in this paper. Long haul advantages incorporate more grounded social connections, greater inventiveness and care, and more prominent mental prosperity. As for the review evaluation, after a bliss occasion, people will survey whether the occasion was valuable or not. At the point when people experience constructive feelings and addition profits by participating in a joy occasion, they will have good review examinations, which will improve the probability of taking part in, and at last evaluate comparable encounters decidedly later on. For instance, if an occasion is charming and gives a chance to grow new fellowships with associates, people may see the occasion as beneficial and be bound to evaluate future occasions all the more positively. In any case, when people don't pick up

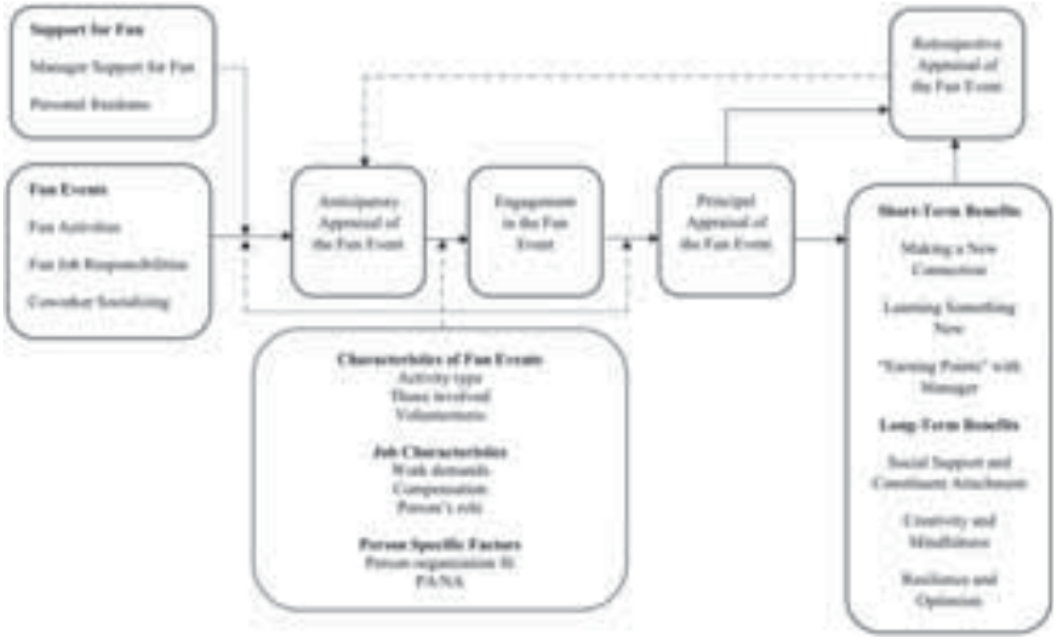

Fig. 3. The appraisal diagram for happiness in the workplace.

advantage from taking part in a bliss occasion, they will have ominous review examinations and subsequently be less inclined to participate in future occasions. It ought to be noticed that people may have an ideal essential examination yet neglect to understand any long haul benefits. Regardless of whether people gain no different advantages than "having satisfaction," their review examinations may even now be good. For instance, having a positive involvement with a casual party time will positively affect how an individual assesses other future occasions of joy in the work environment (see Fig. 3). We fight that it is imperative to separate among people's evaluations previously, during, and in the wake of taking part in satisfaction occasions since examinations may advance through the span of the experience. Albeit a few people may have comparable constructive or antagonistic evaluations previously, during, and after a particular occurrence of bliss in the work environment (harmonious examinations), others' examinations may contrast all through the procedure (incongruent examinations). The accompanying models outline various ways of incongruent examinations that people could make. In one way, while the expectant evaluation is troublesome, the head and review examinations are good. An individual may fear the possibility of going to the yearly organization occasion party however has a pleasant encounter and winds up becoming more acquainted with a few associates better during the merriments and winds up profiting by the experience. In a subsequent way, in spite of the fact that the expectant evaluation and head examinations are both troublesome, the review evaluation winds up being positive. An individual might not have any desire to go to a compulsory teambuilding action and sees that the genuine encounter is excessively made and "silly." However, in light of the fact that the individual took an interest in the movement, he accepts he will be seen positively by the board, which might be of advantage later on. In a third way, the expectant examination is ideal, yet the essential and review evaluations are negative. For instance, an individual might be eager to venture out on a brief siesta with some collaborators she has never interfaced with, yet during lunch the individual did not by any means make the most of her communications with her companions. Upon reflection, she never again wants to cooperate with this gathering of colleagues later on. These models are intended to represent one's examination related to happiness at the work environment may be dynamic and worth to be picked up repeatedly concentrating on satisfaction in working environment during various purposes of any encounter.

10. HAPPINESS@WORKPLACE APPRAISED: CONTEXTUAL AND PERSON-SPECIFIC FACTORS

From the previous segments, it is contended that the happiness in the working environment was agreeable as well as valuable to people and depends to any limited extent

on multi-stage examination system. Underneath it is proposed for some significant logical as well as individual explicit components which presumably fortify (or debilitate) the probability that people's evaluations of satisfaction in the work environment will be ideal or not. We center around four classes of relevant variables—strong practices for bliss, attributes of joy in the working environment, qualities of the activity, and individual explicit elements. Steady practices for joy incorporate chief help for satisfaction and individual opportunities. Attributes of joy in the work environment incorporate action type, those engaged with an occasion, and intentionality of contribution. Qualities of the activity incorporate work requests, pay and the individual's job in bliss in the working environment. At long last, individual explicit elements incorporate individual association competent, with advantageous and disadvantageous affectivity.

10.1. Happiness@Work Supportive Practices

Earlier it was discussed about chief help for bliss and individual flexibilities as segments of affinity in the professional conditions. We additionally disclosed this because of similitude between these builds, it might be ideal to join them into a solitary develop—steady practices for bliss in the working environment. In particular, chief help for bliss in the work environment alludes to the degree to which administrators urge people to participate in satisfaction in the working environment occasions at work, and individual flexibilities mirrors the degree to which joy in the work environment is allowed and upheld all through the working environment. We contend that strong practices for satisfaction in the work environment are basic factors in deciding how people evaluate joy occasions. At the point when people see that sharing in joy in the working environment is supported by the board, they will have progressively positive evaluations about the bliss occasion and be bound to see the experience as helpful. People may seek the executives for prompts with respect to in the case of participating in bliss in the working environment is satisfactory or not. Strong practices for satisfaction in the work environment can likewise decrease any dread people might thought about pessimistic repercussions that might experience while participating in happiness in work environment [10]. A few people might expect to be taking part in satisfaction in any working environment is considered by someone as "a misuse of important work time." However, while people see this, participating in joy in the working environment is upheld as well as esteemed, they might esteem happiness in the working environment all the more exceptionally and be progressively open to putting themselves completely in a joy occasion.

10.2. Happiness@Work and Type of Activities

One principal requirement that might decide the positive a satisfaction occasion is assessed is by the kind of action. On a recent examination, Ref. [5] explained that not all exercises can be assessed similarly by people. While occasions including nourishment, festivities of individual achievements, and work environment excursions were most favored by members, occasions that were increasingly unpredictable in nature were least liked. People are bound to evaluate bliss occasions all the more positively when the occasion is more standard and lined up with their own advantages. A few people may evaluate an occasion less positively upon the event that they will not accept they will be effective in that occasion. For instance, people will be more averse to assess a game as great if they can perform well and feel that taking part in the occasion may cause them to seem absurd and compromise their character with collaborators.

10.3. Happiness@Work and People Involved

Different people took part in satisfaction occasion which likewise had impact how people can assess the expertise. On the off chance that an occasion will be gone to by others the individual preferences or who have comparative qualities, the occasion will probably be evaluated more positively than if an occasion is populated by those somebody doesn't especially like. What's more, people may incline toward a satisfaction action that includes individuals one knows instead of outsiders. At the point when required with a movement with others who knew, as the individual is progressively adept to experience as simplicity. At the point when there are outsiders engaged with a joy understanding, there might be vulnerability about how one ought to carry on and vulnerability whether one will be fruitful exploring the social scene. Moreover, a few people may lean toward satisfaction occasions that don't include bosses or chiefs. At the point when satisfaction in the work environment includes directors or supervisors, representatives may feel less liberated to act naturally and feel progressively compelled to hold fast to their recommended work job.

10.4. Happiness@Work and Voluntary Supports

Self-assurance hypothesis places that people worth encounters where they are managed more noteworthy self-rule. At the point when people feel increasingly self-ruling, they feel all the more naturally inspired to participate in an action volitionally. Consequently, when interest to take part in bliss in the work environment is at people's own tact, their examinations will be progressively great, and they might be bound to see that the experience will be helpful. Then again, when people accept that contribution in is compulsory, their examination will be less ideal, and they will see less potential incentive from the experience. On the off chance that an organization supports a special occasion for people and independently feels that his administrator is driving to partake on the occasion, the individual might evaluate this occasion negatively as well

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as see that experience as a block instead of an advantage. Moreover, people may see that bliss in the work environment is bound to meddle with work life equalization issues when commitment in the occasion is required sections deliberate. The degree to which happiness in working environment causes work-life struggle, people assess joy in work environment not positively and very less attracted to profit by taking part in satisfaction occasions.

10.5. Happiness@Work and Requirement in Job

At the point when people feel that work requests, for example, all out hours worked, expend a lot of time and vitality they frequently turned out to be focused on in view of the restricted time staying to manage different requests other than job. As for satisfaction in the work environment, when people are encountering high work requests, they may see that taking part in bliss occasions is one more snag in their calendar. On the other hand, those with low work requests might be bound to have great examinations of joy in the working environment since they have even more leisure time they have in the timetables. It is conceivable to all over the top that work requests will have negative effect especially upon their expectant examination, however these requests will have less effect on one's specific evaluation. To this degree that any happy movement reduces pressure or enables people to make constructive associations related to others, all individuals could see bliss related to their work environment as expected and required leave from one's furious job requests [28].

10.6. Happiness@Work and Compensation Practices

Regardless of whether people are paid on an hourly or pay premise could likewise affect examinations of bliss in the working environment. At the point when joy in the work environment happens "on the clock," representatives will have increasingly great evaluations of bliss in work environment and be bound to participate in the occasion since they are made up forever spent at work. Happiness in the work environment might be significantly increasingly esteemed among hourly representatives when joy in the working environment reaches out past a forty-hour weeks' worth of work, qualifying people for extra time pay in U.S. under the Fair Labor Standards Act. Interestingly, professionals will have less ideal examinations of satisfaction in the work environment since they see participating in bliss in the work environment as a diversion from finishing work obligations. Salaried representatives are not held to a customary forty-hour weeks' worth of work, and they should frequently endure in finishing work duties until it is completed, regardless of effort taken at work or at home. At the point, happiness in the working environment requires a critical duty schedule far from finishing center occupation duties, people might be impervious to taking part in such occasions. In this regard, bliss in the work environment might be seen one more occupation request. Salaried representatives may not really see bliss in the working environment adversely but rather might be increasingly able to do as such when gone up against with noteworthy errand requests.

10.7. Happiness@Work and People's Role

Contingent upon the various reasons for an individual to join as a member, facilitator, even onlooker, people could respond all around distinctively toward satisfaction in the work environment. Apparently, joy in the work environment may be evaluated most positively by the individuals who perform as the central members during the occasion. Accepting the facts related to the degree of satisfaction in this working environment is lined up based on people's interest as well as an individual requirement, has room schedule-wise to dedicate the bliss in contributing to the working environment, a member might just experience delight and joy. In the meantime, there exist discontent between one's felt requirements namely as tension or disappointment as well as the feelings people is relied upon to show like bliss or delight, for example. Based on any such manner, taking an interest in bliss in the work environment might be viewed as a type of passionate work. Thusly, on the off chance that one is the facilitator of a satisfaction action, the person in question may feel another arrangement of weights, coming from a longing to guarantee that an occasion runs easily and that members delight themselves. Finally, spectators, for example, supervisors who go to a bliss occasion in help of representatives, may encounter minimal measure of delight as their job may be only to watch.

10.8. Happiness@Work and Person-Organization Fit

Individual association or the PO fit alludes explaining the "similarity among individuals and their associations in which they work." PO fit hypothesis attests the representative dispositions as well as practices that are affected by how much qualities (i.e., necessities, qualities, and objectives) of people are harmonious with the aggregate attributes of the association. At the point when people see comparability in their qualities as well as those embraced in the association, there is real PO fit. Referring to this writing, associations having solid PO fit for happiness in their working environment will prove to maintain a solid culture of bliss in the work environment, since it will pull in, hold and select the representatives whom can be trusted to offer satisfaction as typical worth. All things considered, it is suggested that people will be having progressively good examinations for happiness contained in the work environment when there emerges a solid worth congruence widely rooted between the person and the association as for satisfaction in the working environment. At the end of the day, when people who worth joy, work in associations that additionally esteem and advance joy in the work environment, they will be bound to positively assess joy in the

work environment. Notwithstanding, for people who don't esteem bliss, working in an association that qualities and advances satisfaction in the work environment will make them assess joy in the working environment less positively and perhaps even reason the person to search for employments in associations with comparable qualities of their's own.

10.9. Happiness@Work and Positive and Negative Affectivity

Singular contrasts will bring changes as to how any individual can evaluate bliss in their work environment which can include dispositional affectivity in the work environment. The dispositional affectivity is explained as a character characteristic aimed to predict general full of feeling inclinations crosswise over different areas of profession. The people with high impact in positive affectivity have a higher pattern of positive state of mind, aimed to display get-up-and-go for living and will in general be more joyful, vivacious, and agreeable. Then again, those people with high-in negative affectivity will in general be furious, apprehensive, restless, and effectively tormented. Contrasted with this, people with high in contrary response, individuals having high positive affectivity will direct the effect so that they can encounter positive feelings independent of outside conditions. Authorities contend that with having a high positive affectivity can improve whether joy in the working environment are assessed positively. Since people with high constructive affectivity are more joyful, they will be bound to have positive evaluations of joy in the working environment in light of the fact that such occasions give an instrument to them to make the most of their time at work. Then again, having negative affectivity can l build this degree to which person's examinations of bliss in the working environment are ominous? Moreover, on the grounds that people exhibits high contrary affectivity exhibits poor self-ideas based on their evaluative examinations of bliss in the work environment are likewise liable to be horrible in light of the fact that such occasions give pointless worry at work; in this manner, they will commonly experience antagonistic effect from satisfaction in the working environment.

11. HAPPINESS@WORK: BUILDING POSITIVE AND ENDURING RESOURCES

Based on the discussions, contended beforehand, the manner by which the long haul advantages of bliss in working environment were created through widen and-manufacture interests. At the point where people expertise increments in constructive feelings from participating in various joy in the working environment additional time, they may likewise experience increments in execution and prosperity through the widen and-manufacture process. As indicated by Fredrickson's expand and-construct hypothesis, individuals react diversely to positive and negative feelings. Fredrickson contends that not at all like pessimistic feelings which restricted an individual's fleeting idea and activity collections in anticipation of snappy activities (e.g., to fend off pressure), constructive feelings expand an individual's flitting musings and activities, which enable them to mull over a more extensive exhibit of practices, perspectives, or results, hence advancing the advancement of scholarly, mental, physical and social assets, which helps to draw on promptly or sometime in the future when required. Individuals who experience increasingly positive feelings will in general adapt all the more successfully to difficulty, appreciate better triumphs in the work, exhibits better connections, and even expected to live more. Therefore, it is suggested that encountering positivity in feelings explained in participating in satisfaction occasions after some time ought to urge people to relinquish regular perspectives and activities and rouse them to take part in innovative, clever, and even sudden perspectives and carrying on at work. As idea activity collections extend, people create significant scholarly (e.g., inventiveness and care), mental (e.g., versatility and good faith), social (for example social help and constituent connection), and physical (e.g., low ailment and better rest quality) assets which can improve execution, adapting, prosperity and maintenance. For instance, encountering delight (a typical positive response to joy in the working environment) is contended to make the desire to play, push the cutoff points, and cultivate imagination. Nonetheless, we additionally suggest that encountering negative feelings from taking part in occasions expected to be satisfaction, may make people search for approaches to "get away from" the circumstance so they can cease their interest in the occasion. In that capacity, people who experience contrary feelings after some weeks this will encounter a "narrowing" of considerations as well as practices, which can lessen the inspiration to perform better undertakings, adapt better aptitudes as well as diminish their prosperity. This can even explained as potentially for their longing to remain with the association.

12. HAPPINESS@WORK: AGENDA FOR FUTURE RESEARCH

Better featured all through the study, however a few examinations have inspected satisfaction in the working environment, a solid hypothetical system to clarify how people may decipher bliss in the work environment and how joy in the work environment can be gainful presently can't seem to be created. Drawing on the thought that it is critical to see how satisfaction in the work environment is seen by people, our proposed system fills this significant void and gives a more nuanced comprehension of the transient procedures and logical variables that clarify how people assess and at last profit by bliss in the working environment. In the accompanying segments, we advance a motivation related future experimental research to explain the

plans of the proposed system. To begin with, we talk about how future research needs to give more noteworthy qualification between the elements of joy in the work environment since people may assess a few occasions more positively in relation to others. In addition the study talk about how better research ought to analyze this evaluation procedure by utilizing an inside subject plan on the grounds that doing as such will help explain how examinations change throughout a satisfaction occasion. Third, we talk about how future research ought to inspect how extraordinary logical and individual explicit variables fill in as limit states of individual evaluations of bliss in the work environment. Fourth, we talk about how research in future ought to be directed to explain the degree to which satisfaction in the work environment, which experienced additional time, will start an expand and construct procedure as well as at last make long haul extended benefits for people. Based on the drawing from the transient evaluation structure of bliss in the work environment, we offer a few suggestions to direct future research.

- The degree to which bliss in the working environment prompts good work results is a component of expectant evaluations and head examinations of satisfaction occasions.
- The degree to which joy occasions will be identified with good evaluations can be directed with the help for bliss which included director support related to satisfaction and individual flexibilities, in the examinations of joy occasions will be increasingly ideal while backing is high.
- The characteristics for happiness occasions which included movement type, this included, as well as willfulness for the occasion will affect the degree to the extent to which the expectant and head examinations are sure with the negative incidents and whether people are probably going to take part in the happy occasion.
- Job attributes which include work requests, pay, as well as the individual's job will affect the degree to which the expectant and head examinations are certain versus negative and whether person is probably going to participate in the satisfaction occasion.
- Individual explicit variables which included individual association fit as well as constructive or even antagonistic affectivity can affect the level to which the expectant and head examinations are sure versus contrary and whether people are probably going to participate in the satisfaction occasion.
- Degree to which people increase transient advantages, for example, making another association, discovering some new information, or "acquiring focuses" with the chief is an element of the idealness of their foremost evaluation of the bliss occasion.
- The degree to which people addition long haul advantages, for example, social help and constituent connection, innovativeness and care, and flexibility and hopefulness is created after some time through the widen and-fabricate process.
- The degree to which people will encounter positive review examinations of joy occasions will be a component of the present moment and long haul advantages picked up from taking part in bliss in the work environment.
- Favorable review examinations of joy occasions will prompt ideal expectant evaluations of future bliss occasions.

13. HAPPINESS@WORKPLACE: DISTINGUISHING DIMENSIONS

Extended research ought to led towards all the more likely recognize the various kinds of bliss in the work environment. As recently talked about, a few measurements have been inspected in the writing. With couple of exemptions, a large portion of the past studies on bliss based on the working environment that concentrated either based on a solitary measurement (e.g., satisfaction exercises) or based on any multidimensional, better-request build of happiness in working environment (i.e., falling various elements of happiness into a solitary develop). At the same time bodes well because of normally high relationships among the measurements, crumbling the various elements of satisfaction in the working environment into a solitary develop is dangerous as each measurement is hypothetically and for all intents and purposes unmistakable. Besides, despite the fact that various parts of bliss in the working environment have been propelled, no examination has analyzed all perspectives together in a solitary examination. Inspecting all parts of satisfaction in the working environment could explain the similitudes and contrasts among most of the components of happiness in the working environment. For instance, future study could investigate if individual flexibilities and supervisor support for bliss are two unmistakable develops, or if individual flexibilities are essentially instances of how administrators bolster joy. Thus, looking at supervisor support for bliss and worldwide atmosphere for satisfaction together can decide whether these two develops are generously unmistakable parts of joy in the working environment or on the off chance that they are basically a similar build at various degrees of examination—worldwide atmosphere for joy at the hierarchical level and administrator co-operation towards happiness at the gathering or office-level. One of the related, yet somewhat extraordinary, concern is whether bliss work duties ought to be considered as a part of satisfaction in the work environment or in the event that it is just an assignment that is characteristically agreeable. Past research has been directed to investigate how various kinds of joy in the working environment identify with various business related results. For instance, Ref. [9] found that joy exercises favorably affected execution and supervisor support for satisfaction had a good effect in decreasing turnover. Be that as it may, director support for joy adverse affected execution. Furthermore, Ref. [10] gave proof that associate mingling and supervisor support for satisfaction had

more grounded impacts in decreasing turnover in respect to joy exercises. Given discoveries, for example, these, extra research shows up justified in further evaluates the various differential effect for the components towards happiness in the working environment. This will open door towards future study is for further analyze the various components of satisfaction in work environment on employment execution. Tews [10] conducted study referred to earlier inspected work execution involving eatery servers. Despite legitimacy of the discoveries, future studies could analyze the connections related to the various elements of joy in work environment in other employment settings. Another open door for future research is to analyze how various components of bliss exercises effect work results.

14. HAPPINESS@WORKPLACE: TEMPORAL NATURE OF APPRAISING JOB INVOLVEMENT AND HAPPINESS EVENTS

Based on the explanations proposed in this study, people usually make various examinations, previously, during as well as in the wake of taking part in joy occasions at work. Though a few people may evaluate satisfaction in the work environment comparably previously, during, and in the wake of participating in a bliss occasion, others may assess joy in the work environment diversely all through the procedure. Accordingly, future research should utilize an inside subject plan to perceive how a person's examinations of and passionate responses to bliss occasions change (or don't change) additional time. Using an inside subjects configuration would not just recognize how people's evaluations of bliss in the working environment change additional time yet would likewise pinpoint attributes that impact how people translating in the case of taking part in a joy occasion is agreeable and helpful. Future research could along these lines utilize an encounter testing system in which members are approached to stop and rate their ebb and flow influence and general observations about their experience previously, during, and in the wake of taking part in a bliss occasion. Based on the experience, members could be approached to evaluate the degree to extent they delighted on the occasion, increased any present moment or even long haul profits by the occasion, and how better they can take part in a comparative occasion later on.

15. HAPPINESS@WORKPLACE: CONTEXTUAL AND PERSON-SPECIFIC FACTORS

The study recently explained few logical as well as individual explicit variables that can modify in case people evaluate satisfaction occasions positively or not. These relevant and individual explicit components were arranged into four wide subjects—strong work rehearses for bliss in the work environment, attributes of joy occasions, work qualities, and individual explicit elements. Future research ought to be led to look at how much every one of these components directs the connection between satisfaction in the working environment and individual examinations of bliss. Besides, to the degree to which examinations intervene the connection between satisfaction in the work environment and present moment and long haul advantages of joy occasions, future research ought to analyze how much the relevant and individual explicit components moderate the proposed interceded connections. For instance, people might be bound to make reliable positive evaluations of satisfaction in the work environment and experience resulting short term and extended benefits when this association utilizes steady take rehearses for joy in the work environment. At last, future research ought to look at if certain relevant or individual explicit variables moderate with certain pieces of the evaluation procedure much better than others. For instance, job requests are bound to direct the connection related to the happiness in the working environment and expectant examinations since people will make less good evaluations of a joy occasion on the off chance that they are excessively occupied at work. Be that as it may, the sort of satisfaction action is bound to direct the connection between the central examination of bliss in the working environment and extreme profit by the occasion.

16. HAPPINESS@WORKPLACE: BROADEN-AND-BUILD THEORY

At long last, based on the details of the recently talked subject, the author contend that encountering better feelings with participating from satisfaction in this working environment after some time may raise a person's standard degree of constructive effect and urge people to desert regular perspectives and activities and rouse them to take part in imaginative, creative, and even startling perspectives and carrying on at work. In the long run the widening procedure will enable people to turn out to be progressively inventive, hopeful, socially associated with others and versatile, every one of this has been observed to be significant parts of personal prospering. Advanced study should in this way utilize a cross-slacked longitudinal plan to analyze if in actuality rehashed commitment in bliss in the work environment expands a people's gauge level of constructive feeling, at last helping people create constructive assets that can be attracted on to grow long haul benefits. Seven days in length field test configuration could be utilized to test these attestations. In particular, specialists could assess the effect, execution and prosperity of members before arbitrarily allocating them for trial and in protected conditions. Members working in this trial situation need to be displayed the chance to take part in various bliss occasions through the span of the week. During the week, members could be given cerebrum mysteries,

mental readiness recreations, or imagination difficulties to check whether members in the test gathering are considering more comprehensively as well as imaginatively than the control gathering. Toward the week's end, evaluation of individual effect and mental assets could be thought about between members in the exploratory and control conditions. Two or after three weeks, the presentation and prosperity of members could be surveyed and contrasted with check whether in reality joy in the work environment enables people to thrive through a widen and-fabricate process.

17. CONCLUSION

Joy in the working environment has surprised associations, however our comprehension for how and under what conditions satisfaction in the working environment work needs further consideration from researchers. In spite of the fact that bliss in the work environment has been grasped by a few fruitful associations, up to this point scholastic research on joy in the work environment has been meager. To the extent that concern driven research remains focal beginning stage for academic request, there is a need to give an unmistakable comprehension to why associations ought to underscore bliss in the working environment and how captivating in joy occasions benefits people. We accept that our survey and hypothetical system gives a significant initial move toward clarifying how people may decipher satisfaction in the work environment and in which way the bliss in the working environment can change to be supportive either at the long or even in the short run situation in employment.

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Received: 1 January 2019. Accepted: 11 March 2019.

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5327–5331, 2019

Prophylactic Effect of Memantine on Chronic Migraine Headache

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RESEARCH ARTICLE

Given the high prevalence of migraine treatment failure and resistance to existing drugs and side effects of drugs, finding alternative therapies for refractory patients or chronic migraine is essential. Fifty four patients with migraine headaches were stochastic classified to the 2 groups: placebo and memantine. In first one, memantine is managed at a dose of 20 mg in a day, that enhanced 4 weeks to this dose, and in second group placebo was given. The severity, duration, incapacity, and frequency of migraine headache attacks were recorded at the starting of the research, and the end of first, second, third and fourth months of the study. The mean of VAS score did not have a significant difference at the beginning of the study and at the end of the first month, however here was a significant decrease in the memantine group, during the end of second, third and fourth. After 4 months of behaving, MIDAS score were 22.44 ± 10.62 in the memantine group, when in the placebo group, this was 14.47 ± 1.79 ($p < 0.0001$). The outcomes shows the role of memantine on the treatment and prevention of chronic migraine headaches. In addition, the migraine headaches incidence is mainly decreased in the memantine group in comparison to placebo at the end of the research.

Keywords: Migraine Headache, Memantine, MIDAS, VAS.

1. INTRODUCTION

Migraine headache is a usual neurology disease happened with increasing excitability of central nervous system (CNS) and considered among debilitating diseases worldwide. Chronic migraine is defined as a migraine headache that affects the patient at least 15 days a month for 3 months which completely fulfills migraine criteria for a minimum of 8 days. Most chronic migraine headaches occur by gradual increase of frequency of periodic migraine headaches [1]. It is estimated that 15 percent of people all over the world suffer migraine headache. Studies in this field reveals that migraine headaches, especially its chronic type, severely affect patient's quality of life; migraine headache highly limits patient's social activities and reduce their ability for household activities as well as physical and non-physical activities and disturbs them in their leisure time [2, 3]. A variety of methods such as drug therapy and psychotherapy are implemented for migraine treatment. All medications are associated with different adverse effects while not providing satisfactory efficacy [4, 5]. There is a high tendency in the recent years to use glutamate mediators for migraine headache prophylaxis, since it is proved that glutamate and/or its receptors are engaged in many pain related structures. CSF glutamate level is increased in patients with chronic migraine headache suggesting higher levels of glutamate secretion in patients with chronic migraine headache [6, 7].

It is acting by blocking afferent pain signals, known as glutamate system, and hence play a significant effect in chronic migraine headaches pathophysiology [8]. Memantine shows as a low potent non-competitive voltage-dependent NMDA antagonist to prevent from excessive calcium influx to neurons thus prevent form neuronal over stimulation in pain transferring pathways in such a way [9]. Consequently, this drug can be considered as suitable effective medication in prophylaxis and treatment of chronic pains such as chronic migraine headaches [10]. Previous researches have investigated few rare side effects of Memantine. In addition to the studies in this field, enough citable studies are not available on Memantine prophylaxis in patients with chronic migraine headaches. The current research is intended to calculate Memantine prophylaxis efficacy on chronic migraine headaches.

Remarkably, anti-migraines, especially painkillers, make headaches more durable in the digestive, kidney and liver. Indiscriminate consumption of painkillers accounts for 2% of chronic migraine headaches. Medications have not yet been effective in treating and preventing migraine, or many

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of them have severe side effects. Unfortunately, many patients with recurrent or chronic migraines do not take preventive medications or treat migraines because of insufficient efficacy or adverse effects.

In the last ten years, no new and effective drug has been introduced to the market. Therefore, there is a need for preventive treatment with similar or even greater effects than those available on the market and more importantly with fewer side effects. According to the findings, physicians and scientific research centers around the world have always sought effective and therapeutic treatments without adverse effects. Research suggests that peripheral nerve stimulation (PNS) has promising effects in the prevention of periodic and chronic migraines. In the past, nerve stimulation was used to control pain through electrical stimulation of peripheral nerve branches by implantation devices, but recently one of the world's research centers has succeeded in developing a device called "clay" with trigeminal nerve stimulation and a posterior region. It is made on the skin so that the patient can easily tolerate it and does not feel any pain. Peripheral nerve stimulation through the skin has the advantage of being noninvasive and thus suitable even for patients with less severe periodic migraine.

The CEFALY device resembles a headband; doctors say it should be mounted on the forehead and used daily for 20 minutes. In this way, by stimulating the nerves of the forehead and head, it increases endorphin production, thereby raising the patient's pain threshold, thereby reducing the frequency and severity of headaches. It also helps calm patients and even healthy people over time. On the other hand, there are no side effects to other anti-migraine treatments, so it is ideally suited for any possible side effects and for children and adolescents over 6 years of age who are not able to use anti-migraine during lactation. They can also be used with parental supervision. In addition to migraines, it also has a diminishing effect on any recurring headache. Research shows that in 2014 more than 10,000 patients in the United States have used and declared this individual treatment consent. Studies at five Belgian universities have also confirmed the beneficial effects of this technique. Also, the latest US Patient Satisfaction Survey shows that 94% of treatment outcomes have been successful and only less than 6% of patients have not continued their treatment after a 60-day period. There are currently more than 100,000 pottery units worldwide used to treat and prevent migraine and chronic headaches by its patients, and numerous articles on its effect on migraine headaches have been published in prestigious journals including the American Academy of Neurology. The number of doctors prescribing pottery for the treatment of migraine headaches and other debilitating headaches is increasing daily. This drug-free and aggressive-free treatment seems to open new horizons for the treatment and prevention of migraine and other chronic headaches for patients and physicians and has provided them with a far less costly and uncomplicated treatment. The method approved by major medical and academic centers and also approved by the US FDA as the most authoritative authorized center.

2. METHODS

Migraine headaches are one of the causes of recurrent headaches in children. Prevention of headache attacks improves quality of life in affected children. In the current research the therapeutic affects and side affects of sodium valproate and propranolol compared in the prevention of migraine headaches. All cases with migraine headaches who were diagnosed with migraine for at least 6 months were included in the study. Those who had taken sodium valproate and propranolol before taking the study were excluded.

Six patients could not complete the study and the study was finally finished with 54 patients. Informed consent was taken from patients after explanation of study objectives. Patients were randomly assigned to Memantine or placebo group. Patients in Memantine group received Memantine 20 mg daily which reached this level after 4 weeks. Patients in placebo group received topiramate 50 mg daily as a base medication which started at 25 mg daily and increased to 50 mg daily in two weeks. Pain severity, disability level, frequency of attacks at the beginning of study, at first, second, third, and fourth month were recorded in follow-ups. Migraine Disability Assessment Test Survey (MIDAS): This questionnaire includes 7 questions. The first five questions are related to the score of disability caused by migraine headaches. All questions are about headaches in the last three months and responses are in days. Total number of days in these five questions will determine MIDAS grade of disability in patients [11]:

1. MIDAS I or no or little disability: score zero to 5.
2. MIDAS II or mild disability: score 6 to 10.
3. MIDAS III or moderate disability: score 11 to 20.
4. MIDAS IV or severe disability: score 21 or more.

Reliability and validity of MIDAS questionnaire is assessed and proved in several studies [12].

(VAS) was utilized to show pain severity in this questionnaire. It was explained to patients to consider score 10 for the most severe pain of their life, 5 for moderate pain, and zero for no pain. Afterwards, they were asked to score their migraine headache pain.

2.1. Statistical Analysis

Mann Whitney Test employed for comparing quantitative variants among the two groups. Moreover, repeated measurement was utilized for mean difference comparison. A P-value <0.04 was considered statistically dominant.

Table I. Results of mean pain intensity in two groups during 16 weeks.

	Memantine group	Placebo group	*P* value
Beginning of study	7.56 ± 1.05	7.93 ± 1.17	0.227
First month	6.63 ± 1.11	7.07 ± 1.14	0.154
Second month	5.78 ± 1.21	6.48 ± 1.08	0.030
Third month	5.04 ± 1.40	5.85 ± 1.26	0.029
Fourth month	4.33 ± 1.51	5.11 ± 1.21	0.043

3. RESULTS

Twenty seven cases were assigned to Memantine group and 27 cases to placebo group. Mean age of patients was 37.9 ± 8.86 Memantine and 39.76 ± 5.87 in placebo group ($P = 0.003$). There were 2 men and 25 women in Memantine group while there were 5 men and 22 women in placebo group. No significant difference is observed in terms of gender between the two groups ($P = 0.786$). In Memantine group, 10 Patients experienced unilateral headache and 17 patients had bilateral headache. Moreover, in placebo group, 8 patients had unilateral headache while 19 patients experienced bilateral headache ($P = 0.773$). Table I shows mean measured VAS pain severity in Memantine and placebo groups. Figure 1 presents pain severity changes in the four months of flow-up for both groups separately which shows that pain severity has decreased for both groups; though, pain severity decrease was significantly more prominent in Memantine group ($P < 0.0001$).

As it is presented in Table II, patients in Memantine and placebo groups experienced migraine headaches 22.63 ± 2.92 and 23.33 ± 2.88 days a month, respectively. At the beginning of the research, there was no main difference among the two teams in terms of the number of days experiencing migraine headache ($P = 0.377$).

In terms of number of days with migraine headache, a significant difference was seen among the two groups in third and fourth months ($P = 0.047$ and $P = 0.029$). Figure 2 demonstrates the trend of the number of days with migraine headaches in the four months follow up for both groups separately. Accordingly, the number of day with migraine headache decreased in both groups. Though, this difference was significantly more prominent in Memantine group ($P < 0.0001$).

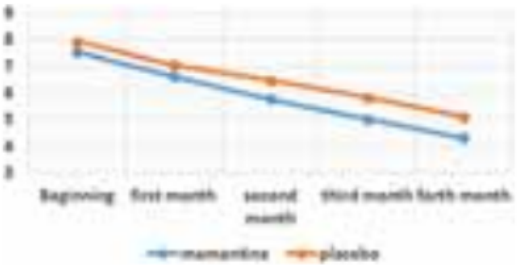

Fig. 1. Variation in the pain intensity over the follow-up of 16 weeks classified in 2 groups.

Table II. Results of the mean days of migraine headache in the two groups during 16 weeks.

	Memantine group	Placebo group	*P* value
Beginning of study	22.63 ± 2.92	23.33 ± 2.88	0.377
First month	19.93 ± 2.71	21.11 ± 2.54	0.103
Second month	14.01 ± 3.84	17.04 ± 2.73	0.064
Third month	8.26 ± 1.51	13.74 ± 3.83	0.047
Fourth month	6.74 ± 2.31	10.33 ± 2.88	0.029

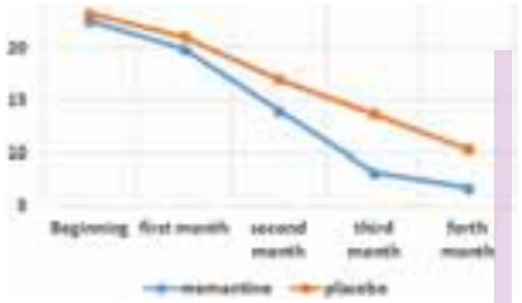

Fig. 2. The variation of days over 16 weeks in medium and memantine.

Table III. Results of the mean days over the application of memantine for 16 weeks.

	Memantine group	Placebo group	*P* value
Beginning of study	11.34 ± 2.86	12.56 ± 1.27	0.478
First month	9.27 ± 2.65	11.24 ± 3.22	0.351
Second month	7.37 ± 3.53	10.12 ± 3.09	0.047
Third month	5.86 ± 1.76	9.09 ± 3.87	0.024
Fourth month	4.75 ± 1.14	8.53 ± 3.44	0.001

Table III compares the mean days-analgesic consumed in Memantine and placebo groups in the four months of follow up. Numbers of days-analgesic consumed in both teams did not indicate main distinct at the starting and at the end of the first month of research, though it was mainly lower in Memantine groups at the end of 2nd, 3rd, and 4th months. After four months of treatment, mean MIDAS score was decreased by 22.44 ± 10.62 in Memantine group, while the difference was 14.74 ± 1.78 in placebo group which was significantly higher in MIDAS group ($P < 0.0001$).

4. DISCUSSION

Mean pain severity was measured according to VAS which did not show any significant difference among Memantine and placebo teams at the starting of the research and at the terminating of the 30 days. Though, VAS mean score was mainly less in Memantine tram during the 2nd, 3rd and 4th end of month. The pain severity decreased in both groups in the four-month treatment. Though, the reduction was significantly more prominent in Memantine group.

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Glutamate CSF and serum concentration is elevated in migraine headaches. Additionally, formation of a stimulation in pain related structures increases the level of glutamate. Glutamate receptors are identified in a several pain related structures such as trigeminal ganglion, tregeminocervical complex, and thalamus. Hence, the relationship between glutaminergic system and migraine must be paid attention [18]. Glutamate plays an important role in many pain related pathways such as central stimulation, trigeminovascular response, and Cortical Spreading Depression (CDS). In Peeters et al. study [19] on CDS in rats conducted in England, it was found that NR2B subtype of NMDA receptor are mediators for cortical spreading depression. For example, Memantine and other NR2B selective antagonists can be helpful as new medications for migraine headaches and other disorders related to CSD such as cerebrovascular accident. Nonetheless, chronic usage is more effective compared with acute usage. Also, it is proved that excessive amounts of glutamate may be involved in chronic migraine headaches [20]. Memantine can compete with magnesium and prevent from long-term calcium efflux and this way prevent form neural excitability. As a result, it can be considered for chronic migraine headache prophylaxis [21]. The most important advantage of Memantine over other drugs used for migraine headache prophylaxis is related to adverse effects. Other medications used for migraine headache prophylaxis are usually associated with considerable side effects. Hair loss, overweight are unwilling side effects of valproate especially for women suffering from chronic migraine headaches. Topiramate is associated with cognitive disorders and paresthesia while venlafaxine is associated with gastrointestinal side effects [22, 23]. Additionally, contrary to many medications for migraine headache, Memantine is among group B drugs in pregnancy making it a good choice for pregnant women suffering from migraine headache. Collectively, Memantine is obviously advantageous compared with other medications used for migraine headache prophylaxis.

5. CONCLUSION

Headache is one of the most usual problems and at least 90% of the population develops headache once a year. The most common cause of migraines is migraine headaches. In fact, migraine is a chronic, debilitating headache that results in significant economic and social damage, and the costs involved in treating illness, absenteeism, and loss of quality of life are part of these injuries. Most patients receive a multi-drug regimen. Research has shown that glutamate is important in the pathophysiology of migraine (5). Memantine is a nonspecific antagonist of glutamate, which has been shown by some studies to have a positive effect on the treatment and prevention of migraine recurrence (6). Despite the research that has been done in this area, there is still no investigation in this regard in our country. In addition, the research was a case-control study or a pre- and post-test study. Therefore, we aimed to investigate the effect of memantine on patients with migraine headaches as a clinical trial.

Considering the outcomes of the research, an obvious difference among two groups, Memantine and placebo was observed in deceased severity, frequency and period of migraine headaches starting 2 months after treatment which suggests the effectiveness of Memantine in treatment and prevention of chronic migraine headaches. Moreover, migraine headache disability improvement was significantly more prominent in Memantine group in comparison to placebo group.

Acknowledgments: We would like to thank the nursing, administrative and secretarial staff of the neurology department and clinic at our hospital for their contribution to the maintenance of our patient record without which this project would have been impossible.

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Received: 14 April 2019. Accepted: 29 October 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5332–5346, 2019

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Earthquake Risk Analysis and Qualitative Comparison of Attenuation Relationships in Garmsar City, Iran

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Despite the scientists' wide efforts to determine earthquake risks all around the world, it is not still possible to predict the exact time, location and magnitude of future earthquakes and aftershocks at the ground surface so precise results are not predictable within near future. The most significant reason for this relates to numerous complexities of earthquake mechanism and causal conditions and waves through different ground layers with completely different properties. Logical tree method was used with weights to determine acceleration spectra due to spectral nature of region. Probabilistic analysis of earthquake hazard was done using SEISRISK III program. The analysis results are proposed through spectral acceleration maps for 50 years in Garmsar. Moreover, uniform hazard spectrum and spectrum with constant shape are presented.

Keywords: Risk Spectrum, Seismic Risk Analysis, Attenuation Relationships, Garmsar City.

1. INTRODUCTION

Despite the scientists' wide efforts to determine earthquake risks all around the world, it is not still possible to predict the exact time, location and magnitude of future earthquakes and aftershocks at the ground surface so precise results are not predictable within near future. The most significant reason for this relates to numerous complexities of earthquake mechanism and causal conditions and waves through different ground layers with completely different properties. However, it does not mean that reliable prediction of earthquake hazards and buildings' safety are completely impossible. Scientific findings and experiences have shown that available data besides statistical and probabilistic methods can be used to estimate optimal level of buildings' safety during earthquake. Two basic factors of site safety are considered in feasibility, analysis, construction and maintenance of structures against earthquake. Site safety depends on the geotechnical hazards and probable geology of the site including landslide, liquefaction, and intensification of ground movements owing to site conditions. Past earthquakes indicate that site conditions play a vital role in level and type of structure destruction [1]. Adverse effects of earthquakes, which lead to destruction of structures and installations, depend on two phenomena: (1) effect of seismic waves, (2) shear displacement caused by faults' shear movement. Crossing seismic waves create some shakes that can destroy structures directly or indirectly through some phenomena such as subsidence, liquefaction, and foundation slide. Seismic motions intensity depends on the magnitude of earthquake, focal length, damping characteristics of site, type and thickness of sedimentary deposits, and topographic conditions. Seismic risk is estimated to evaluate ground motion measures (peak acceleration, peak velocity, peak displacement, etc.) logically in selected site affected by the earthquake in potential seismic sources during a period that is usually useful life of structure. In fact, earthquake risk analysis calculates probability of certain levels of ground shake in time unite caused by earthquake. This analysis is summarized by an earthquake risk curve, which illustrates annual exceeding probability against ground vibration amplitude. Indeed, earthquake risk analysis is the starting point to enter into the decision-making process for earthquake damages reduction. Ultimate goal of risk analysis and earthquake engineering is to determine seismic intensity, which leads to quantification of earthquake effect on structures; this process is presented in response scale.

2. STUDY IMPLEMENTATION

In conducted studies, a complete database on historical and instrumental earthquakes in the region sent to site center within 200 km distance is collected from reliable sources. The prepared list includes time, longitude and latitude, earthquake epicenter, focal depth and earthquake

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1546-1955/2019/16/5332/015 doi:10.1166/jctn.2019.8613

magnitude that are reported in attachment. Other required data for analysis implementation include position of active faults or seismic sources in the regain and determining their seismic parameters and potential. Active fault is defined as a fault that there is at least one seismic incident during the last 35000 years or two seismic activity during 500000 years. Hence, all of faults that have cut the Quaternary alluvium are active faults. According to the obtained results, seismic sources are modeled as linear seismic sources [2].

2.1. Estimation of Seismic Recurrence Interval Using Gutenberg-Richter Method

After calculating a, b values from the experimental command of Gutenberg-Richter, the following formula is used to determine T recurrence interval.

$$M_s = [\log(T/N) + a]/b$$

For instance, recurrence interval of an earthquake with magnitude of M_s for Garmsar is calculated using following formula.

$$M_s = [\log(T/6) + a]/0.76$$

Average recurrence interval of T as the expected time for an earthquake with magnitude above or equal to M:

$$T = 1/N$$

According to seismic formula of Garmsar area, recurrence interval of earthquakes with different magnitudes was examined for this region.

2.2. The Relationship Between Magnitude and Intensity of Earthquakes

Following experimental orders are significant in this field:

• Experimental instruction of Ambraseys and Melville for Iran's earthquakes in which, IO indicates relative intensity of earthquake in the earthquake focus based on the Mercalli Scale.

$$\mathrm{IO} = 1.04M_b + 2.6 \quad \mathrm{IO} = 1.3M_s + 0.09$$

• Experimental instruction of Mohajer Ashjaee and Noroozi for earthquakes with focal depths lower than 60 km.

$$\mathrm{IO} = 1.7M_s + 2.8$$

2.2.1. *Seismic Intensity Reduction*

Chandra suggested following orders for Iran's earthquake intensity reduction based on the 12 maps of seismic bends during 20th century (quoted by Pourkermani):

1. Average intensity reduction within distance lower than 120 km

$$\mathrm{IR} = \mathrm{IO} + 6.435 + 0.00121(R) - 4.960\mathrm{Log}(R + 20)$$

Where, IR: earthquake intensity in site at Mercalli Scale; IO: earthquake intensity in earthquake focus at Mercalli scale; R: focal distance based on Km (focal distance in above project based on the statistical studies for considered 35 km).

Earthquake intensity reduction within $R < 160$ km distance

$$\mathrm{IR} = \mathrm{IO} + 4.82 - 0.00548(R) - 3.708\mathrm{Log}(R + 20)$$

Ambraseys and Melville suggested following experimental order based on assessment of 26 historical earthquakes in Iran:

$$\mathrm{IO} - \mathrm{IR} = -3.44 + 0.002(R) + 3.10\mathrm{Log}(R)$$

• Estimation of velocity, acceleration and displacement.

To estimate aforementioned parameters, instruction of Trifunac and Brady were used (quoted by Pourkermani):

1. Peak horizontal and vertical accelerations:

$$\log ah = -0.041 + 0.3\mathrm{IO}\ \mathrm{cm/sec^2}$$

$$\log av = -0.18 + 0.3\mathrm{IO}\ \mathrm{cm/sec^2}$$

2. Peak horizontal and vertical velocities:

$$\log vh = -0.63 + 0.25\mathrm{IO}\ \mathrm{cm/s}$$

$$\log vv = -1.10 + 0.28\mathrm{IO}\ \mathrm{cm/s}$$

3 Peak horizontal and vertical displacements:

$$\log Dh = -0.53 + 0.19\mathrm{IO}\ \mathrm{cm}$$

$$\log Dv = -1.13 + 0.28\mathrm{IO}\ \mathrm{cm}$$

Where, IO indicates relative intensity in focus location at Mercalli Scale (between IV and X).

• Experimental order of McGuire to calculate peak displacement (quoted by Pourkermani)

$$D\max = 0.393\exp(0.999M_s)(25 + R)^{-0.88}$$

Displacement is based on decimeter.

2.3. Estimation of Seismic Recurrence Interval Using Final Values Fitting

Distribution function of Gutenberg-Richter had not great accuracy at high domain indicating values larger than reality. It has been revealed that final values theory can be used to estimate magnitude of earthquake. He studied large-scale earthquakes in the world and seismic zones and showed that probability of earthquake occurrence can be calculated by using Gumbel probability accumulative functions [3, 4]. Three practical distribution functions have been used in this

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research. Two conditions should be set before using these functions:

- Number of each earthquake magnitude at the year should be reduced exponentially compared to the magnitude; this condition exists based on the Gutenberg-Richter equation.
- Earthquakes should be independent from each other; hence, statistics of aftershocks and foreshocks in large earthquakes that make second condition biased should be removed from seismic database in order to achieve real results and analyses when using mentioned functions.

Researchers have presented many other probability accumulative functions to determine final values of magnitude. These functions are described herein.

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2.3.1. *Probability Accumulative Function Type I*

According to Gumbel theory, if number of earthquakes is reduced exponentially per year (based on the Gutenberg-Richter relation) is reduced and aftershocks and foreshocks caused by a large earthquake are removed from the studied data and if there is not any earthquake that creates minimum or maximum magnitude (magnitude is without bound), then it can be stated that probability of magnitude of the largest earthquake per year is equal or lower than m (non-probability of largest earthquake) equals:

$$GI(m) = \exp[-\exp(-\propto (m-u))]$$

This accumulative function is called probability function type I in which, α and u are constant values.

In general, this function is used when upper and lower bounds are not clear for magnitude of earthquakes (earthquake peak). General form of this function for earthquake magnitude is as follows:

$$P(M \leq M_i) = \exp\{-C \times \exp[B \times (-M_i)]\}$$

$P(M \leq M_i)$ indicates probability of the largest earthquake is lower than or equal to M_i per year, which is statistically called lack of probability of an earthquake larger than M_i per year that is represented by q in this research.

B and C represent constant values that are calculated using linear fitting between q and M_s. To fit the issue, above exponential function should become linear so that required numbers are calculated by logarithm of equation sides. In distribution function type I, the fitting process is done between—M_s and $\mathrm{Ln}(-\mathrm{Ln}q)$. If this distribution function is considered for the seismic acceleration, then it will be:

$$P(a \leq a_i) = \exp\{-C \times \exp[B \times (-L_n a_i)]\}$$

$P(a < a_i)$ indicates probability of the largest acceleration caused by earthquakes per year (q) is lower than or equal to a_i. Estimation of earthquake recurrence interval are illustrated in Figures 1–24 for various conditions.

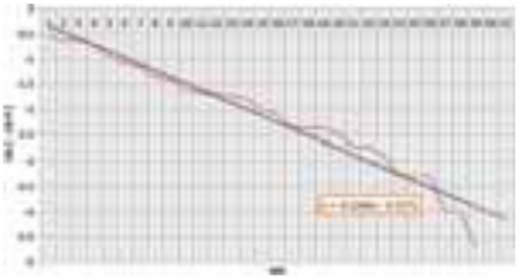

Fig. 1. Linear fit between earthquake probability and magnitude of surface wave to determine constant values of α and u in accumulative function type I.

The fitted line curve is illustrated in the Figure 1; accordingly, constant values are:

$$\propto = 12321$$

$$u = -1.921$$

According to this process and Gumbel theory type I, recurrence interval of different earthquakes can be estimated as Figure 2.

2.3.2. *Probability Accumulative Function Type III*

According to the Gumbel theory, if the conditions of type I exists (except for bounded earthquakes), then magnitude of earthquake per year may be lower than or equal to m that means lack of probability of the largest earthquake is as follows:

$$\mathrm{GIII}(m) = \exp[-C \times \exp[B \times L_n(m_{\max} - m)]]$$

This accumulative function is called probability function type III in which, C and B are constant values.

If magnitude of earthquake had upper bound of $M_{\max}$, accumulative distribution function of MS magnitude is defined as:

$$P(M < M_i) = \exp\{-C \times \exp[B \times L_n(M_{\max} - M_i)]\}$$

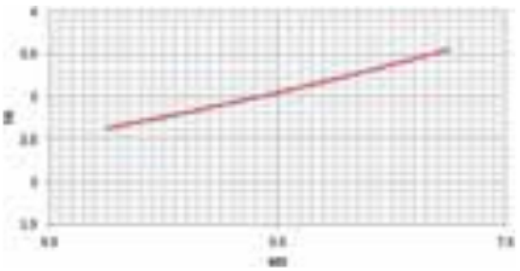

Fig. 2. Estimation of earthquake recurrence interval using accumulative function type I in Garmsar.

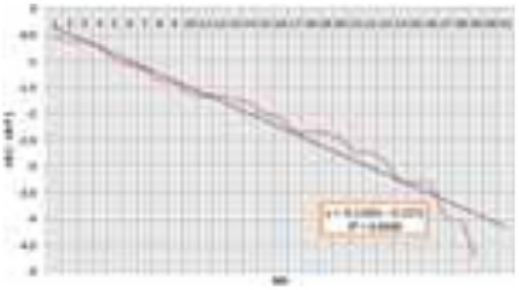

Fig. 3. Linear fit between earthquake probability and magnitude of surface wave to determine constant coefficients of B and C in accumulative function type III.

General form of this equation for seismic acceleration is written as follows:

$$P(M < a_i) = \exp\{-C \times \exp[B \times L_n(L_n a_{\max} - a_i)]\}$$

Where, linear fit is done between $\mathrm{Ln}(m_{\max} - m)$ and M_s considered maximum magnitude of 7.4 and B and C coefficients are:

$$B = -0.126, \quad C = 0.796$$

Figure 3 indicates fitted line; by setting above coefficients in the equation, following results are obtained:

$$Y = A + BX = -0.126X - 0.277$$

$$A = -0.126, \quad B = -0.277$$

$$A = \mathrm{Ln}C \dashrightarrow C = e^{-0.126} = 0.881$$

Now data obtained from past earthquakes can be used to calculate recurrence interval more accurately using Gumbel theory type III [5, 6].

2.3.3. *Probability Accumulative Function Type S*

This function is calculated by probability accumulative hyperbolic tangent function; function type I has two boundless sides and function type III has Lowe bound so is bounded from both sides [7].

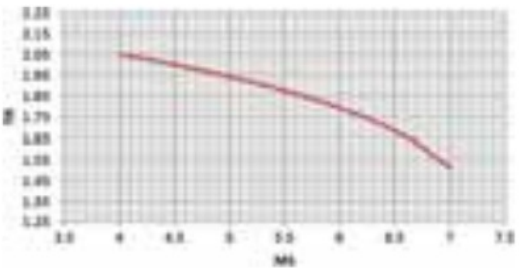

Fig. 4. Estimation of earthquake recurrence interval using accumulative function type III in Garmsar area.

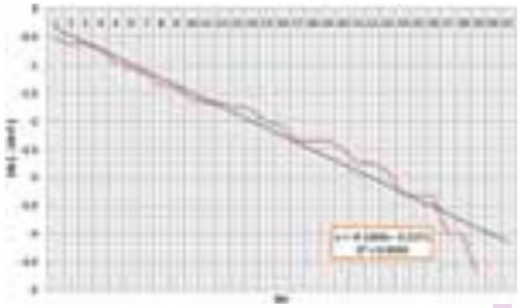

Fig. 5. Linear fit between earthquake probability and magnitude of surface wave to determine constant values of C and β in accumulative function type S.

Studies on past earthquakes have indicated that the best pattern is related to earthquakes with upper bound. For this reason, Howell introduced a function with maximum value of M_a. When $m < m_a$, the function is conformed to the probability accumulative function Type I and when $m > m_a$, then the function matches with an experimental form of hyperbolic tangent function. The probability that largest earthquake's magnitude per year is lower than or equal to m (lack of probability of the largest earthquake) equals:

$$G_S(m) = \exp\left\{-C \times \exp\left[\beta \times \frac{1}{2} \times L_n \frac{m_{\max} - 2m_a + m}{m_{\max} - m}\right]\right\}$$

This function is called hyperbolic tangent function. This function was introduced by Howell that is known as distribution function type S; this function is used when not only upper bound of earthquake ($M_{\max}$) is determined but also a critical point (M_a) exists.

For peak ground acceleration:

$$P(a \le a_i) = \exp\left\{-C \times \exp\left[\beta \times \frac{1}{2} \times L_n \frac{L_n a_{\max} - 2L_n a_a L_n a_i}{L_n a_{\max} - a_i}\right]\right\}$$

Seismic critical point is between maximum earthquake and tangible earthquakes (about magnitude of 5).

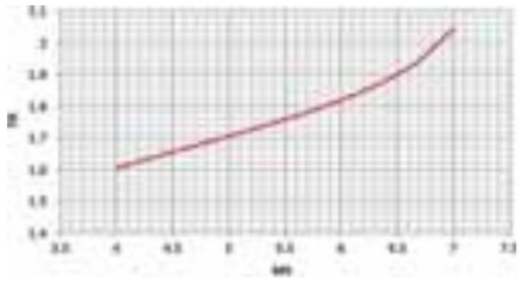

Fig. 6. Estimation of earthquake recurrence interval using accumulative function type S in Garmsar city.

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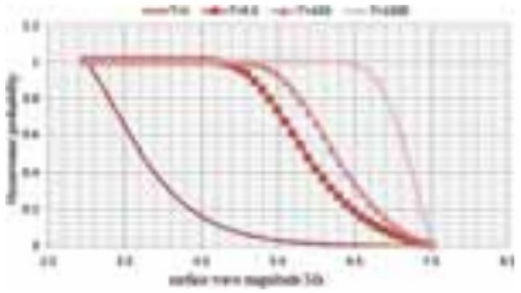

Fig. 7. Occurrence probability based on the surface magnitude within 200 Km area of Gramsar using Kijko method.

In this equation, linear fit is done by consideration of $M_{\max} = 7.4$ and $m_a = 5.0$ to determine constant coefficients of C and β. The fitted line is plotted in Figure 4. Coefficients are calculated as $a = -0.126$ and $b = -0.227$ ($y = bx + a$). This equation is rewritten by placing C and β coefficients:

$$1 - q = G_S(m) = \exp\left\{-C \times \exp\left[\beta \times \frac{1}{2} \times L_n \frac{M_{\max} - 2M_a + M_i}{M_{\max} - M_i}\right]\right\}$$

$$A = \mathrm{Ln}C \dashrightarrow C = e^{-0.126} = 0.881$$

Accordingly, Gumbel method type S can be used to calculate values of earthquake recurrence interval based on different magnitudes (See Fig. 4).

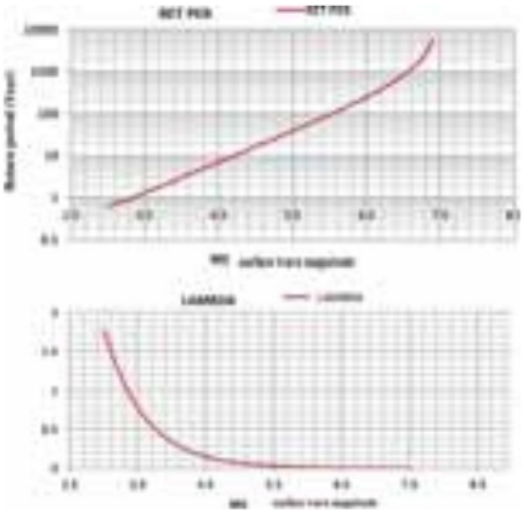

Fig. 8. Return period of earthquakes in studied area (surface magnitude) using Kijko method.

Fig. 9. Selected dots to determine uniform risk spectrum and PGA.

2.3.4. *Estimation of Seismic Measures Based on the Kijko and Sellevoll Method*

The proposed method by Kijko and Sellevoll (K-S)- and its completion by Kijko-Graham (K-S-B)—is useful for mixed and heterogeneous earthquakes and proper for seismic data of Iran. The applied functions in Kijko (2000) application includes distribution function of final values fit for earthquakes before 20th century that are usually large but inaccurate and distribution function of Gutenberg-Richter with two bounds for recorded earthquakes and use of statistical method of probable maximum estimation [8, 9].

In K-S-B method, historical and recorded earthquakes can be used simultaneously in order to categorize them based on different threshold magnitude error and maximum magnitude (see Fig. 5).

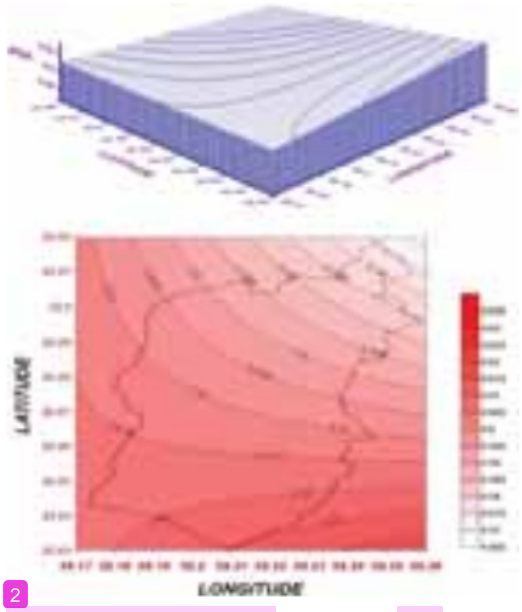

Fig. 10. Acceleration map at bedrock (PGA) with 2% occurrence probability in 50 years for Garmsar.

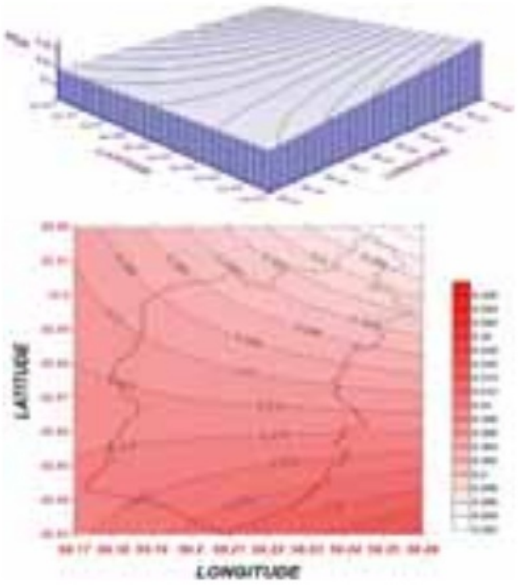

Fig. 11. Acceleration map at bedrock (PGA) with 10% occurrence probability in 50 years for Garmsar.

This method is useful for tectonic zones that have incomplete historical seismic data or do not have any historical earthquake. This method can be used to determine seismic measures including β and λ coefficients (seismic rate and velocity), to calculate maximum acceptable magnitude M_{max}, to determine recurrence, event probability and lack of probability for earthquake occurring, and earthquake magnitude in different time intervals.

This method considers time interval of earthquakes as varying component so that earthquake catalogue is divided to three periods including historical time (before 1900), instrumental type one (1900–1964) and instrumental type two (after 1964).

There are three earthquake categories in this method:
1. First category: historical earthquakes with magnitude error of 0.3, 0.4 and 0.5 magnitude unit for earthquakes with good, average and bad quality, respectively.

Fig. 12. Logic tree of spectral acceleration Sa (g).

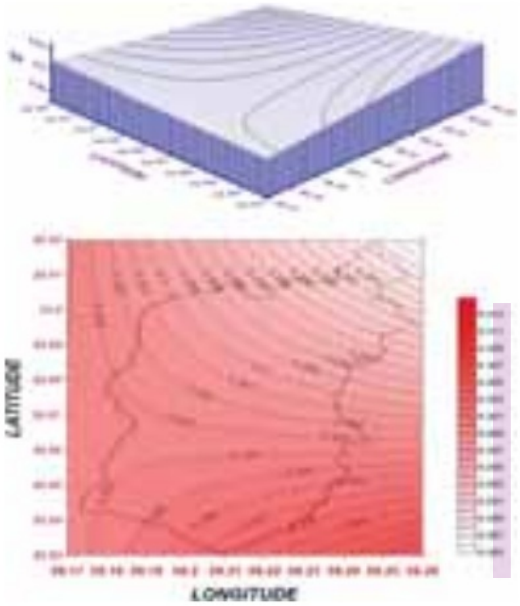

Fig. 13. Spectral acceleration Sa (g) map in 0.1 second and 10% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

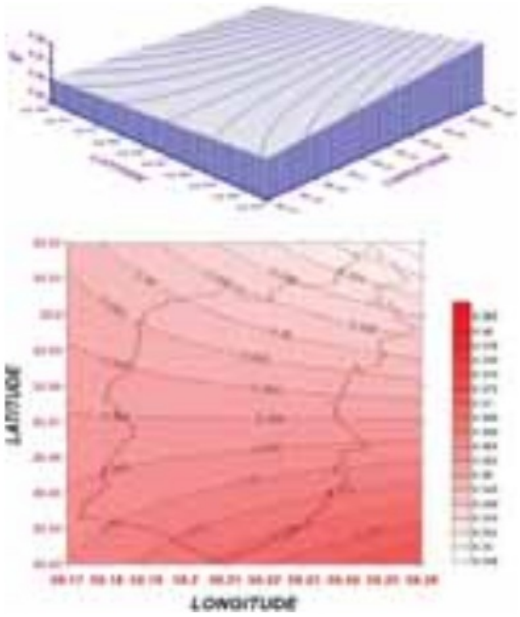

Fig. 14. Spectral acceleration Sa (g) map in 0.3 second and 10% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

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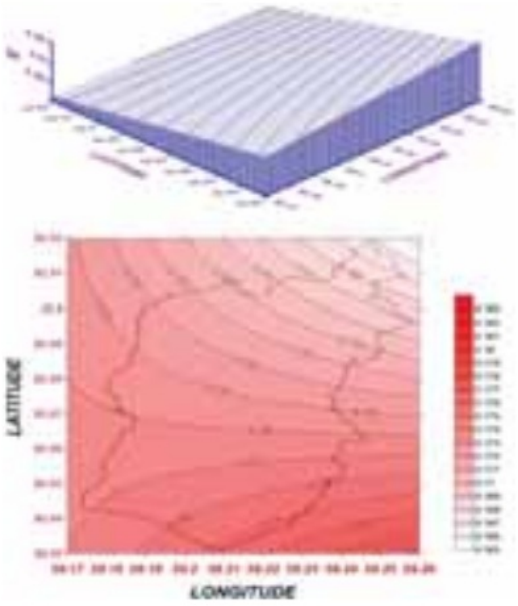

Fig. 15. Spectral acceleration Sa (g) map in 0.5 second and 10% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

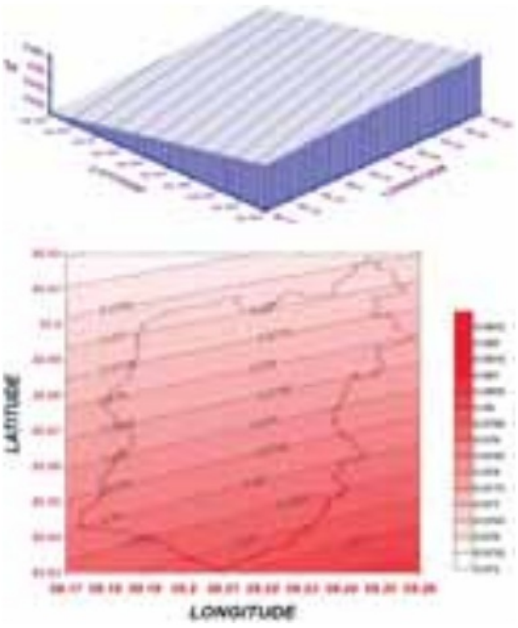

Fig. 16. Spectral acceleration Sa (g) map in 1.0 second and 10% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

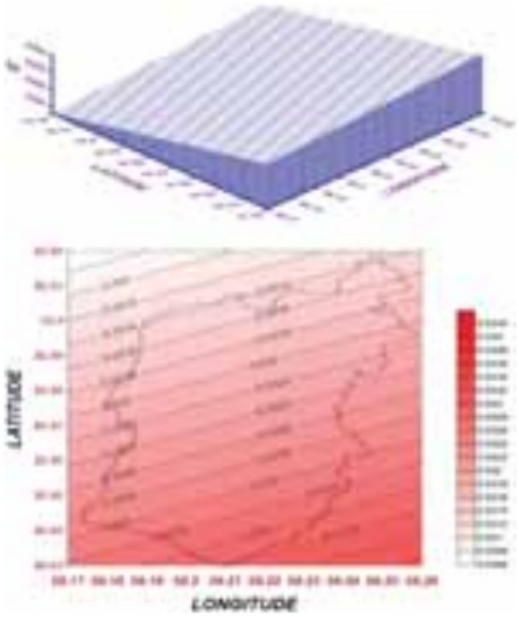

Fig. 17. Spectral acceleration Sa (g) map in 2.0 second and 10% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

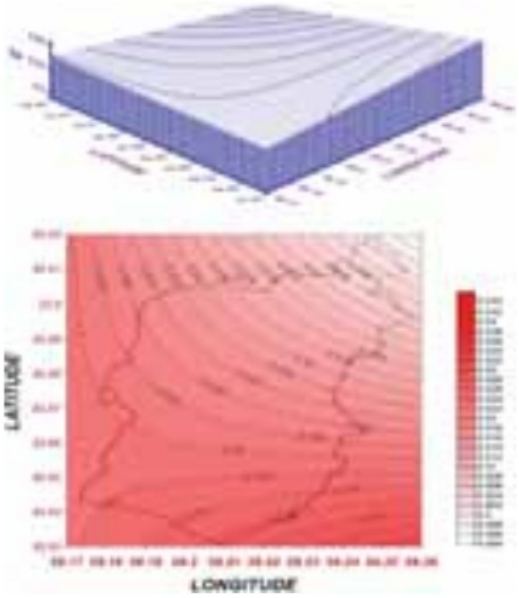

Fig. 18. Spectral acceleration Sa (g) map in 0.1 second and 2% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

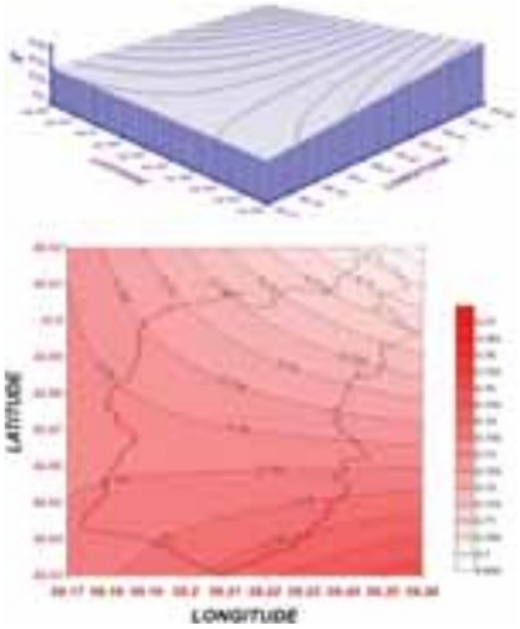

Fig. 19. Spectral acceleration Sa (g) map in 0.3 second and 2% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

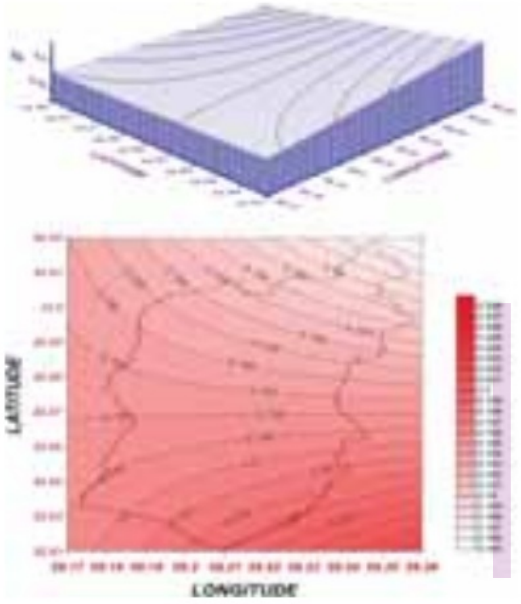

Fig. 21. Spectral acceleration Sa (g) map in 1.0 second and 2% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

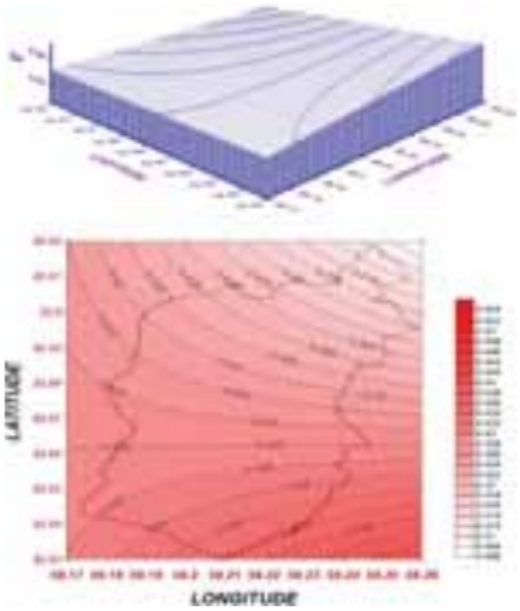

Fig. 20. Spectral acceleration Sa (g) map in 0.5 second and 2% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

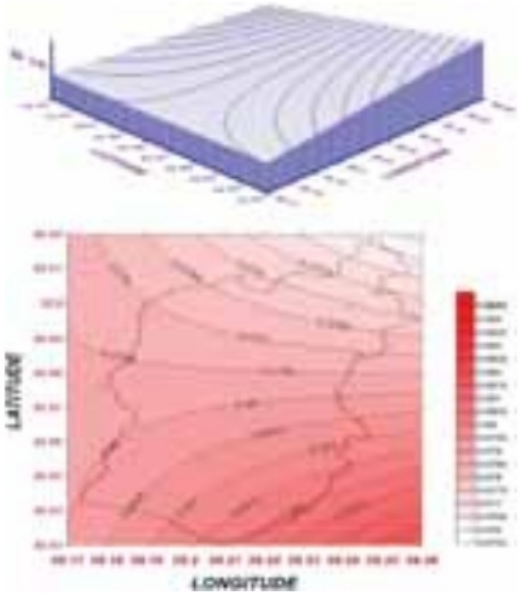

Fig. 22. Spectral acceleration Sa (g) map in 2.0 second and 2% occurrence probability in 50 years for horizontal component of soil type III Garmsar city.

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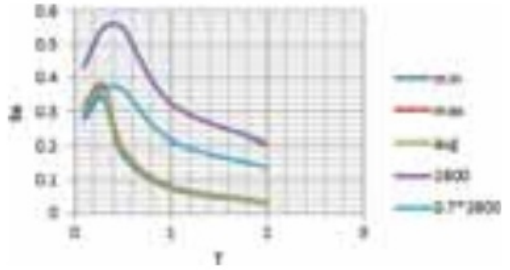

Fig. 23. Sa (g) uniform hazard spectrum of soil type III with 10% occurrence probability in 50 years in Garmsar city.

2. Second category: earthquakes in present century at the considered area are related to the period before installation of world seismic network (during 1900–1963) with 0.2 magnitude error and threshold magnitude of $M_s = 4$.
3. Third category: istrumental earthquakes have been recorded precisely with fewer errors from 1964 until now. Magnitude error of these earthquakes is considered to 0.1 and threshold magnitude of them equals to $M_s = 4$.

According to the above hypotheses and using the software designed by Kijko et al., seismic measures have been determined for the area of 200 km distance from city center of Garmsar as shown in Table I.

The maximum magnitude value expected was selected based on the maximum seismicity of 200 Km radial range and maximum expected statistical values using Kijko Method. It should be noted that maximum expected magnitude in Garmsar obtained to 8.1 ± 0.71 using Kijko Method (2000).

2.4. Estimation of Earthquake Return Based on the Probability Examination Method (Kijko Method)

As it was mentioned, accumulative distribution function of Gutenberg-Richter was used in this research and return period of earthquakes was fitted based on their magnitude within 200 Km radial range around the Gramsar City [10, 11].

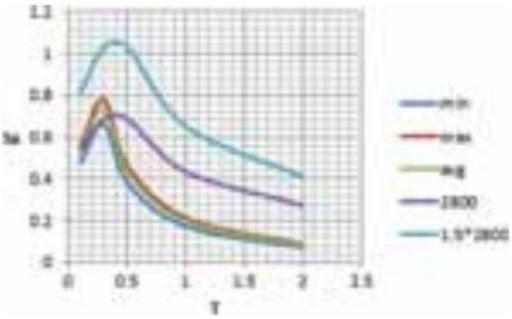

Fig. 24. Sa (g) uniform hazard spectrum of soil type III with 2% occurrence probability in 50 years in Garmsar city.

Table I. Results of Kijko (2000) (values of seismic coefficients).

Results
Beta = 1.49 + −.09 b = .65 + −.04 Lambda = 1.80 + −.32 for $M_{min} = 3.00$ $M_{max} = 8.10 + -.71$ for SIG(X_{max}) = .50

Table II indicates return periods of surface magnitude within studied areas so the relevant plot has been illustrated based on this information.

According to comparison between different methods used to determine return period of maximum magnitude, it is concluded that probability maximum examination (Kijko Method) is more realistic as not only accumulative distribution function of Gutenberg-Richter but also historical earthquakes have been used in this method.

It should be expressed that return period and magnitude of earthquakes have been calculated based on the occurred earthquakes in studied area using various statistical methods so they cannot be used as a correct measure to select earthquakes so they can be considered along with seismic sources in the area in order to identify the most important seismic scenario simultaneously.

The results obtained from Kijko Software indicate occurrence probability of earthquakes with different magnitudes compared to different return periods so these results can be used to plot occurrence probability-surface magnitude chart for various return periods (see Table II).

2.5. Estimation of Earthquake Return Period of Region

Average time interval between twice earthquake recurrence with magnitude of M is called "return period" (T_R) of the earthquake. Obviously, annual probability of earthquake occurrence (P) with magnitude of M is statistically defined as reverse value of earthquake return [12].

$$P = \frac{1}{T_R}$$

As all of probability functions of earthquake hazard only exist for accumulative frequency of earthquake number, return period and annual probability in aforementioned definitions also should be calculated based on the accumulative frequency of earthquake number with magnitude of M and higher magnitude. According to the mentioned definitions, earthquake return period is calculated as follows.

Table II. Parameters of seismic coefficients.

Catalogue	Parameter	Value	Contribution parameters (%) Data		To the
			<1900	1900~1964	1964<
Historical and	Beta	22.4	58.5	19.1	21.2
instrumental data	Lamda	1.80	10.4	22.4	67.2

If there are N_c numbers of earthquakes with magnitude of M and above within time interval of database collecting (T years), T_R (earthquake return period with magnitude of M and above) is calculated as follows:

$$T_R = \frac{T}{N_C}$$

According to definition of annual probability, we will have:

$$P = \frac{1}{T_R} \Rightarrow P = N_C \cdot T$$

Hence, it will be revealed that annual probability of earthquake occurrence is average numbers of earthquake occurrence in time unite (one year); it means:

$$P = N$$

Statistically, if probability of an event occurrence is P, lack of probability of that event will be $q(1-P)$. Therefore, lack of probability of annual occurrence (q) of an earthquake with magnitude of M and higher magnitude is calculated using following formula:

$$P = 1 - q$$

Lack of occurrence probability of an earthquake with magnitude of M and above means that either there has not occurred an earthquake ($M_i = 0$) or an earthquake with magnitude smaller than M ($M_i < M$) has been occurred. Therefore, lack of annual occurrence probability of an earthquake with magnitude of M and above was equal to annual probability of an earthquake with magnitude lower than M; so we will have:

$$q = P(M_i < M)$$

Different methods was used to estimate event recurrence period of earthquakes relative to magnitude of M_s; first, Gutenberg-Richter linear equation was used as the primitive method then some other modern methods was used based on the suitable distribution functions to calculate return period and related charts.

2.5.1. *Estimation of Earthquake Return Period Using Kijko Method*

In this method, accumulative distribution function of Gutenberg-Richter was used and earthquake return period was fitted based on their magnitude within 200 Km radial distance from the Garmsar city center.

3. ATTENUATION RELATIONSHIPS AND GROUND MOTION MEASURES

Attenuation relationship is a functional relation between earthquake characteristics (such as peak ground acceleration, peak ground velocity, etc.) or response quantities (such as spectral response values) and different parameters such as magnitude, local conditions of soil, site-source distance, etc. Although many of response values are useful, peak ground acceleration is more common in engineering applications. After describing effective parameters in attenuation of seismic waves, different forms of attenuation relationships used in risk analysis will be introduced [13, 14].

High acceleration may be hazardous but it causes few damages in many kinds of structures if its duration is short. Recorded motions of Earthquake that occurred on 27 June 1966 in Park Field Station could be a great example in this field. Peak ground acceleration (PGA) in this record reached to 0.5 g but there was not any serious damage to buildings due to high frequency and short duration of ground movements.

On the other hand, a movement with a relatively small range that keeps a monotone frequency for few seconds can create damaging movements in different movements. Such situation has been observed in damages to Mexico City buildings on July 28, 1957. PGA in central part of the city was estimated equal to 0.15 g–0.2 g. However, frequency properties and movements were enough for destruction of multi-story buildings.

3.1. Estimation of Ground Strong Motion Parameters

Ground strong motion caused by earthquake is expressed based on the different parameters, which describe effects caused by the earthquake. The most important parameters of ground strong motions include peak acceleration, velocity, displacement, and acceleration response spectrum or velocity in attenuation relationships that are used to evaluate earthquake risks and behavior of different structures toward earthquakes. As these parameters are determined based on the data obtained from important earthquakes occurred all around the world, new assessments are done in seismic measures after each important earthquake to design and estimate ground strong motion parameters for substantial structures such as large dams. Attenuation equations and relations are the most common and suitable methods for such estimation; the simplest form of these equations is ground strong motion that is expressed based on a function to magnitude and distance. According to the mentioned points and seismic studies of Garmsar, structure analyses are done based on the ground strong motion parameters and for horizontal component. Two deterministic and probabilistic methods were used to estimate these parameters at such informational level.

3.2. Effective Parameters in Attenuation

Seismic waves' attenuation depends on some parameters including source mechanism, wave movement (travel path) and local conditions that can be developed. For instance, source mechanism comprises some factors such as stress-strain conditions, rapture dimensions and depth of seismic source. Travel path includes some factors such as

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geometric spreading, reflection, refraction, adsorption and geologic structures; local conditions comprise subsurface conditions, topographic variations, and soil-structure interaction. Although it is theoretically possible to develop some relations that include abovementioned factors, few data of earthquake is a barrier to correct understanding of factors' effect; two factors of geometric spreading and adsorption are common ones in attenuation expressions.

3.3. Geometric Spreading and Adsorption

It is possible to have geometric spreading and adsorption in many of relationships as these phenomena have been recognized as well. The meaning of geometric spreading can be explained in relationships simply by energy conservation. Spherical Wave Front occupies more area as it progresses from a seismic source. According to law of energy conservation, amplitude of waves should be reduced followed by distance increase. Therefore, it is mathematically proved that wave's amplitude is reduced proportionally by $1/R^{\eta}$; where, R indicates distance and η is a constant value depending on travel path and geologic conditions. This expression is general, so some considerations should be taken for effects of some factors such as unusual geologic conditions.

Compared to geometric spreading, adsorption is more sophisticated. In general, adsorption occurs due to internal friction of the environment and waves scattering leading to destructive interference. Expression $Q = Q_0 \cdot f^n$ is used usually to create correlation between adsorption, frequency and rock properties. Large values of Q correspond to low adsorption and attenuation and vice versa.

3.4. Types of Attenuation Relationships

True form of attenuation function depends on the method used in inference or basic theory. Generally, this expression is shown in two forms. Various names have been used to name these two types. In this research, these relationships are called empirical and theoretical relationships.

It should be noted that these names are somewhat ambiguous as many of empirical expressions include parameters with theoretical based and many of theoretical relationships consist of empirical constants.

The distinction between these two expressions can be explained as follows: empirical relationships are calculated by using fit analysis methods for recorded earthquakes; while in theoretical expressions, earthquake physic and dependent mechanisms along with empirical constant are modeled directly. In some cases, it is difficult to distinguish theoretical expressions from empirical ones.

3.5. Selecting Attenuation Relationship

It is essential to select the suitable attenuation relationship in order to achieve reliable results within risk analysis; therefore, some points should be considered when selecting attenuation relationship:

- Most importantly, the applied relationship should spectral and peak spectral acceleration should be calculated based on various periods.
- One of most significant parameters in selecting attenuation relationship is that this relationship should be belonged to the area in which risk analysis is done. Therefore, this parameter can exclude many of existing relationships.
- Magnitude unit of attenuation relationship should be similar to used magnitude unit. The suitable magnitude unit and variations were done on it was based on the ground surface waves (M_s). Therefore, a M_s-based relationship was required.
- Area is one of effective factors that should be the considered area for risk analysis. In case of Garmsar, minimum magnitude was $M_s = 4$ and maximum value was $M_s > 7.5$.
- Distance area and relationship range should be higher than the considered range. Area of 200 Km was selected for Garmsar.
- Diversity of structure soil in the relationship should be matched with region soil so that region soil categories can be entered in the relationship.

According to the mentioned points and numerous spectral attenuation relationships, some relationships were found to achieve considered goals; these relationships include Ghodrati, Berge-Thierry, Akkar and Bommer, and Campbell and Bozorgnia. It should be noted that following attenuation relationships were used to calculate PGA in earthquake risk analysis of present report: Akkar and Bommer, Campbell and Bozorgnia, Ghodrati, Campbell and Bozorgnia.

3.6. Attenuation Relationships of PGA

Peak Horizontal Acceleration (PHA) is the most common range parameter in ground motion. PHA for each motion is the largest (absolute value) horizontal acceleration obtained from acceleration mapping. Vector addition of two components perpendicular to each other is done to calculate PHA. Ii is assumed in engineering applications that peak vertical acceleration (PVA) is two-thirds of PHA. Although peak acceleration is a useful parameter, it does not have any information about frequency content or duration of ground strong motion.

3.7. Attenuation Relationships of Peak Ground Velocity

Peak Ground Velocity (PGV) is one of significant parameters in describing ground motion range. As acceleration has lower sensitivity to higher frequency components of ground motion, it is more suitable than PGA at average frequencies for accurate description of ground motion scales.

In case of structure and installations that are sensitive to loading at this medium frequency range (such as tall or formable structures, bridges, etc.), PGA is more accurate indicator for destruction evaluation compared to PGA.

3.8. Attenuation Relationships of Peak Ground Displacement

Peak Ground Displacement (PGD) is usually along with motions of an earthquake at lower frequencies. It is difficult to determine these motions due to process errors in filtering or integration of accelerometers in a long period. Hence, PGD is less used compared to peak velocity and peak acceleration.

4. ANALYSIS

4.1. Case Study of Probabilistic Analysis of Earthquake Risk in Garmsar

The applied risk analysis method for Garmsar has been examined precisely in this part of study. According to data analysis and studies on active and quaternary faults as well as reliable collected seismic data, there are more than 100 linear seismic sources within 200 km area of Garmsar; map of active faults of seismic sources has been plotted considering uncertainties existing in determination of surface center and magnitude of earthquakes. Hence, those regions with similar seismotectonics where concentration and scattering of seismic events were observed in presence of active faults were modeled as seismic source; to increase reliability, models were determined using linear method alongside of active faults. Active faults of region are modeled spatially in many of seismic risk analyses then each spatial source is determined based on the presence density of seismic events and extent or length of the source is divided by subzones with similar lengths finally site-to-subzone distance is calculated.

It should be mentioned that location, length and properties of faults of the region exist in map of active faults and relevant Tables III and IV of the region. Using the designed software (PSHA), geographical location (latitude and longitude) should be entered to obtain length and distance.

4.2. Seismic Risk Maps

Seismic risk maps are changed through time by completing data associated with earthquake and identification of earthquake sources.

Common maps are designed based on probabilistic analyses and some risk measures and levels; most of these maps indicate PGA and or PGV showing probabilities of 2% and 10% for 50 years (with constant attenuation). As it was mentioned, PGA expresses acceleration rate on the rock (within 0 period) so PGA maps can be illustrated by calculating PGA of different locations and plotting some counters. The maps that have been usually used based on 2% or 10% of useful life of structures (50 years) are now replaced with spectral acceleration maps. As their name suggest, spectral acceleration maps indicate peak acceleration (ground motion parameter) in different periods with various occurrence probability and certain attenuation within different return period.

Table III. Probabilistic analysis of structures' risks in Garmsar.

Useful life of structure (year)	Risk level of structures (%)	Occurrence probability	Return period (year)	Peak ground acceleration (g)
50	2	0.000404	2475	0.65
	10	0.0021	475	0.32

All of aforementioned probabilities for PGA exceeding from a certain acceleration rate are considered for all of magnitudes and distances. It is assumed that earthquakes follow Poisson Process; therefore, probability of PGA exceed from certain acceleration level caused by an earthquake is calculated at first using mentioned relationships; then, annual exceedance probability is calculated using Poisson Model then earthquake risk chart is plotted.

4.3. Seismic Risk Maps Changes

Seismic risk maps are usually changed through time by completing data associated with earthquake and identification of earthquake sources. Common maps are designed based on the probabilistic analyses and some risk measures and levels; most of these maps indicate PGA and or PGV showing probabilities of 2% and 10% for 50 years (with constant attenuation).

As it was mentioned, PGA expresses acceleration rate on the bedrock (within 0 period) so PGA maps can be illustrated by calculating PGA of different locations and plotting some counters. The maps that have been usually used based on 2% or 10% of useful life of structures (50 years) are now replaced with spectral acceleration

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Table IV. Coefficients of spectral attenuation relationship (Ghodrati).

	Rock ground				Soil ground			
Period(s)	C_1	C_2	C_3	σ	C_1	C_2	C_3	σ
0.1	3.013	0.040	−0.788	0.240	2.454	0.294	−1.253	0.366
0.2	2.718	0.086	−0.710	0.228	2.092	0.302	−1.208	0.336
0.3	1.708	0.160	−0.421	0.232	1.973	0.336	−1.113	0.344
0.4	1.300	0.222	−0.480	0.277	1.648	0.363	−1.083	0.335
0.5	1.233	0.242	−0.600	0.283	1.337	0.392	−1.054	0.341
0.6	1.057	0.239	−0.566	0,304	1.138	0.424	−1.084	0.347
0.7	0.943	0.262	−0.630	0.285	1.015	0.430	−1.081	0.366
0.8	0.696	0.277	−0.576	0.294	0.840	0.439	−1.057	0.366
0.9	0.504	0.280	−0.513	0.285	0.696	0.457	−1.068	0.365
1	0.455	0.289	−0.546	0.277	0.548	0.463	−1.038	0.368
1.25	0.235	0.290	−0.503	0.296	0.249	0.521	−1.127	0.381
1.5	0.420	0.300	−0.693	0.304	0.031	0.554	−1.164	0.387
2	0.414	0.296	−0.774	0.336	-0.180	0.574	−1.218	0.396
3	0.407	0.312	−0.945	0.343	-0.372	0.611	−1.368	0.414
4	0.426	0.330	−1.096	0.374	-0.485	0.623	−1.437	0.436

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maps. As their name suggest, spectral acceleration maps indicate peak acceleration (ground motion parameter) in different periods of 0.1, 0.3, 0.5, 1.0, 2.0 seconds with various occurrence probability and certain attenuation within different return period.

In probabilistic method of earthquake risk analysis, ground strong motions are usually considered for different occurrence risk probability levels (different exceeding probabilities). Considering seismic rehabilitation guidelines for existing buildings, two risk levels were chosen:

- "Risk level-1": This risk level is determined based on the occurrence probability of 10% during 50 years that equals return period of 475 years. "Hazard level-1" is called "design basic earthquake" (DBE) in Iran's 2800 standard.
- "Risk level-2": This risk level is determined based on the occurrence probability of 10% in 50 years that equals return period of 2475 years. "Risk level-2" is called "maximum possible earthquake" (MPE) in Iran's 2800 standard.

The studied area should be reticulated for risk analysis before calculations. To this end, a 10×10 network or in other words 100 dots are placed on the map to cover the Garmsar City.

After reticulation using SEISRISK III Software, peak acceleration map at bedrock was determined for each risk levels (1 and 2) of these dots.

It should be noted that PGA maps at bedrock have been estimated for 10×10 network using Logic Tree Method and four different attenuation relationships that have been combined with calculation method of seismic parameters with different weights) for horizontal component at two risk levels 1 and 2.

4.4. Designed-Based Earthquakes of Site Area

After probabilistic analysis of earthquake risk and plotting site seismic risk curve using Poisson Model and based on the useful life of the structure and acceptable risk percent for structures' plan, design basic earthquakes are presented in following Table IV based on seismic risk analysis considering acceleration map at bedrock with 2% and 10% occurrence probabilities in 50 years for Garmsar.

As it was mentioned, DBE was selected for useful life of structure equal to 50 years and 10% risk. MPE was determined for useful life of structure equal to 50 years and 2% risk.

4.5. Determining Spectral Acceleration and Same Risk Spectrum for Garmsar

4.5.1. Design Spectra Based on the DBE and MPE

Response spectrum is used to design a structure and analyze it to reinforce it against earthquake. Response spectrum that design coefficients are extracted from it is called design spectrum.

Ground Peak velocity and displacement are usually calculated for the site estimated by peak acceleration. The values related to mentioned contribution could be plotted on a triple diagram (Fig. 5). As there are numerous variations in ground motion spectrum curves (caused by earthquake), while a simple spectrum is required for structure design to indicate reactive behavior of structure against ground motion, time intervals of the restructure should be separated to use specific diagrams for each design (see Figs. 6–24).

4.5.2. Standard Design Spectrum

Standard design spectrum is calculated by multiplying building reflection spectrum values (B) by design basic acceleration (A) [standard 2800]. Standard design spectrum for risk level 1 is calculated by multiplying coefficient 0.7 by spectral values of $A \times B$; moreover, standard design spectrum for risk level 2 is calculated by multiplying coefficient 1.5 by spectral $A \times B$ values.

4.5.3. Site Specific Design Spectrum

Site specific design spectrum is prepared to do calculations related to special building improvement based on the specific risk analysis for the site. Deterministic and probabilistic approaches were used for risk analysis in this research.

4.5.4. Spectral Acceleration Maps

As their name suggest, spectral acceleration maps indicate peak acceleration (ground motion parameter) in different periods with various occurrence probability and certain attenuation within different return period. In this research, analysis was done based on the 2% and 10% occurrence probabilities during 50 years and 5% attenuation in different periods of 0.1, 0.3, 0.5 1.0 and 2.0 seconds using attenuation relationships of Akkar abd Bommer, Campbel and Bozorgnia, Berge-Thierry and Ghodrati.

4.5.4.1. Spectral Attenuation Relationship of Ghodrati. In Ghodrati spectral attenuation model, parameters of magnitude and distance are considered directly in attenuation model. Moreover, effect of bed type, faults mechanism and tectonic conditions are included by classifying data to different groups and obtaining models for each group.

The obtained models for Zagros area, Alborz and Central Iran are obtained for different site conditions for S_a parameter.

Some data with focal distance of $5 < R < 200$ km have been used in this model; magnitude equals $4.5 < M_s < 7.5$ based on the surface wave.

Site conditions of rock can be corresponded to shear waves' velocity equal or above 375 (m/s) and site conditions of soil can be corresponded to shear wave velocity lower than 375 (m/s).

$$\log(S_a) = C_1 + C_2 M_S + C_3 \cdot \log(R)$$

In this relation, SA is based on centimeter per S^2.

4.5.4.2. Spectral Attenuation Relationship of Cambell. Complete definition of this attenuation relationship may be seen in empirical attenuation relationships of near-source for horizontal and vertical arrays of peak ground acceleration and spectral acceleration virtual factor. Present relationships have been obtained from previous attenuation relationships corrected by the author during 1990–1994. According to researches on soil mechanics laboratory of Semnan Province and results of geotechnical studies on several regional water organizations in different place of the city, soil type of this region is type III based con the soil categorization in standard 2800.

4.6. Uniform Hazard Spectrum

As the name indicates, a uniform hazard spectrum (UHS) is formed as a response spectrum that is related to spectral lengths with similar occurrence probability. Steps to form UHS are as follows:

1. Obtaining seismic hazard curve (SHC) for different spectral lengths; it should be noted that all of curves should be based on a constant attenuation level and different frequencies (for instance, $f = 1, 2, 5, 8, 10, 25$ HZ); in addition, SHC should be obtained for PGA (for period 0).
2. The considered hazard level should be selected (for instance, an annual occurrence probability $\lambda = 0.001$).
3. Considering the λ value (annual occurrence probability) on Y axis and hazard curves and corresponding X value (that is ground motion parameter) for each curve, the result of this step is a set of values including Sa (f_2, ζ_c, λ), Sa (f_1, ζ_c, λ), PGA (λ), etc.
4. Dragging a graph in which Y-axis indicates acceleration and X-axis indicates frequency. Sa (f_2, ζ_c, λ), Sa (f_1, ζ_c, λ), ... values are shown in this graph. The result obtained from this step is a UHS curve indicating constant attenuation level (ζ) and a constant uniform level of hazard (λ).
5. UHS curves can be illustrated for different attenuation or hazard levels. UHS curves indicate that reduction in hazard level (annual occurrence probability) leads to increase in UHS based on the UHS curves.

To estimate possible earthquake damages, possible earthquakes in the region should be estimated. To this end, spectral analysis of earthquake hazard in region should be implemented. As PGA indicates acceleration of rigid object ($T = 0$), it cannot meet the need for design of structures with different periods (in particular, structures with high periods). Hence, detailed examination of structures' behavior and formulation of design guidelines make it required to illustrate spectral maps; hence, these maps are formed to use in design guidelines in United States, Canada and some other countries; in this regard, they are testing in NEHRP guideline.

5. CONCLUSION

Following PGA on bedrock was obtained by analyzing earthquake risk using probabilistic method:

1. PGA with occurrence probability of 10% in 50 years (475-years return period or hazard level 1 of seismic improvement guideline of existing buildings) in Garmsar City varies between 0.28 g and 0.34 g; this value is determined to 0.3 g in standard 2800 (PGA with 10% occurrence probability during 50 years in Garmsar can be 0.04 g higher than the guideline).
2. PGA with occurrence probability of 2% in 50 years (2475-years return period or hazard level 2 of seismic improvement guideline of existing buildings) in Garmsar City varies between 0.55 g and 0.65 g.
3. Uniform hazard spectra indicate that horizontal spectral acceleration has the highest value within 0.1 and 0.3 seconds periods so that an increased spectral acceleration is seen in 0.3 s period then a gradual reduction of spectral acceleration in spectra. This point can be seen in reflection spectrum of Iran's standard 2800.
4. Spectral acceleration maps, in particular uniform hazard spectrum should be prepared using a fixed hazard level; in this project, these maps were prepared for different 2% and 10% occurrence probability levels in 50 years useful life of structure. Therefore, seismic hazard is fixed at each period of this spectrum contrary to other spectra and this helps designer to design at different hazard levels. Therefore, designer can have horizontal spectral acceleration using uniform hazard spectra at each location of studied area and any required period with certain seismic hazard level.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5347–5351, 2019

RESEARCH ARTICLE

The Analysis of Application Information System as e-Business GO-BABY Application of Child Care in Bandung

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The purpose of this research is to provide solution by approach through analysis about the problem by homemakers who have children. The condition of being happens is limited have time in childcare are responsible for a woman and limited childcare in Bandung City. As for research, methodology is based on method action research, in the first year the interview, observation, documentation, and processing statistical data. Research methodology will produce calculation statistical housewives data, the problems, then solution in solving problems of application design mobile of GO-BABY is reservations online for child care based on android, and iOS, and does that which is the integration data to centralized system.

Keywords: GO-BABY, Online, Application, Android, iOS.

1. INTRODUCTION

Child care information system is a system was a collections of information through the creation of a system for the purpose help in providing facilities in child care though service functions an application in facilities mothers/woman in doing child care. Information systems is necessary to provide solutions to problems that occur. Some making especially for information systems, that supporting information systems for children includes analysis and design in-patient information system in hospital, are the role of mother and children hospital is the saying this is the provision of the service the child health, mother, and the public in general, to help the hospital in data processing administration for health services to maternal and child [1], however analysis which was built by only to the hospital in resolving the hospital administration while those directly felt its benefit by mother or woman in the city of Bandung. Information system such as health services to patients through Information System Outpatient information system web-based for Clinic Winong where can help the performance of clinic in data processing patients and preparing reports community health [2]. These information systems except used for clinic, system established by only based of web and inaccessible directly by public who uses health. The two article it is give prominence of services to the public but cannot to give direct application that can be accessed by the public.

Therefore, this research built through problems that could support the creation of a system information for a child care through application that can be applied in public, this research would give a big impact directly easier application usage required based on the problem. Through this application based on the design of the technology that is had previously existed developed and used for mothers or woman in the city of Bandung by providing services facilities childcare and nursery which will be built, so that mothers or woman can be increasing productivity household welfare in there life.

2. THE MATERIAL AND METHOD

In this research, the method applied as a step in making analysis design this application as shown in Figure 1 [3, 4].

2.1. Year 1

Analysis data is research qualitative was conducted through procedures the development of a pattern, theme, and the characteristics of common [5].

This stage consists of activities:

1. *Interview*:

Interview is data collection method or tools data collection that shows research as the person interviewing had some questions at participating states as the subject who were interviewed [5].

Activities conducted to public around Bandung in this is interview to mothers/woman in Sekeloa

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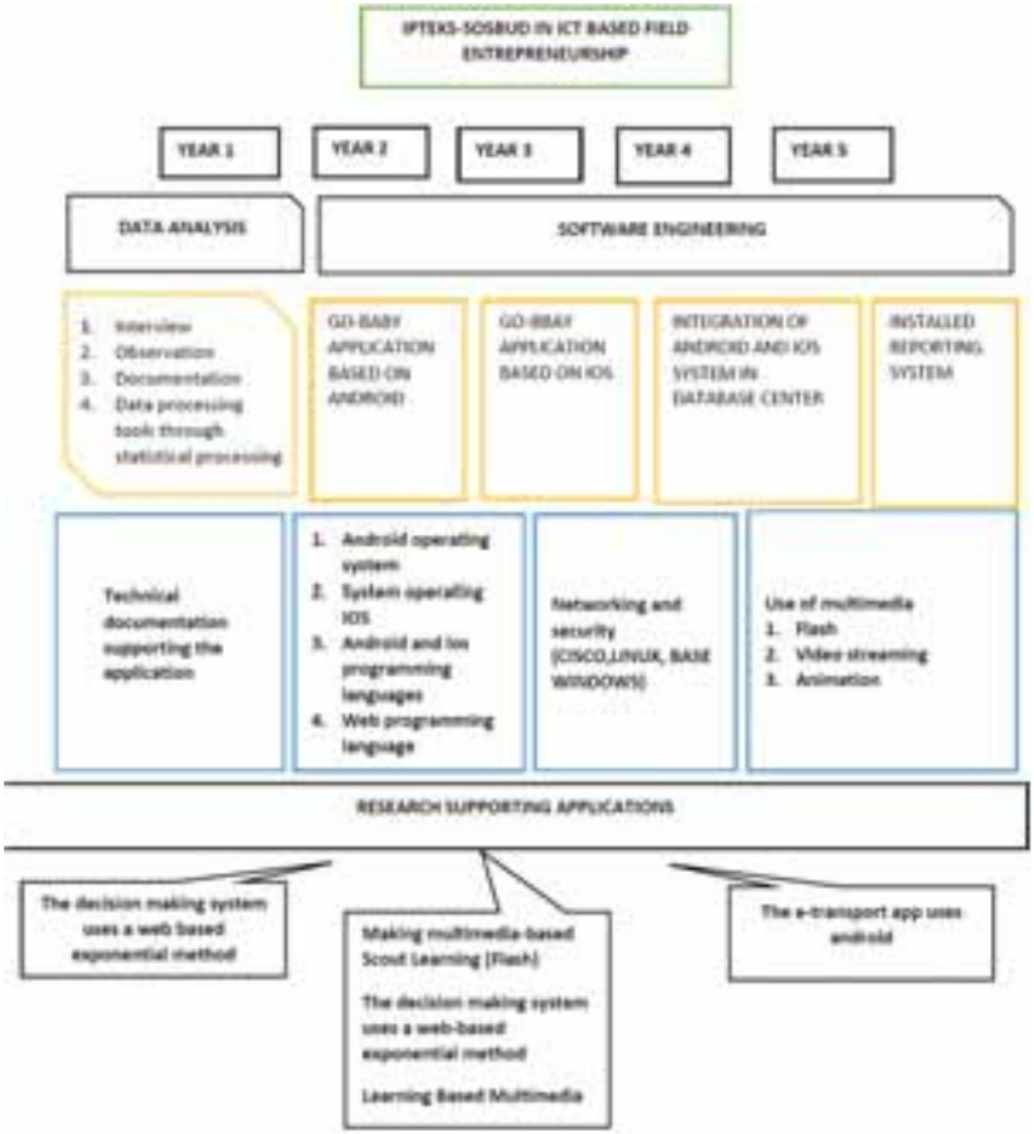

Fig. 1. Research methods.

Bandung, general questions that most asked is about the problems the constraints that is experienced in being a housewife and housewifes who may also be employed.

2. *Observation*:

This activity is very important to know the location where they who have problems, so it can be an example for the application that will be built.

3. *Documentation and statistical data*:

Based on documentation and the statistics or on numbers of women in Bandung whose work can be seen in Table I.

At the Table I show increasing about women work West Java and it can be ascertained data every year will continue to increase until this 2017, so level of needs more higher in Bandung city.

Table I. Increasing women work west Java.

Year	Amount
2002	1.062.568
2003	1.041.366
2004	1.117.620
2005	1.098.624
2006	1.137.410

Source: https://jabar.bps.go.id/.

2.2. Year 2 and Year 3

This activity is the technique where activities to make application on demand public especially they using applications built overarch 2 consist of:

(1) *Android*

Android is an operating system for mobile device based linux which includes operating system, middleware and application. The android application who developed using java and easily scaled them out to a new platform. Developed in various operating system, of them are: Windows XP/Vista/7/8/8.1/10, Mac OS X (Mac OS X 10.48 or later) and Linux [6].

Making application will be made application based android, devoted because the average mobile users in a Bandung city is based android so intended to ease application can be downloaded.

(2) *iOS*

iOS is an operating system developed by cellular phone Apple company for iPhone, but evolved to can be used with tools apple to other like iPod Touch, Apple TV and iPad. This operation system is are private and just only be utilized by an Apple device [7].

Some women career in Bandung city used the cell phone basing iOS. So this design covering iOS based program.

2.3. Year 4

(1) *Web Service*

Web service is used for the management application in this matter is part of admin. Where admin will manage data and function that is in application, both in added, replace, remove, and reduce data [8].

(2) *Microservice*

To adjust programming language and technology and function (facilities built) will use mircoservices so applications can play quickly and accurate [9].

(3) *Architecture Framework*

In making this application built architecture framework so that commonly modules function application can be well integrated [10]. Next architecture framework to be built for application is presented in Figure 2. Architecture framework.

2.4. Year 5

In this case goal is made centralized reporting any activity undertaken by all systems or recorded data on the system will be created reports automatically so that it is illustrated all the data surrounding each part.

The report to be made is divided into 3 parts is

(1) *Incoming report*:

This report covers the number of data acting as child nursery, data on the number of they who entrust children, data on the number of children entrusted. Data on child care services, child care data.

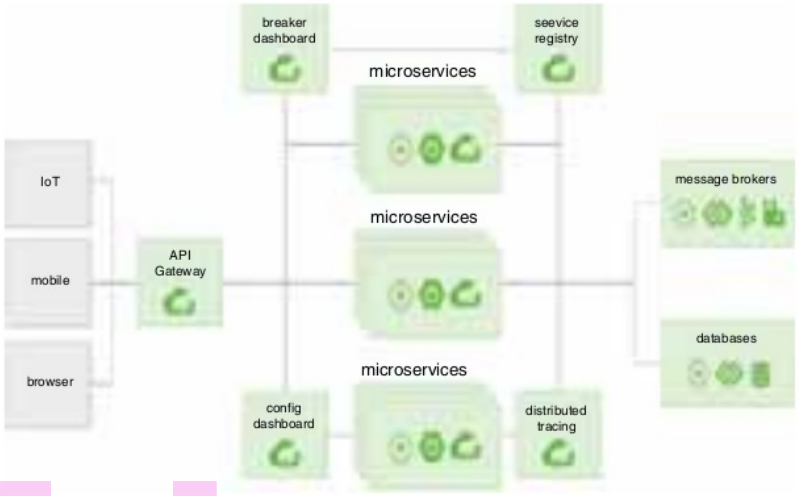

Fig. 2. Architecture framework.

(2) *Outbound report*:

This report consists of data on the number of services used by them, child care data, customer complaints/complaints data.

3. RESULTS AND DISCUSSION

So based on the research will be build problem of this research can be explained through Figure 3.

3.1. Troubleshooting Proposed

Placement applications is intended because the problem in the greater Bandung, among others:

(1) *The amount of increase in woman career in Bandung*.

Of needs and price basic needs which requires the housewives/woman provide time to working to help their families [11]. For the data woman career Bandung presented Table II.

(2) *To restrictions in child care*.

Ascertained if a woman have to work, so many of the other problems what emerges is who and how to child care, if have a family, then the impact of this is that has been a problem prolonged in a family [12].

(3) *The limited child care and facilities nursery*.

The solution which is in the community and submit they child to baby sitter is apparently causing new problem who makes woman/households do not believe or fear submit they chid, because many cases that occurred in the town of Bandung, about child abuse, kidnapping and other. This is excuses the absence of insurance legally about services for children [12].

Fig. 3. Proposed troubleshooting flow.

Table II. Increasing women.

Year	Number of households (thousand)
2002	10207
2003	10545
2004	11324
2005	10185
2006	10364
2007	10556.2
2008	10708.1
2009	10860.7
2010	11540
2013	12104.3
2014	12244.2
2015	12415.4

Source: https://jabar.bps.go.id/.

3.2. Application Proposed

From trouble above then the researcher plans to design application for the purpose of among others:

1. Providing some facilities in the form of GO-BABY application that provide services to the community especially career woman and housewives in the problem of between the division of working time and responsibility for the children.
2. By the presence of application GO-BABY so it can improve the integrity of career woman and housewives in order to maximize its performance in the company or place in work.
3. Give job opportunities to public especially Indonesian woman who do not have job or provided additional income.
4. Can increase regional income and reduce unemployment especially for the government west java.

3.3. Roadmap Research

At the time of building the system needed a roadmap research to build the basic concept of making the system.

3.3.1. First Years

a. Problem formulation and needs analysis

In making problems based on the problems that occur in the community of West Java, especially for those in the city of Bandung so that researchers can describe what are needed in answering the problems that occur in society.

b. Study of literature

The literature study conducted is to conduct comparative observations through direct visits to the community and search for supporting data through the source of books and libraries.

c. Data collection.

The resulting output is as follows:

1. Analysis of the system of making the application of IS/IT at the previous college.

This process is required as a benchmark for measuring existing systems, and to what extent community needs are well realized.

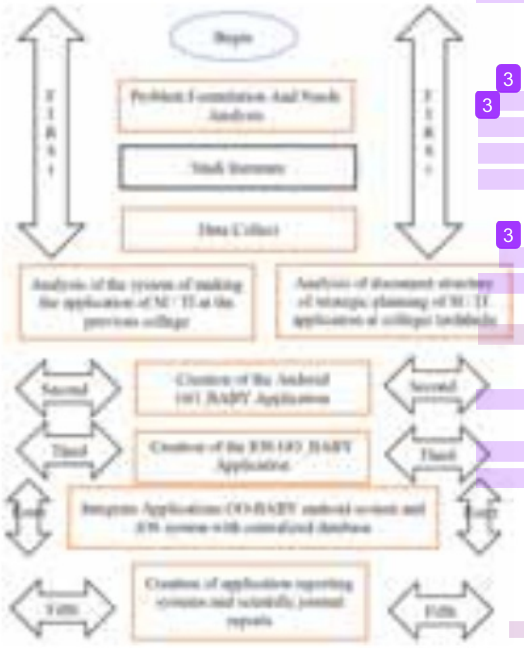

Fig. 4. Roadmap research.

2. Analysis of document structure of strategic planning of IS / IT application at college.

Create lists of IT/Application technologies tailored to the existing problems so that the technology used is the most recent technology, which takes place in a real society.

3.3.2. Second Year

This year, the Android GO-BABY Application Development phase. This is done because people are generally already using mobile applications, so this creation has an impact on the ease of the community in accessing the application. So it can be used directly by the community.

3.3.3. Third Year

In this year's GO-BABY Application Generation stage. This is done because people are generally already using mobile applications, so this creation has an impact on the ease for community in accessing the application. So it can be used directly by the community.

3.3.4. Fourth Year

The year in which it will integrate GO-BABY android system application and iOS system with centralized database. If previously the application separated its data storage. So for improvements are both applications are built through a centralized storage so that the data generated can be made data intact and accurate.

3.3.5. Fifth Year

a. Report Creation

After the integration is successful, the last step is the creation of an application reporting system, the goal is that the resulting report can provide useful information for the community or as a community evaluation to the system that has been applied.

b. Scientific Journal Report

Scientific Journal Report is conducted so that the system built into one solution that can be pursued by the community as a solution that made the answer to the problems that occur especially for child care issues.

Acknowledgment: To thank DPRM DIKTI Directorate of Research and devotion to the public education and culture ministry as it has been granted the funds for this research activity, and to UNIKOM who are willing to participate in providing support facilities for the research activities.

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Received: 2 November 2019. Accepted: 14 November 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5352–5359, 2019

RESEARCH ARTICLE

Coral Reef Cultivation Through Online Donations

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The amount of damage to coral reefs caused by human activities has an enormous impact on human life, then with that there must be conservation of reefs to preserve coral reefs in Indonesia, involve the Department of Fisheries and Maritime must play an important role in providing solutions to these problems. The role of the Institute can be done by conducting the cultivation and supervision of coral reefs. The cultivation can be done by making online donations to coral reefs. That way the community will participate in preserving coral reefs. However, facilities for serving online donations are not yet available, then this research is focused on making the system. The system will serve a donation system through the purchase of coral reefs and implanted by a diver agent at a specified location of coral reefs. This donation system was created using a structured approach in analyzing problems that occur in making the system to be built. The existence of this system will facilitate the community to participate and increase public awareness in cultivating coral reefs.

Keywords: Coral Reef, Donation, Online, System.

1. INTRODUCTION

Donations are humanitarian activities aimed at the needs of social activities, so that donations become an important part of society. Many activities can be supported by donation activities. In Indonesia, the level of community awareness of donation activities is quite high, as long as these activities are useful activities for the community [1]. With the technology, services can be done online. The word Donation Online is a sentence that is currently developing in society, from the use of technology, donation activities can be done via transfer from various banks [2]. This is a benchmark for research on coral reef cultivation, which is how to create community participation in conserving coral reefs. The previous studies supporting the research were the technology of coral reef conservation and rehabilitation [3] which says that the supply of coral reefs in Indonesia has dropped dramatically due to human activity, and there is no government control over coral reefs in Indonesia. In this study describes the technology applied to coral reefs such as artificial coral reefs and transplanting. But in this research, there is no role and involvement of the community in conducting coral reef cultivation. Dynamic System Effect of Seaweed Cultivation and Population on Coral Reef Degradation [4]. In this study produced how the role of seaweed on the coral reefs in Poteran-Madura Island, the existence of seaweed cultivation conducted by fishermen then had a major effect on coral reefs. As a result of pressure from the amount of seaweed cultivation, the clear waters (quality) no longer fit the requirements for the growth of coral reefs. In this case the coral reef is only as a fulfillment of the needs of the community, especially fishermen. However, there is no replanting activity of coral reefs that have been used. Other research is the Socio-Economic Study of Communities in the Utilization of Coral Reefs in Tumbak Village, Southeast Minahasa Regency [5], in this study discusses the excessive use of coral reefs that damage coral reef ecosystems, which are used as a food source and as building material, the damage data is presented through questionnaires but this research does not discuss how to deal with the damage that has occurred. Therefore, based on previous research, research should focus on coral reef ecosystems, namely by conducting coral reef aquaculture that involves the wider community by applying technological assistance in the form of online donations. It aims not merely to rebuild coral reefs. However, educating the public that coral reefs are very important in aquatic ecosystems. The community is expected to not only participate through online donations, but also participate in preserving coral reef sustainability through insight/knowledge of coral reefs. To support this online donation research, it is necessary to involve the Department of Fisheries and Maritime Affairs with the aim, among others:

1. Apply online donation technology through the purchase of coral reef seeds that will be planted in locations that have been determined by the Fisheries and Maritime Services. In this case the area that has damage to coral reefs.

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1546-1955/2019/16/5352/008 doi:10.1166/jctn.2019.8615

Fig. 1. Research method [6, 7].

2. With online donation technology, people will be more concerned with coral reef cultivation.

2. RESEARCH METHOD

To build an online coral reef donation, a research method is needed to solve the flow of problems that occur, especially in the Department of Maritime Affairs and Fisheries. The method used uses a structured approach with descriptive flow. The research method can be seen in Figure 1.

The purpose of this research is to produce an application in the form of an online donation application. The stages in building this application consist of:

1. Identify system requirements This identification includes problems that occur on coral reefs, so that it can be used as a basis in building applications. This identification also involves system problems that are running in the Department of Fisheries and Marine Affairs itself related to coral reef problems and related technologies that support online donation applications [8].
2. Make Prototype. This stage is the stage of building the current system design, then analyzed to produce a system that will be proposed based on the needs that exist in the Department of Fisheries and Maritime Affairs. This prototype consists of functions built into online donations, such as donation methods in the form of payments, nursery locations and coral reef nursery evaluation functions [9].
3. Testing. Testing is done so that the application is functioning as expected, this test avoids errors of procedure, function or mechanism of making the program.
4. Research Evaluation. So after testing is done, the evaluation phase needs to be done to improve the application that has been made. The evaluation was also carried out by discussing with the Fisheries and Maritime Affairs Office and

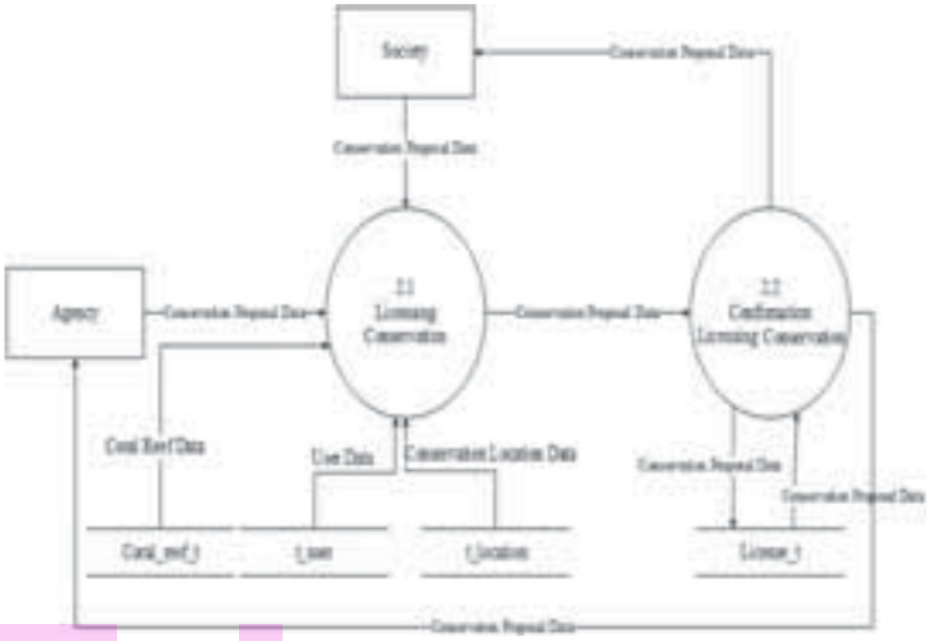

Fig. 2. DFD conservation licensing [10].

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also to the community as the main parties directly involved with the system.

5. Implementation. When implementation needs to be considered, because when the application will be published online, it must be estimated regarding the capacity of the data needed, the speed in processing data, and the speed in accessing applications. And this online donation application data security system is also needed.

3. RESULTS AND DISCUSSION

The purpose of making this application is to provide a clear picture and is expected to help these users to be able to see the function of conservation licensing, preserve coral reefs by means of online donations, and conduct an assessment of coral reef conservation. The involvement of users includes individual communities, agencies and the Office of Fisheries and Maritime Affairs itself.

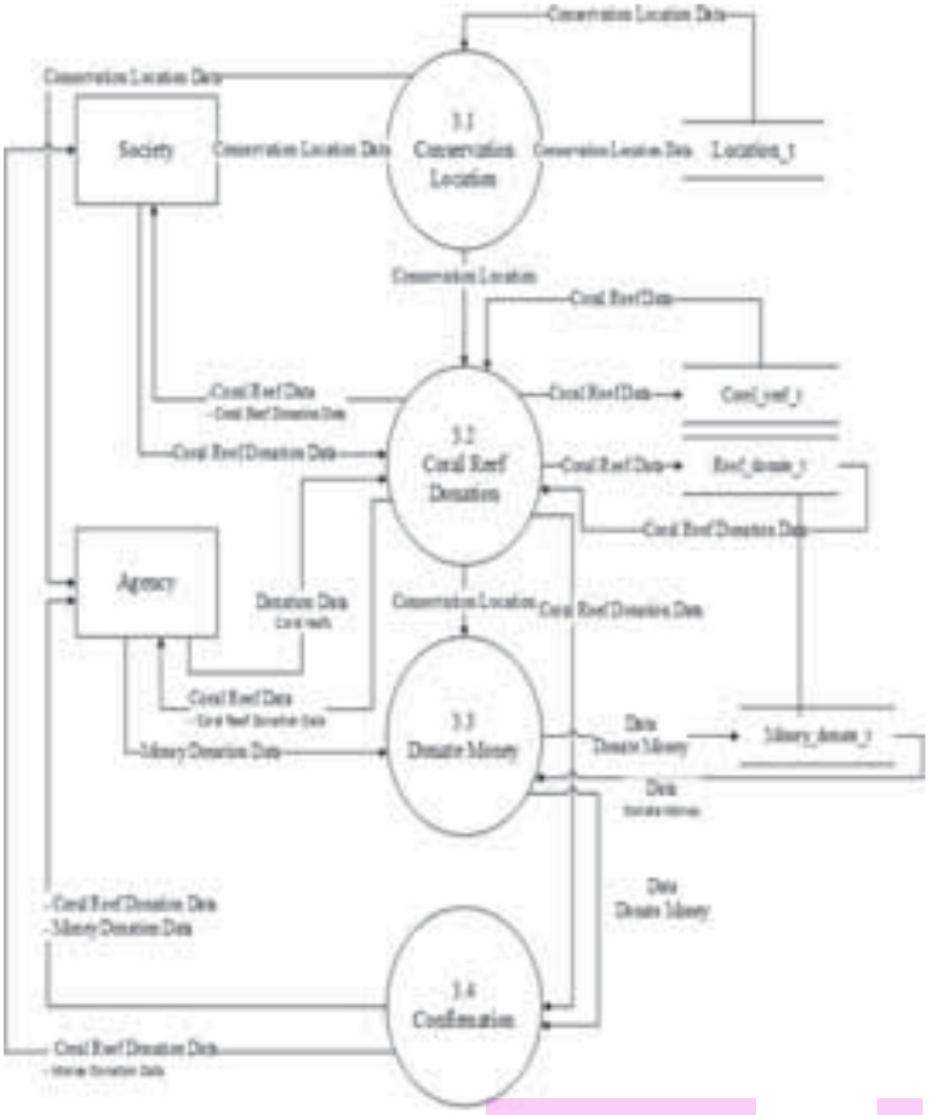

Fig. 3. DFD online donation.

The design consists of drawing through DFD, ERD, Table Relations, File Structure.

3.1. DFD (Data Flow Diagram)

3.1.1. Conservation Licensing

This process aims for people who want to carry out aquaculture directly in a predetermined location under the supervision of the Fisheries and Maritime Affairs Office. All procedures in conservation licensing will be carried out online, including in terms of administration especially for the document requirements that must be completed. The procedure for licensing is:

1. Incoming proposal from the agency or community regarding conservation.
2. Letters received by the staff of the letter section that handles incoming proposals.
3. Proposals are recorded and given serial numbers and attached disposition sheets.
4. Proposals that have been recorded in the personnel section of the letter are given to the head of department.
5. The head of the office proposes the proposal in accordance with the subject letter to the field and the sheet is signed by the head of the office.
6. Proposals that enter according to disposition are derived from echelon 3 officials to their lower echelon, namely echelon 4, in this case, the signature of echelon 3.
7. The next composition is echelon 4 to the staff in this case the signature of echelon 4.
8. Recipient of the last disposition, namely staff who will identify to the field.
9. The identification report will provide an analysis that the activity can be continued or not.
10. If the staff does not make an identification report that the activity cannot be continued then it is given to the staff of the letter section after which it is filed and then the staff of the letter section informs the public or the institution cannot be continued.
11. If yes the staff section makes a work plan and budget report and then it is given to the personnel section of the letter after it is archived and then the staff section tells the community or agency that the proposal can be continued.

3.1.2. Online Donation

Online donation process can be seen in Figure 3,

There are 4 stages that will be carried out by the community or agency, namely:

1. Conservation Location Determine There are 4 stages that will be carried out by the community or agency, namely the location of coral reef nurseries based on maps/locations. Maps/locations will be displayed based on the area under the supervision of the Department of Fisheries and Maritime Affairs. In this case the location is a location that really needs coral reef cultivation.
2. Coral Reef Donation Communities or agencies can participate by being involved in providing coral reef seeds that are already owned or making purchases from seeds provided by the Fisheries and Maritime Affairs Office.
3. Donate Money. The form of donations can also be in the form of a sum of money that can be transferred to the Department of Fisheries and Maritime Affairs, which will later be allocated to procure coral reef seeds [1, 2].

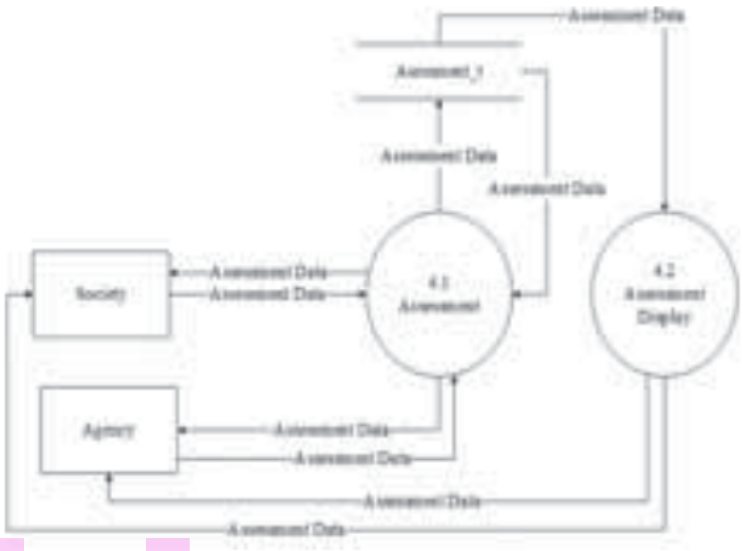

Fig. 4. DFD assessment.

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4. Confirmation. After the coral reef donation process or a donation of money, the community/agency will receive a message in the form of a confirmation from the Fisheries and Maritime The Department, that the process has been successful.

3.1.3. Assessment

This process is a direct evaluation process by the community/agency related to coral reef cultivation conducted by the Fisheries and Maritime Affairs The Deparment. This is done as an effort in evaluating the performance of the Department of Fisheries and Maritime Affairs. The assessment process can be seen in Figure 4.

This stage of the process consists of 2 parts:

1. Assesment This process is the process by which the community/agency will conduct an assessment in the form of an online questionnaire that must be filled out. The questionnaire consisted of a number of questions related to coral reef cultivation. Questions asked include the process of cultivation itself based on the location of coral reef nurseries.
2. Display Assessment Then the results of the assessment of the community/agency can be displayed in the form of a graph stating each category, consisting of very good, good, sufficient, not good, and not good. This is done to facilitate the Fisheries and Maritime Affairs Department in improving the process of coral reef cultivation.

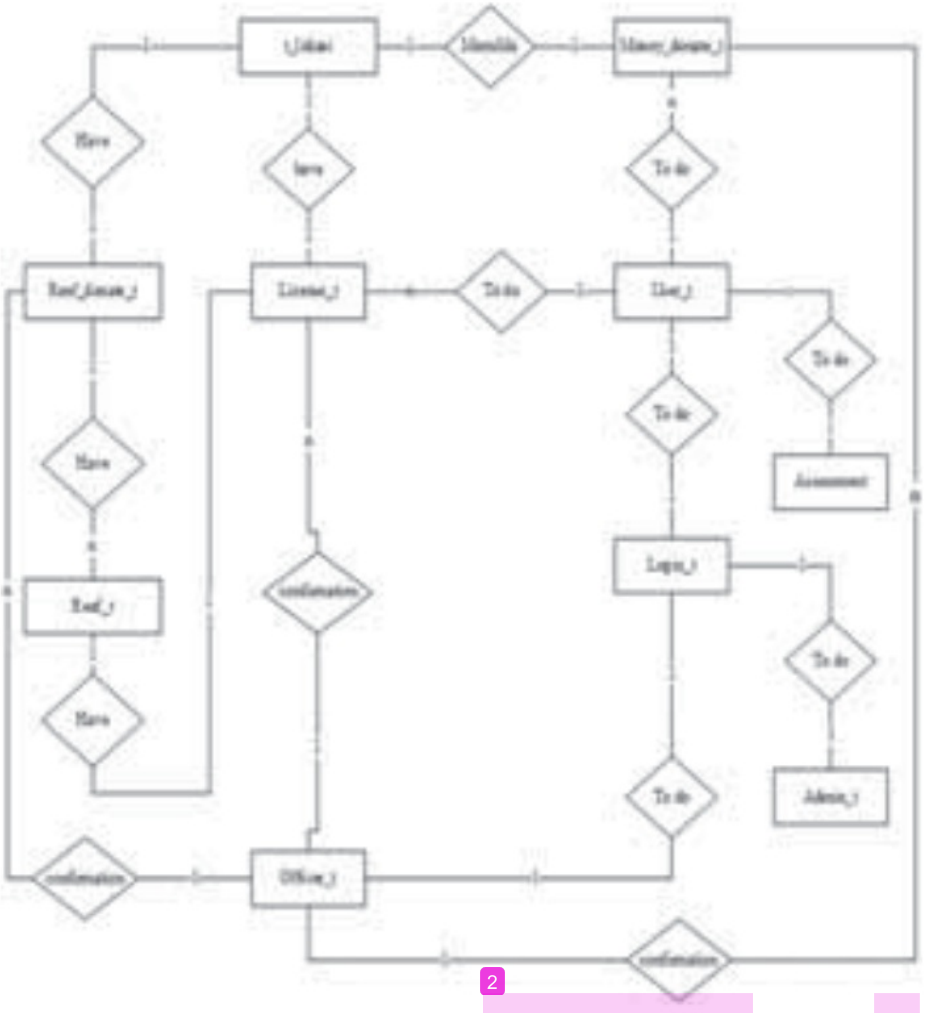

Fig. 5. ERD.

3. *ERD* Entity Relationship Diagram (ERD) is a model to explain the relationship between data in a database based on data objects that have relations between relations [11]. The ERD can be seen in Figure 5.

In this ERD process, the online donation application consists of several tables built, among others:

a. Table
   1. Reef donation table
   2. Reef table
   3. Location table
   4. Licensing table
   5. Employee table
   6. Table of donations of money
   7. User table
   8. Login table
   9. Rating table
   10. Admin table.

b. *Relation.* And for the relationship itself is built by 12 relationships that connect each table in the coral reef online donation application.

4. *Relation Table.* The relation table is the relationship of a table with other tables, each table has different functions and uses from each other. This process is carried out to make it easier for the team of programmer experts to

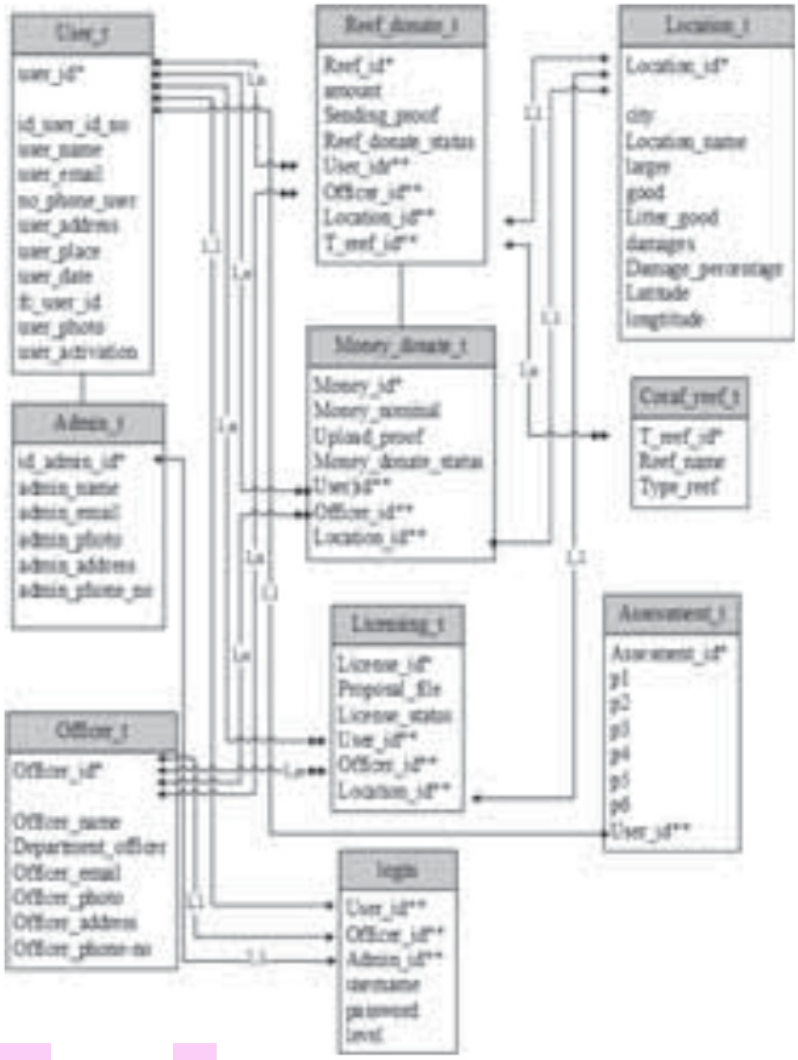

Fig. 6. Table of online donation application relations.

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Table I. User.

Field	Type	Information
user_id	int(11)	Primary key in the user table
user_id_no	int(20)	id number on the user account
user_name	varchar(50)	The name of the account owner
user_gender	varchar(25)	The gender of the account owner
user_email	varchar(50)	Email from the account owner
user_phone_no	varchar(15)	Account owner's phone number
user_address	varchar(100)	Account owner address
user_place	varchar(50)	The place of birth of the account owner
user_date	date	The date of birth of the account owner
user_id_fc	varchar(255)	Copy of ID card from the account owner
user_photo	varchar(255)	Photos used by the account owner
user_activation	varchar(50)	Activation in the user table

Table II. Login.

Field	Type	Information
user_id	int(11)	Guest key in the login table.
officer_id	int(11)	Guest key in the login table.
admin_id	int(11)	Guest key in the login table.
username	varchar(20)	Account owner username
password	varchar(20)	Account owner password
level	varchar(20)	Account owner level

compile the database related to the formation of the application as data storage, and as data used in functions that exist in the application [12]. The relation table can be seen in Figure 6.

This relation table follows from the description of the ERD. The number of tables in ERD represents the number of tables illustrated through the reaction table. Each

Table III. Licensing.

Field	Type	Information
licensing_id	int(11)	Permission primary key in the permissions table
user_id	varchar(11)	Foreign key in the permissions table, Primary key in the user table
location_id	varchar(11)	Foreign key in the licensing table, Primary key in the location table
proposal_file	varchar(255)	Proposal file in the licensing table
license_status	varchar(25)	Licensing status
coral_id_t	int(11)	The foreign key id of a coral reef in the coral reef donation table, the primary key in the coral reef table

Table IV. Coral reef donation.

Field	Type	Information
reef_id	int(11)	Primary key or primary key in the coral reef table
reef_id_t	int(11)	The foreign key id of a coral reef in the coral reef donation table, the primary key in the coral reef table
reef_name	varchar(25)	The name of the coral reef in the reef table
reef_type	varchar(25)	Types of coral on the reef table
amount	varchar(25)	Amount of coral reef donation in the reef table
location_id	varchar(11)	Foreign key conservation location table

Table V. Donasi uang.

Field	Type	Information
money_id	int(11)	Primary key in the money donation table
money_nominal	varchar(20)	The amount of money in the money donation table
upload_proof	varchar(255)	Proof of upload on money donation table
location_id	varchar(20)	Foreign key in the money donation table, primary key in the location table
user_id	varchar(20)	Foreign key in the money donation table, primary key in the user table
money_donation_status	varchar(20)	The status of money donations in the money donation table

Table VI. Location.

Field	Type	Information
location_id	int(11)	Primary key id location in the location table
city	varchar(50)	Regency/city in the location table
location_name	varchar(50)	Location name in the location table
large	float	Area on the location table
good	float	Good location conditions on the location table
little good	float	Little good location conditions in the location table
damage	float	Damaged location conditions in the location table
damage percentage	float	Percentage of damage to coral reef locations in the location table
latitude	float	Latitude in the location table
longtitude	float	Longtitude in the location table

Table VII. Coral reef.

Field	Type	Information
reef_id_t	int(11)	Primary key of coral reefs in the coral reef table
reef_name	varchar(50)	The name of a coral reef
type_reef	varchar(50)	Types of coral reefs

Table VIII. Rating.

Field	Type	Information
assessment_id	int(11)	Primary to assessment in the assessment table
officer_id	int(11)	Foreign key on the assessment table, primary key on the employee table
P1	varchar(15)	Assessment questions 1
P2	varchar(15)	Assessment questions 2
P3	varchar(15)	Assessment questions 3
P4	varchar(15)	Assessment questions 4
P5	varchar(15)	Assessment questions 5
type	varchar(15)	Question type

table consists of fields that are adjusted to the process that is currently running in the Department of Fisheries and Resources, only the difference is that the process is described through a computerized process. The results of the computerization process will produce a web-based online donation application.

5. *File Structure*

To facilitate the programmer in doing database documentation, the file structure was made. The file structure given to the tables that have been formed through the ERD process and the relationship Table.

The following file structure can be seen in the following tables.

To see the login table can be seen in Table II.
To see the login table can be seen in Table III.
To see the login table can be seen in Table IV.
To see the login table can be seen in Table V.
To see the login table can be seen in Table VI.
To see the login table can be seen in Table VII.
To see the login table can be seen in Table VIII.

Acknowledgment: Expressing thanks to the Director General of Research and Development Strengthening who have funded this research to be able to produce an online donation application designation with a decree number 7/E/KP/2019 and to the Fisheries and Maritime Department who are willing to be the object of research and participate in providing contribution in research.

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Received: 2 November 2019. Accepted: 14 November 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5360–5363, 2019

RESEARCH ARTICLE

Web-Based Environmental Learning Information System in SMA Angkasa Lanud Husein Sastranegara Bandung

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The Purpose of this research is to build an information system application to help teachers and students in high school in learning environmental education. Angkasa Lanud Husein Sastranegara Bandung Senior High School is an adiwiyata green school project, they also have an environmental friendly institution curriculum that is environmental education. The method used for this research is descrptive method. His method is carried out by examining an existing event and analyzed by interview and observation data collection technique. The result of this research is an application of environmental learning information systems that can help the learning process of students and teachers to achieve the appropriate target material and interactive learning so that students can easily understand the contents of the material provided.

Keywords: Environmental, Learning, Application.

1. INTRODUCTION

Senior High School Angkasa Lanud Husein Sastranegara Bandung is a private school under the education department of the city of Bandung which seeks to increase the quantity of learners and the quality of education. In the educational curriculum because SMA Angkasa always follow the race Adiwiyata routine then this school has a content subject Sustainable Space agency, the Environmental Education.

Environmental learning or education is an educational program to foster children or students so that they have rational understanding, awareness, attitudes, and behavior and are responsible for the mutual influence between residents and the environment in various aspects of human life [1, 2].

However, there are some problems that occur such as the difficulty of students to get the material when the teacher is unable to attend, the presentation of the theory that less interactive so that students do not understand because only read only from books, the delivery time science theory and assignments by teachers is limited because it must be followed by action PLH outside the classroom so that the target is not achieved the delivery of content and the lack of a place for discussion between teachers and students outside of school hours. Thus the need for facilities that help to address the above issues and to improve the learning process.

In the Information System, all data will be processed and presented correctly according to user needs so that the information needed will be conveyed properly. This Environmental Learning Information System can be used by students and teachers in the learning process to be more optimal and to improve the quality of learning [3, 4].

2. LITERATURE REVIEW

2.1. System

The system is a combination of elements that are related and have a specific purpose [5]. From this understanding, it can be obtained that the understanding of the system is a number of components or elements that are interconnected and synergize to achieve certain goals or the same goal so that it can be processed into an information.

2.2. Information Systems

Information system is a collection of organizational procedures that when done will provide information with a clear, concise and simple systematic and easy to understand for decision making or to control the organization [6].

2.3. Environmental Learning

Environmental learning or education is an educational program to foster children or students so that they have rational understanding, awareness, attitudes, and behaviors that are responsible for the mutual influence between residents and the environment in various aspects of human life [7, 8].

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1546-1955/2019/16/5360/004 doi:10.1166/jctn.2019.8616

Fig. 1. Proposed use case diagram [13].

2.4. PHP

PHP (Hypertext Preprocessor), a server-side programming language that allows programmers to insert commands for web server software (Apache, IIS, or whatever) to be executed before the command is sent by the page to the browser that requests it [9].

2.5. MySQL

MySQL is a multithread, multi-user SQL or DBMS database management system software, with around 6 million installations worldwide [10].

Table I. Software implementation.

Software	Specification
Operating system	Windows, Linux, Mac OS
Hosting application	000webhost
Other applications	Google Chrome, Safari, Opera, Internet Explorer

Table II. Hardware implementation.

Hardware	Specification
Processor	Intel pentium IV
RAM	2 GB
Hard drive	10 GB/20 GB
Other devices	Mouse, Keyboard, Internet Network

Fig. 2. Theory page.

Fig. 3. Tasks page.

3. RESEARCH METHOD

Method. The system approach used by the authors in this study is to use the Object Oriented Programming method [8] which is object-oriented programming, where all data and functions are wrapped in classes or objects. Each object can receive messages, process data, send, store and manipulate data. Some objects interact by giving each other information. Each object must contain information about itself and can be linked to other objects.

Fig. 4. Questions page.

Fig. 5. Answer questions page.

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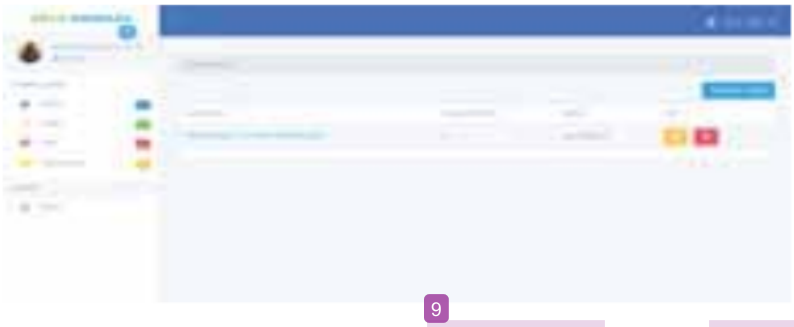

Fig. 6. Discussion page.

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System Development Method used by the author in designing this application is to use the Prototype Model. Prototype is one of the most widely used software development methods. With this prototyping method developers and customers can interact with each other during the process of making the system. The author uses the Prototype method because in this method the writer and user can interact with each other during the process of making the system to be created [11, 12].

4. RESULTS AND DISCUSSION

4.1. Proposed System Design

This modeling is used to describe the activity as well as the relations between the actors and use cases within the system is running. Here is the Use Case Diagram proposed Environmental Information System Learning at SMA Angkasa Bandung Husein Sastranegara.

System design is a new system development that is carried out to overcome the problems of the existing system. From this study the differences with the previous system are found in the data management process, with a computerized data management process. And the addition of several features that can be used to help convey or provide information about baby's growth to the parents of the baby. Figure 1 shows the Use Case of the proposed system.

The following is a Class Diagram of a Web-Based Environmental Learning Information System Application at SMA Angkasa Laund Husein Sastranegara Bandung.

4.2. Software Implementation

Here are the software requirements of this application.

4.3. Hardware Implementation

Here are the hardware requirements of this application.

Figure 3 shows that teachers can create, modify and delete tasks that can later be downloaded by the students. In addition, students can also upload a task that will be collected.

Figure 4 shows that teachers can create, modify and delete tasks that will be done by the students.

On Answer Questions Page (Fig. 5), students answer questions from questions that have previously been made by the teacher, the final score results will be obtained after the student has completed work on the problems.

Figure 6 shows that students and teachers can exchange thoughts or ideas through the topics that were created by teachers and comments.

On this Chatbox (Fig. 7) students and teachers can interact directly in real-time.

Fig. 7. Chatbox.

5. CONCLUSION AND SUGGESTION

Based on the results and a description of the discussion above it can be concluded that the information system Learning Environment in Senior High School Husein Sastranegara is a solution offered to support and assist the learning process subjects the environment, and help teachers achieve the target material to be conveyed to students such as providing content and work in digital form so that students can access anywhere and anytime.

Development is not enough to be here, because the system needs continue to grow. To the authors try to convey

suggestions that could be considered for future research some of them:

1. Adding video upload feature for students to put int tasks.
2. Applications can be developed further into android and iOS mobile apps.
3. Can be redeveloped so that it can accommodate all of the subject matter in school.

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Received: 2 November 2019. Accepted: 15 November 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5364–5369, 2019

RESEARCH ARTICLE

Optimization Approach to Automation of Multiple-Path Synthesis of Design Solutions in the Integrated Design of Evolving Systems

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Background: In the context of the global digital transformation of the modern society the rationalization of the software development process remains one of the most relevant issues. The article suggests an approach to automation of multiple-path synthesis of design solutions for a given class of information systems (IS) namely evolving systems. *Objectives*: The goal of the research is the development of a methodological framework for the rationalization of the process of building Evolving Information Systems. *Methods*: The article uses methods of linear and nonlinear optimization, system analysis, theory of information processes and systems. *Results*: As a result of the research, the developed approach to building evolving information systems is proposed. The article considers the basic principles of a rational approach to multiple-path synthesis and describes the steps of algorithm and features of its applying to the IS building project.

Keywords: Digitalization, Evolving Systems, Iterative Integration, Multiple Integration.

1. INTRODUCTION

One aspect of the modern industry is the global digital transformation, which completely determines the development of both global markets and separate companies. One may talk about such a phenomenon as the Fourth Industrial Revolution, which characterizes the trend of the mass manufacturing application of cyber-physical systems and the use of big data, the Internet of things (IoT), digital twins and distributed computing. Under the conditions of the total digitalization of differently oriented organizational processes the search for methods and means of the rationalization of building IS is a relevant objective [1–3]. The study of the modern software nature allows you to identify quite steadily one of the classes, namely evolving software systems (ESSs), which are characterized by the following features:

1. Uncertainty of functional requirements to a product, impossibility of accurate planning of the product functional structure in the aggregate with the significant subject orientation which prevents investments into generalized solutions.
2. Uncertainty in the area of project resources, which seriously complicates planning of the project progress, implementation and control of its stages, creation and maintenance of a permanent team having project-specific competences.
3. Initial uncertainty in the area of architectural requirements to the project, including inaccurate definition of the subject area and integration infrastructure of the future project, as well as errors in the assessment of possible pathways of scaling the solution.

The most common approach to the development of this class of systems, along with other systems, is Agile, the principles of which are formulated as a manifesto in 2000. The Agile approach, as shown by the analysis of CHAOS Report statistics, allows you to increase the percentage of successfully completed projects; however, almost all methods of the Agile generation have the following disadvantages:

1. Unpredictability of terms and results of the development. Agile generation methodologies focus primarily on achieving the highest quality both in terms of implementation of user requirements and in terms of building system architecture, which in practice often leads to misplaced project priorities and, as a consequence, to the failure of the initial terms or poor quality solutions caused by lack of time at the end of the project.
2. The development process depends heavily on the human factor, namely on the staff motivation, competency and experience. Incorrect selection of project executors

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1546-1955/2019/16/5364/006 doi:10.1166/jctn.2019.8617

can lead to failure of the project because of insufficient qualification of its participants, or, in case of excessive qualification of employees, to an over-expenditure of resources and to decrease of motivation in the team.

3. In many cases, teams accustomed to organize their Agile activities neglect strategic planning within the project, which increases the risk of failure through excessive attention to details.

These disadvantages of the Agile approach play a significant role in the projects related to the development of ESSs, which significantly reduces the probability of the successful completion of ESS projects and forces you to look for new approaches to the development process organization [4, 5].

The article considers the methodology of multiple-path synthesis of design solutions, the pilot use of which in the planning of IT projects, according to the expert study, is a promising approach to the optimization of the process of building ESS.

2. SOURCE REVIEW

The software development methodologies research carried out in recent years by research teams from different countries can be classified within the framework of the following directions:

1. Research of the software evolution process, studying the peculiarities of the SDLC (Software Development Life Cycle) variations, identification of methods and means of evolution control [6]. The book "Managed Software Evolution" published in 2019 can be considered as one of the most complete sources. It presents the outcomes of the program, which was launched by the German Research Foundation ("Deutsche Forschungsgemeinschaft (DFG)") to develop new approaches to software engineering with a specific focus on Long-Lived Software Systems. For this purpose, the study of peculiarities of the software evolution is largely connected with the search for methods, approaches and means of the system development support at each stage of its evolution. The issues of the controlled evolution organization of the software systems depending on the evolution of user requirements [7, 8] are considered.

2. Expansion of modern methodologies based on the principles of Agile into the field of building large corporate systems, working with large teams of developers, development of solutions based on big data, working in the field of IoT, etc. It is associated with the requirements of the Fourth Industrial Revolution (Industry 4.0), which implies a high level of digitalization of business processes, building complex automation solutions, creating digital twins and working with data that is appropriate for the set of VVV (volume, velocity, variety) features [3, 9, 10].

3. Adaptation of modern methods of project management in the area of software development to the peculiarities of modern startup projects, including their special aspects of funding, lack of resources and competencies, a high degree of uncertainty and phase transitions associated with the scaling of the development team, number of users, number of implemented business functions, etc. In general, the development of approaches and methods of project organization meets the needs of the digital industry, which is replacing the traditional economic way of life, but is primarily focused on solving problems within the framework of each of these directions, without an attempt to generalize and study the general phenomena and patterns. The present article attempts to solve problems typical for a certain class of systems within each of these directions [11, 12].

3. METHODOLOGY

Let us consider the class of evolving systems as one of the subclasses of dynamic systems, which includes dynamic systems with discrete phase space and initial nonzero amount of development resources [6, 10]. In general terms, the class of dynamic systems in linear and finite-dimensional approximation can be represented in the form

$$R(t) = \int_{-\infty}^{t} K(\tau, t) I(\tau)\, d\tau \qquad (1)$$

where I is a vector of input actions, R is a vector of system reactions, K is a matrix of impulsive admittance functions of the system, t is time. In nonlinear cases K depends on I. In case of modeling the simplest ESS we have two functions:

1. Internal, which ensures its existence
2. External, resulting from interaction with the external environment.

Integral description of evolving systems is quite convenient for their thorough study, but its main disadvantage is the practical impossibility of using it to describe real software systems because of their complexity. In case of the ESS model application to finding system solutions in the area of software design for computer systems, the objective complexity of modern software, as well as the pathway of its development, determines the difficulty of building rigorous mathematical models and solving problems within the framework of their statement.

One of the most mature approaches to the integrated building of systems, as well in the field of the software development, is the SEMAT (Software Engineering Method and Theory). According to the SEMAT, the quality of software development is defined in the framework of the following key elements:

Opportunity (customer level)
Stakeholders (customer level)
Requirements (solution level)
Software System (solution level)
Work (endeavor level)
Way of Working (endeavor level)
Team (endeavorlevel).

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From the ESS design point of view, the starting point of the methodology application is the solution level containing two key elements: Requirements and the Software System. The customer and endeavor levels are sources of uncertainty determining the creation and existence of the ESS as a result of project activities. The structure of a key element of the Software System can be planned also with the use of two cardinally different approaches: top-down and bottom-up design. In the first case, the initial result is the concept of the ESS general architecture, which includes a description of the structural rules for the building and layout of the system. In the second case, it is a strategy for implementing individual components of the system in the most rational way. As can be seen from the above, as an object of rational designing, the software system can be described by three aspects:

—Organizational structure design of the project (requirements management);

—Architectural design (top-down approach to building ESS):

—Definition of ESS components production technology (bottom-up approach to building ESS). Thus, the task of building a rational architecture can be considered as a task of the integrated rationalization of architectural, technological and organizational-oriented approaches, which in the general case can be described on the basis of the following sets of candidate options:

$$\alpha = \{A_1, \ldots, A_n, \ldots, A_N\} = \{A_n, n = \overline{1, N}\}$$
$$\beta = \{B_1, \ldots, B_m, \ldots, B_M\} = \{B_m, m = \overline{1, M}\}$$
$$\gamma = \{C_1, \ldots, C_l, \ldots, C_L\} = \{C_l, l = \overline{1, L}\}$$

where N, M, L is the number of variants selected into the set under consideration on the basis of the problem analysis using the corresponding representation. In this case, in the process of rationalization of the architecture itself, it is possible to highlight the aspect and complex approaches.

It should also be noted that the following sets of characteristics should generally be taken into account in assessing the approaches used as options for building ESSs:

1. Characteristics and indicators describing the degree of achievement of the overall system evolution objective in the case of a particular candidate option. The degree of achievement of the overall system evolution objective may be assessed in the framework of the following partially formalizable directions:

—Satisfaction of business needs by organizing business processes in the most efficient and technological way as far as possible;

—Development and improvement of design, development, support and modification of IT services, as well as rationalization of their support during the life cycle;

—Designing a secure and flexible IS architecture that makes it easy to deploy and use various IT services;

—Efficiency improvement of interaction between service developers and users in order to enable them to make the most effective decisions in the design of services from the business point of view;

—Improvement of the overall quality of the system organization by means of increasing the share of reusable services.

2. Indicators describing the cost characteristics, the probability and quality of achieving the objective under the conditions of different sets of project resources. In the general case these indicators are based on the Service Level Management (SLM) concept. Within the framework of the project, it is necessary to determine what level of one or another service provision will be acceptable in each particular case, and on the basis of this to form a package of SLA (Service Level Agreement) specifications. The use of the SLM within the framework of the organization, in its turn, is focused on achieving the following objectives:

—Improvement of relations with customers of the system;

—Elimination of misunderstanding between the customer and contractor regarding certain functional modules by means of assigning roles and responsibilities;

—Focusing automation efforts on those areas, which are considered key from the business point of view;

—Identification of the corporate IS vulnerabilities in terms of security and productivity;

—Orientation of the IT service development process towards meeting the required level of service.

The proposed aspect approach is directed to reducing the diversity of initial sets and in our case it is formalized as follows:

1. The architectural aspect: many design options in the form of $r = \overline{1, R}$; design efficiency indicators $i_a = \overline{1, I_a}$
2. The component aspect: many design options for $n = \overline{1, N}$ ESS components; $v_n = \overline{1, V_n}$, $n = \overline{1, N}$, performance indicators $i_k = \overline{1, I_k}$
3. The organizational aspect for $m = \overline{1, M}$ directions $o_m = \overline{1, O_m}$, $m = \overline{1, M}$, performance indicators $i_o = \overline{1, I_o}$

Within the framework of the aspect automation, sequential execution of all stages of the dichotomous reduction up to the synthesis of the rational design solution is carried out. However, the given method does not always lead to a rational solution because of the main disadvantage of the aspect automation that is the non-optimality of the design solutions of one aspect for the others, because the sets of indicators are overlapping, i.e., $I1 = Ia \cap Ik \neq \varnothing$, $I2 = Ia \cap Io \neq \varnothing$, $I3 = Ik \cap Io \neq \varnothing$.

The integrated approach intending the implementation of multiple-path synthesis of design solutions, in our case will have the following form:

1. Implementation of the first stage for all aspects and obtaining the reduced sets

$$r^* = 1, \quad R^*, \quad v_n^* = \overline{1, V_n^*}, \quad o_m^* = \overline{1, O_m^*}$$

2. Solution to problem of searching for a reduced set of variants of the complex automation by means of the dichotomous reduction $S = R^* \cup V_n^* \cup O_m^*$ on a variety of indicators $I = I_1 \cup I_2 \cup I_3$ and obtaining the reduced set $s^* = \overline{1, S^*}$
3. Solution of the following dichotomous reduction problems on the set $s^* = \overline{1, S^*}$:

B2. Choice of an effective option for integration of alternative components taking into account existing level integration.
B3. Choice of the precedence order of project operations.
B4. Grouping of set elements of different integration levels into local design routes.

The design object may be the complicated, poorly formalized system, or the design process initially assumes the use of the iterative approach. In these cases the stage-by-stage use of multivariate optimization models allows you to reduce essentially expenses of design stages even taking into account the use of procedures of structural synthesis at separate stages of design within the framework of PDCA model. In this case, keeping in mind the necessity of taking into account system connections, as well as the joint influence of several types of uncertainties, in order to find rational solutions it is proposed to use such an integral characteristic as the entropy of multivariate integration. This characteristic determines the degree of diversity in the variety of possible integration options. On the set of variations the entropy looks like

$$H(\alpha) = -\sum_{n=1}^{N} P_n^{\alpha} \lg P_n^{\alpha}$$

is characterized by a number of properties:
(1) It is symmetrical relative to the vector coordinates p^{α}, i.e., it does not depend on the relative position of the p_n^{α};
(2) It reaches its maximum on the vector p^{α} with coordinates $p_n^{\alpha} = 1/N, \ \forall n = \overline{1, N}$, i.e., when all variants are equal;
(3) It reaches its minimum on the vector p^{α} with coordinates $p_v^{\alpha} = 1$, $p_n^{\alpha} = 0, \ \forall n \neq v$, i.e., when the only variant of integration appears to be suitable for implementation.

Simultaneously it is necessary to adhere to the principles of local and multivariate integration, maximum reliability and adequacy.

4. RESULTS

As can be seen from the above, for organizing the process of building evolving information systems (ESSs), it is proposed to use the methodology of multivariate synthesis, which is implemented within the next set of stages:
1. Formation of a variety of options for each aspect of automation
2. Dichotomous reduction locally for each aspect
3. Comprehensive evaluation of options and reduction of the total set
4. Solution of the tasks B2, B3, B4 on the common set.
5. Formation of acceptable variants of solutions

In this case, problem solving of the variant set formation for each of aspects is solved in accordance with the specifics of the approaches.

Architectural aspect of the system represents a set of interconnected subsystems representing a set of organizational processes of the automated enterprise a_i, $i \in (1, N)$, where N is the total number of possible organizational processes and structures, b_j, $j \in (1, M)$ is a set of platform solutions, where M is the total number of platform subsystems, as well as a functional set of software solutions c_k, $k \in (1, L)$, where L is the total number of software components. From the perspective of this representation, the very structure of the IS can be represented in the form of an oriented multigraph, in which vertices are the components a_i, b_j and c_k, and arcs represent dependencies between these components. It should be noted that a matrix formation of conditional probabilities of the preferred use of multiple options for integration at each level and between levels is impossible to perform directly due to the structure uncertainty of the system individual components, the unique character of organizational processes and software systems under development. The application of expertise in these cases, as practice shows, can seriously distort the picture. Therefore, it is suggested to calculate the preference of sharing not on the basis of statistics, but on the basis of using metric indicators that determine structural, process, object-oriented and other features of the system components. Technically, the implementation of the architectures of IS software subsystems in this paradigm is most convenient to carry out on the basis of service-oriented architecture (SOA). Widespread development of systems based on SOA became possible as a result of the development of Web-services technology. Modern open standards of Web-services play an important role in the organization of IS components interaction of different manufacturers. Architectural solutions based on SOAP, WSDL and UDDI, despite their apparent unproductiveness and redundancy, show their viability and usefulness. As a rule, the mechanism of SOAP services is a framework for the integration of business processes and IT infrastructure which supports them in the form of secure, standardized components (services) designed for multiple applications.

The strategy being implemented within the framework of the component aspect of automation is a solution to the problem of achieving the maximum economic effect from the use of a given component (service). It is proposed to formalize this task in the form of the expression:

$$\int_{T_0}^{T_0+T} f(S(t); F(t)) \rightarrow \max$$

where $S(t)$ is a set of requirements to the IS component, $F(t)$ is the implemented functionality, T is the time of actual use of the component in the system, T_0 is the time of

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start of the component usage, f is the function that evaluates the conformity of the component functionality $F(t)$ to the actual requirements of $S(t)$, $f \in [0, 1]$. In this case, the strategies for achieving the result can be combined from the following basic components:

1. Formation of the set of requirements $S(t)$ to the software in the most convenient way for implementation. From the perspective of relations between the customer and the developer, the ways of forming the most convenient set of requirements for implementation can be divided into the following groups:
   - —Application of a complex of methods and means focused on structuring the requirements and preventing their uncontrolled "evolution" within the framework of the project; facilitating the formation of the implementation strategy;
   - —Formation of counter propositions.
2. Maximizing the functionality $F(t)$ implemented within the framework of the component under consideration to the start of the time interval for the use of the developed component. Implementation of the functionality takes into account the current set of requirements $S(t)$ and the forecast about the possibility of its change, as well as available design techniques and skills of the development team. Most of the proposed strategies for solving this problem are based on empirical data, because the development and use of mathematical models in this case is difficult due to the following reasons:
   - —High significance and unpredictability of the human factor;
   - —Ineffectiveness of formal approaches to organizing the work of small teams;
   - —Strong dependence of the result on the applied technologies and development languages.
3. Maximization of the amount of time $[T_0, T_0+T]$ during which the developed component is used. The time of the component use depends on the following factors:
   - —Elaboration of requirements that reduces the variability of the set $S(t)$ and, as a consequence, increases the time interval T, during which the component is used;
   - —Application in the process of developing a component of the methods providing for the possibility of making changes (object-oriented approach, flexible architecture, etc.);
   - —Pre-defined strategy of support and improvement of the component in the process of its use (management of user requirements, documentation of solutions and technologies, human factor integration).

From the organizational point of view, the project is described by a set of artifacts $b_1, \ldots, b_m$, which are selected from a standard set B_0 of possible artifacts of all the listed types. To form each artifact within the project (for adaptation in the case of third-party subsystems), one or more methods $a_1, \ldots, a_n$ are used from the general set of approaches A_0, formed on the basis of the analysis of different techniques applicability to the production of artifacts. In doing so the following set of artifacts is used:

1. *Document.* A document is understood as an artifact containing descriptive, recommendatory or reference information that affects the decision-making process in the use of project results.
2. *Component.* A component is understood as an artifact created by the project team to solve any problems of the project.
3. *Third-party subsystem.* A third-party subsystem is understood as an artifact used in the "As-Is" project and described by a "black box" metaphor with certain inputs, outputs, states and behaviors.

5. DISCUSSIONS

The task of rational planning of ESS development projects in general is poorly formalized because of the high degree of uncertainty of significant factors. In most cases it is not a question of detailed planning, but a choice of a rational strategy combining a "defensive" approach to the development of the solution architecture with attempts to quickly and effectively implement the business logic concern. The key factor that affects the applicability of the proposed methodology is the procedures for generating the initial set of options. At the same time, if the description of different options is not in terms of specific functional features of the solutions, but in the approaches and ideas underlying one or another solution, it allows you to make more qualitative and long-term assumptions about the development pathway of the project. However, it should be taken into account that, during the period of ESS existence, not only separate functional artifacts but also approaches and methods used in the project may be subjected to revision. In this case, in the process of generating alternatives, it is reasonable to use the following additions [1, 2, and 7]:

1. Research of systems with regard to the laws of technical systems evolution formulated in TRIZ (Theory of Inventive Problem Solving). This approach has proved to be practical in its application to the study and forecasting of user needs.
2. Rapid Foresight methodology, the essence of which is to conduct among the system developers a session on collective modeling of the technical variants for the system evolution in accordance with the projected development of the utilized technologies landscape.

The use of modern methods of software development focused on the formation and management of a competent team in the course of the project. These methods, such as Agile, Lean Development, etc., should be reflected in the process of generating and evaluating alternatives at the stage of aspect design.

It is necessary to notice that in comparison with the techniques of the machine training, which are popular last years, the principle of multiple-path synthesis of design

decisions possesses much greater degree of transparency for a DM (decision maker). It is important in decision-making in the case of problems with high degree of uncertainty to which the design of pathways of ESS evolution also belongs.

6. CONCLUSION

As can be seen from the above, the use of multiple-path synthesis principles in the planning of ESS architectures allows you to achieve the following results:

1. To achieve a rational organization of the ESS building process.
2. To design a flexible application structure suitable for scaling and implementation during the system evolution.
3. To ensure the rapid creation of the business logic concern that can provide a significant competitive advantage and ensure the efficient use of development resources.

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Received: 2 November 2019. Accepted: 14 November 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5370–5377, 2019

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Challenges in the International Business Market Through Fixed Currency Systems: A Study Based on Business Scenario in UAE

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The contemporary global business scenario is significantly dynamic that incorporates modern financial and business potentials and possibilities making business avenues simultaneously flexible and fair. Until recent past sea was considered as worst option to reach nations for doing business. However, after realization of the concept that business can easily be spread beyond national boundaries, men started conquering lands for conducting business and to earn higher income and profit. Consequently, the business faced the challenge of meeting larger demands of goods and services across the nations, as a results business started dealings in number of possibilities such as exchange of facilities, barter system, gold/silver related commodities. Meanwhile, the disadvantage of doing business across borders in such a way was widely propagated. As a result nations and business were forced to use a unique and commonly accepted commodity as a medium of exchange, which should overcome the problems of barter system and gold rates system. This led to the birth of modern currency and further advancements in the form of financial instruments including paper currencies and bullion exchanges. Majority of the modern day business are guided by the profit, and doing business in international currency relatively increases the rate of profit. At the beginning nations started exploring number of possibilities of trade on the basis of fixed and floating exchange rate for capital gains. This modern type of multiple payment settlement system in business across borders has increased the attractiveness of international business; customers search for quality products at competitive prices. Consequently, companies and even economies have been considering international business as best alternative for earing higher profits while at the same time doing business with developed and stable economies. Trade among countries and regions needs unified currency, which has been made easy through introduction of fixed and floating exchange rate systems. Countries entering into international trade agreements either fix-up a common value for the currency in which regular trading happens with another nation or tie up with the currency of a develop economy. The fixed exchange rate system has enabled countries to make prior financial arrangements required for modern day businesses. Present study has been carried out to properly examine the currency arrangements in UAE against US Dollars and other GCC countries' currencies. Hence the study has evaluated the expected benefits of fixed exchange rate system in case of UAE. In addition to that, prime factors that significantly affect the process of pegging UAE currency against major currencies such as USD, Euro, and Pound Sterling have also been examined.

Keywords: International Business, Currency Pegging System, Currency Rate Fluctuations.

1. INTRODUCTION

History reveals that the currency evolution process has its roots back into 2000 BC; the time when transaction were carried out through barter system. The barter system was then replaced by metals with denominations expressed as values and symbols. This system last for number of decades, during which the precious metals were used as a common medium of transaction. With the passage of time, the demerits of this system become evident; money value being dictated against national income. Consequently, it becomes significantly important for policy makers to devise strategies for ensuring stability of fixed

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1546-1955/2019/16/5370/008 doi:10.1166/jctn.2019.8702

exchange rate system [1]. According to Ref. [2] empirical review of the history exposes that global economic crisis results in the depreciation of currencies around the globe. During the great depression the values of the currencies depreciated that was pegged with US dollar, particularly for the case of AED. This phenomenon was explicitly evident in global money markets and also in UAE market. A great significant of fixed exchange rate system is that business across borders enter into deal based on the values fixed against international currency; leaving no room for speculation.

The study in this area is intended to explain the following:-

1. To analyze the benefits of currency pegging of AED against USD to UAE economy.
2. To examine the benefits gained in the international business scenario mainly in the areas of international trade involving import and export of commodities as well as oil and gas.
3. To review the business benefits against the floating exchange rate system and to explain the alternative arrangements which can develop the region's economy.

2. BACKGROUND FOR THE STUDY

It has been observed that international trade among countries and regions has become a great source of attracting foreign investment and development of bilateral relationship among partners. As stated by Ref. [3] that direct exchange of goods and services among nations brings in better business and financial relations among nations.

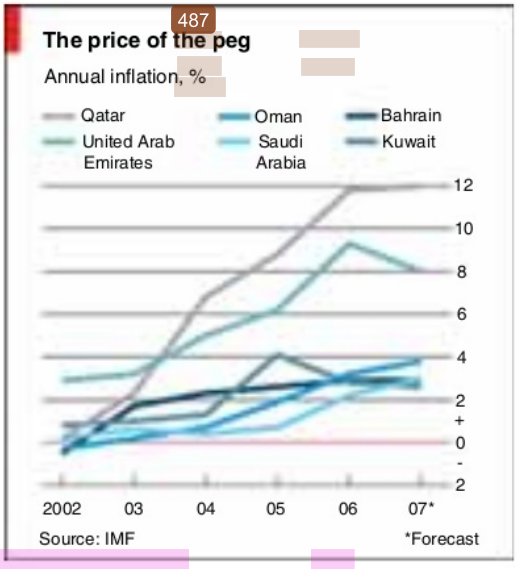

Fig. 1. The price of the peg.

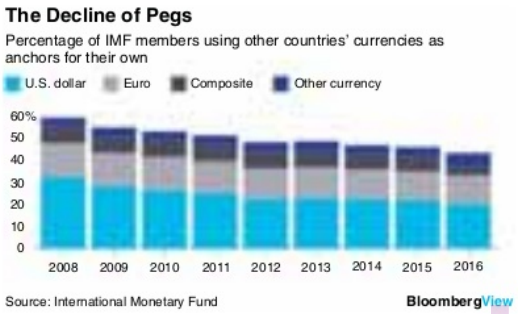

Fig. 2. The decline of pegs.

Generally, the trade is conducted in international currency among partner. Further, trade becomes more convenient and comfortable with the countries that have fixed the value of their currency with other nations for the purpose of trade. According to Ref. [4] this practice leads to pegging; the value of the nation currency is fixed against other countries' currencies. History reveals that trade among nations or international trade has been happening since long, and has resulted in bulk of currency movements across borders. In addition to that, with the development of business and trade, profit earning and sharing among partners has become a matter of concern. Hence it has been proposed to conduct business in single currency denomination. This lead twelve European nations to trade in single currency, while six oil producing countries like Saudi Arabia, United Arab Emirates, Bahrain, Oman, Qatar, and Kuwait, decided the dollarization currency (see Figs. 1 and 2).

3. CURRENCY

According to Ref. [5] use of money in transactions is the prime factor behind the popularity international business, which further defines international trade system. In addition to that, international relations, financial assets movement across nations, participation in other international economic activities, and development of the population across regions are other benefits of international trade. Reference [6] in his attempt stated that international trade with foreign currencies possess important place in the foreign trade operations which are capital accumulation and transfer, international human relations and business, global business investment, transfer of products, services, technology for commercial and non-commercial, scientific and technical, charitable as well as related activities. Similarly, according to Ref. [7] monetary indicators used for better understanding of currency transactions are international currency exchange and monetary operations, investment options in terms of terms of money value of currencies, direct currency investment options such as loans and investment, financial transaction process,

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non-resident investment options and opportunities, development of international bank interlinking process aiming better monetary support process, aggregate financial services including bank guarantees, factoring, and forfeiting, and financial support, advisory counseling and consultancy services. According to Ref. [8] interest rate parity between two countries needs to be considered when the interest rate is equal to the differential between the rate of the forward and spot exchange rate. It seems that in the international market, investors are indifferent towards the interest rate and explains that there exists no arbitrage. Similarly, Ref. [9] stated that a currency gain the status of international intervening currency when it is easily accepted by financial intermediaries and international banks as well as there exists a positive serial correlation based on the returns gained through the usage of currencies.

3.1. Common Currency

In an attempt by Ref. [10] exposed that small countries prefers to use a common currency in international trade system in number of format. Presently, large numbers of small countries are using US Dollar and Euro to international trade. This is not being conducted through any formal procedure, as the case remains. The practice of utilization of Euro for business practices, even in the informal settings has benefitted EU to gain business power as well as to curtail any business losses that might happen due to international recessions. This utilization of Euro and USD has in a way accelerated the growth of the FDI, since the rate across the states was fixed against the currencies. In fact the utilization of Euro and USD by smaller nations, gained more tourism oriented business countries in the region bringing in international business and economy, promoting related trades in these nations. Thus extensive trade market started developing in these regions. Reference [10] in his analysis of ASEAN countries international money markets development revealed that war and instability in terms of currency among EU have always compel other countries to find a substitute currency for their respective international businesses. This is also evident form the fact that numbers of member countries of EU are strongly opposing bail out from smaller economies. Consequently, economists in this region propose that ASEAN's countries should take serious care of common currency fluctuation, as any miscalculation would be significantly perilous. This can leads to strengthening the volunteers to create support for using American Dollar informally into the system. A study conducted by Ref. [5] examined international trade, they exposed that currency unions accounts for the average trade of 45%. Further, this trend has helped regions and economies to regularly monitor monetary and fiscal policies that otherwise could have developed into independent financial union. The financial data has always reveal the trade tripling that happens based on the business are compatible with the best practices in the industrial trade scenario for e.g., the case of German-Irish trade which gained more market and finance than the German British trade [5]. It has been observed that financial unions has gained much popularity and member nations do not consider or think about multilateral trade that considers much resistance than any bilateral trade. Among many others, the problems associated with multilateral are tariff differences, location of the business in the in industrial region, financial transaction process etc. which is usually a matter of consideration and usually all aspects never go all together in multilateral institutional set-ups [8]. In a similar study by Ref. [11] exposed that in contemporary industrial scenario number of factor has been affecting and determining the economic situations of countries such type of technology, openness to globalization drive, political stability, influencers of international market such US and China, and emergence of new economies as well as the introduction of common currency unions. Developing nations started experiencing the industrial growth by 5% through overall improving the connectivity, providing easy access to business and thus prosperity. Industrialization collectively integrated the uneven economies and thus creating another financial trade block for business enterprises [12]. With the passage of time more and more economies have been coming together and forming unions for further enhancement of their economic growth. Presently, due down trend of global economic growth, both USD and Eurocurrencies has been facing challenges of inflation and deflation economy to a wider extent [11]. Reference [13] explained that as a result of changing conditions in international financial markets the Asian region might adopt Euro or USD as a base currency. Using common currency along with every nation pegging their respective currency to base currency would be an ideal solution. It seems advisable to keep a check on the supply of national currency enabling to maintain the global demand at a fixed rate system. There is always an option in the money market, like the geographic set-up to develop a consortium of nations to manage a single currency denomination, enabling the free convertibility of the national currency. It is going to be basically a tough task, in case of Asian democratic nations, as it requires plenty of political and international interventions to discuss and settle the concern. Now the discussion is in line to keep a parallel currency, could be Yen or even US Dollar. China's RMB might find it difficult as it is not convertible and may not be an able to play an anchor for any crisis. Japanese Yen face the problems because of the weak policies in Japanese banking and fiscal monetary systems. However Mudell support USD and Euro as a parallel currencies; both are widely accepted. Reference [14] has presented comments against the creation of common currency; he supposed that the trade increase may be less than expected. The common currency units have been gaining momentum with many states like El Salvador, Ecuador,

and Guatemala legalizing the dollarization of its economy. The Latin American and African countries were planning to follow the Scandinavian nations to utilize the common currency enabling the removal of transactional costs and control of exchange rate fluctuations [14].

3.2. GCC Pegging to Dollar

Reference [15] explains that the oil and gas remains as the international product mainly dealt by the GCC nations. The main reason for the establishment of the currency pegging in the GCC is due to the trade of the international commodity, in the international market to gain a better market value for the product distributed. All these were concern with earning comparatively higher profits in international market. Reference [7] further understands that it is learnt that by fixing the currency against an international currency, there every possibility is there to an accurate prediction of returns on investment which in turn helps to avoid currency risks and market recessions. This in turn enables long term investment forecasting. At times it is learnt that in several nations, the pegging or fixing exchange rate brought instability as it needs to depend on government exchequer to protect the economic situations. According to Ref. [8] technically the term currency integration do not means to adopt a single currency, rather this aims at brining number of financial markets together. Which further leads to trade openness, bringing down the conditions for standardization of financial requirements, basic investments, developing norms as well as in developing a better banking functions through the adoption of currency integration. Necessity is another element of monetary policy where it is essential to take into account the uncertainty factor in the process which keeps occurring continuously in the changing structures of international economies. Two independent researches by Refs. [3 and 7] concluded that uncertainty can arise due to number of reasons such nations with specific financial plans, lacks sufficient experience related to the currency integration policy, or unavailability of financial records or the long term financial data is undependable, similarly economic unreliability as well as the difficulty understanding and Modelling economic processes can results in uncertainty. According to Kritzman the optimum currency theory introduced by Mundell significantly helped in describing fundamental features of an economy, brought down the probability of asymmetric shocks while introducing a common currency. The theory basically aimed to understand the economic benefits which more countries in the financial block generate through a common monetary, credit and currency policies. This include irreversible fixation of currency exchange rates based on one-to-one ratio based on assumptions explaining the economic cycles of these countries are highly correlated with each other [16]. The nations coming under a specific monetary zone, needs to be characterizedby a considerable degree of mutual understanding, financial freedom, and financial interdependence and openness expressed as the ratio of mutual foreign trade to the GDP size. Similarly, a country structural reform should be guided by stimulation of flexible markets that ultimately bring down the desire for adopting inflexible fiscal, monetary, and credit policy measures. Reference [17] carried out a critical review of the studies conducted on the topic of international currency formation. They prime objective of their review was to study the feasibility of financial integration among ASEAN countries. Similarly, they also examined the convergence criteria needed among ASEAN countries that is necessary for the establishment of currency union. The best example of the international trade blocks can be quoted as the North America Free Trade Zone as well as the European Union, which led to the integration of the economies of the member countries. The economic integration in the ASEAN region is very low which can never actually does not augur better for any currency integration. A study conducted by Ref. [18] exposed that in ASEAN the potential financial gap between rich and poor nations is relatively high. There exists the reflection of the 1997 Asian financial crisis even now in the economic scenario. ASEAN countries recently experienced low growth, and gained trade collaboration agreements with non ASEAN members. In the recent past many nations signed preferential trade agreements which have even carried out while excluding the member nations completely [17]. To be in the ASEAN financial trading block a country must needs to fulfill some prescribed trade qualifications such as developing appropriate banking and monetary systems that would reduce the impact of the common currency on the systems of the country. While entering into the financial trade blocks, the member countries needs to surrender their independent and individual identity in terms of policies and practices which can even affect the local financial market dealings. ASEAN nations can even perform the business deals on the basis of the Maastricht treaty that governs the financial policies in the region [17]. They have generated a very impressive economic and financial growth as the ASEAN regions were less on demand from the regions outside the financial block. China's economic and industrial reconstruction increased inter-regional trade providing a protection to the region from any external shocks of recession.

3.3. Advantages and Disadvantages of Currency Union

It is quite evident that once entering a financial block with one common currency denomination, there exists a common economic and federal trade and business aiming for every member's development. Presently the international trade has been gaining popularity; the fixed exchange rate has also been emerging as a much-preferred financial system among nations in the international trade and commodity market. This has been preferred by the global business

as it is considered to help the global business in an incremental phase. This in another way helps in avoiding sharp fluctuations in currency values among nations [19]. The one currency market will help to bring down the costs otherwise associated with international trade. There will be the reduction in interest rate risks, which in another way brings positive effect in investing nation's economy. In a recent study by Ref. [20] explained the process of entering into international trade scenario Euro Act was established as a major currency framework activity aimed at political, social, legal, and cultural integration among European nations. The basic motivation was to develop intra-regional investment in the global business practices. The currency pegging was carried out amongst few of the companies in the international trade scenario. Few nations in the EU traded at a narrow band such as Germany, Belgium. On the other hand countries like Spain, Greece and Italy were permitting larger bands of fluctuations. The Maastricht treaty specified the various convergence criterions such as the average inflation should be controlled at 1.5% when compared to nations with lowest inflation within the union. The nation's rate of interest on long run government bonds needs to be kept at 2% on an average for three countries having the lowest inflation. 3% of the GDP must be kept from government deficits. The government debt should not be more than 60% of the GDP. The nation must associate with EU market for a period of two years. Development and success in any field can be achieved through following the track path of the pioneers of the vary field. Hence, to form a "financial block" intended nations must take lessen from the experiences of developed industrial countries. According to the findings of Ref. [9] the example of Euro Currency has influenced number of countries around the globe and same is the case with GCC member economies. The discussions were conducted many times to have an own currency with the task given to central banks to develop trading blocs. It was learnt that this could bring in more negotiating power in the region. On the other hand, criticism started coming in like central bank will be much busy with the international currency market and will not be able to identify the needs of individual nations and to come up with alternate solutions. It was seen among EU nations that they enjoy freedom from hedging costs, as there exists a protection from money market fluctuations, as well as other benefits like fee discounts, high-capita business etc. bring much more gains [21]. Thus, there existed a much more trade among the nations in the region bringing in much better financial and political benefits. However, a serious threat to the Euro could be the introduction of gold standard or even dollar currency. As experts of the field states that any significant appreciation in the value of both the currencies can bring damage to the EU currencies, while an appreciation can be experienced with currencies pegged against dollars. Previous studies on the current area of interest exposed that higher the volatility in the currency market higher will be probability of trade investment in the domestic business market. Prior to the induction of Euro, there has always been remained currency volatility among EU member nations. However, after joining EU, due to one currency factor they have experience a stabilized growth rate and thereby the international trade concerns. Norway as a nation experienced this big change after joining EU. There was nothing remarkable for indigenous industrial operations for the trade and business involving other nations the change in the economy was significant. Thus, on a closer consideration of the system, there exists no guarantee in the indigenous operations but brings in stability in a much efficient manner [21]. When looking at the economy of the GCC nations, there is a much better similarity in the political, legal and social system as it holds mostly once culture, religion and language. Theory explains that inflation and unemployment are positively correlated. The economic institutions explain the presence of the labor mobility and open economies as the best value towards nations 'economy. The major objective as envisaged towards the development of a GCC monetary union is to:-

1. Total eradication of the cost of transactions across the borders, thereby reducing the unethical competition in the business markets.
2. Bring a parity in the pricing of products in the market.
3. Trading is comfortable through unified currency regulations.
4. International business policies can be much easily coordinated and organized in line with the economic policies of the nation.
5. Better the business relations with organized business in the international business markets [22].

It needs to understand that the differentiated economy through differentiated market discourages any country specific fixes to country specific problems. The GCC countries have exhibited much better acceleration in the international market through US dollar pegging as the business is executed in petro dollar terms. Doubts still exists about the international money market, regarding the stability of the economy through a basket of currencies in which the dollar and Euro is benefitted with a larger share to peg the currencies of the GCC union [20]. It is evident that changes in international business environment occurs irregularly, these changes are rapid and fluctuating these plans remains uncertain while something in the future would have to consider.

3.4. Global Currency System

US Dollar plays a prominent role in the global currency system. This has helped over a period of time to retain better international business, while at the same time has brought in many financial imbalances leading to economic recessions. In fact this destabilization in the economic situation brought in by dollar, even made the financial experts to come out of dollar pegged money market system and

to introduce a better and much reliable common currency for international trade and barter activities [20]. But in this present day of revision from the economic recession, financial experts explains that any such fundamental changes in the financial substitution will never bring much of a benefit and the change will be undesirable. The shift from dollar as a financial intermediary is much of a difficult task and requires a much better efforts from national as well as governmental and related financial organizations dealing in the financial markets [4]. The basic appreciable solution for the concern which benefitted there is requirement of a much appreciated regional currencies in the international financial scenario. Most of the financial concerns that were developed by individual nations were basically organized towards local market development rather than for a global benefit. The restructuring must benefit any financial process in the long term of the business. According to Ref. [9] experts in financial markets should consider factors such as moving towards a much stabilized and organized gold standard, development of a global financial instrument aimed with much wider and secured functions making the international business more comfortable and convenient, protection of financial position of Dollar/Euro as a much appreciated international currency for any international business practices and utilization of regional currencies in a much appreciated manner, bringing in a regional currency promoted international business practices.

3.5. Utilization of US Dollar in International Business

Over a period, Ref. [23] in the details in this regard explains that US economy gained stability among the nations and became much attractive in the long-term investments and international transactions. The US credit holdings as well as the financial investors, started dealing in dollar in the international market. The US credit and fiscal bodies have shown readiness towards granting the dollar for international operations, while maintaining high-quality debt obligations to meet the demand for dollar-denominated assets. Reference [19] in this regard explains that network effect in the international financial market structure takes into account that the currency in demand is the currency in circulation and will be more in demand for all the international business relations.

3.6. Best Practices in Utilizing Poly-Currency System

A feasible alternative solution to this discussion of single currency is proposed in the form of poly-currency system that will be based on the market value of the respective currency [24]. Thus aiming towards the best possible alternative, through the establishment of the poly-currency system, where other currencies even can be given a status in addition to the dollar at an international business scenario. Due to recent global financial and economic recession investors have been investing much carefully in international business, especially in terms of USD. Generating a currency reserve against dollar was thought as a better option, which can lead to stronger and better economies across the world this practice can significantly bring down the pressure on any single currency. This can be done by selecting the currency from the strongest country in that region as the international exchange source in this region for international trade [9].

4. RECOMMENDATION

Empirical analysis suggests that both host and investor economies drive significant benefits form currency pegging. Reference [1] 8 states that when the currency is pegged against one single currency, the pressure on the currency is very high inviting possible amount of concerns in case of any global business erosions (see Fig. 3). In this regards, based on the contemporary global business environment, pegging against prominent currency is the best and only valid option. However, it can bring in difficulties later during the part of organizing the business [25].

UAE has always conducted international business in her domestic currency Dirham independently. The trade over a period of time became market oriented and the risks associated with the same can never be defined. In the case where an economy deals in currency with independent float, a arise to increase the confidence of the local investor in terms of performance of the currency in any future market [14]. The steady investments can bring in confidence in any currency, but the occasional ups and downs related to the currency might bring less confidence to the investors at some point of time. The exchange rate risk associated with the currency would increase in case the currency is traded independently in the international market. Reference [26] expressed that the money market has to redefine the business market with a much better appreciation for the dirham can make the currency strong in the international business market. In case of building confidence among investors, then only the same can be freely traded in the international money market. Reference [27] in his studies states that International business is the main business practice across the globe, to bring in more money in circulation and to strengthen the foreign direct investments, attracting more employment opportunities. In this competitive global business environment, the currency pegging practices have brought in a better financial planning and investment options in the business sector in the country. This has enabled the nations to be more competitive and fairer in business deals as well to improve qualitatively to be in the business scenario. Reference [28] further outlines that this has enabled, better products in almost all the developing markets at the economic prices enabling a global rotation of international currency and economic standards. Reference [10] in his study examined the details of the international trade interest of other nations. To keep economy and currency value on check, even the importing nations prefer dollars as the base for currency trade and

Fig. 3. Saudi Arabia and UAE: Peg to dollar.

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exchange. As an example, we can see that UAE economy is building up over a period with doing business trade with nations like India, Srilanka, Bangladesh, etc., based on dollar currency as even the trading nations too feel comfortable to do business in this currency. In case of trading with nations, not in the pegging policies, UAE as well as other nations prefer to convert the same to dollar rates for better pricing and stability [10]. There exists no specific policy that any nation conducting business and trade with UAE must follow the principles of currency pegging as followed by the country. A review compiled by Ref. [12] aimed at analyzing the basic objective of pegging currency with any of the developed nation currency. She concluded that in majority of the cases the prime objectives are to bring stability to the economy, to induce lower variability in currency exchanges as well as to enhance economic growth. Reference [29] states that it is better for much better economic growth and development in the industries to influence the international trade and business through a stabilized and established currency market and for this the pegging of the currency has contributed to this objective in a much better manner. The international currency market is always fluctuating. The changes in the market remain as a challenge to the business environment. It needs to do a thorough study of the market to reach a perfect analysis of the need of the currency pegging and in case of the currency to be pegged, which currency needs to be better selected and utilized in the market [29].

5. CONCLUSION

This study concludes that all of countries around the globe prefer to use national currency for domestic business. However, when it comes to international trade, majority of the countries peg their currency against the currency of a stable economy that can leads to earning higher profits. Findings of the study are in line with Ref. [9] who states that fluctuation in currency exchange rates are always present as a serious risk for countries dealing with floating exchange rates in international trade. To the present, currency bond is proposed as a preferred source of avoiding financial risk when it comes to dealing with floating exchange rate; encouraging international business practitioners to contribute to the investment options in any preferred nations. European Union, while entering into the Union proposal, mooted up a currency union with the aim for a stabilized business economy in among the members in the union. It has been observed that number of countries around the globe prefers to use USD for international trade. Reference [6] documented that despite remaining effective for the last 35 years GCC has not reached to the introduction phase of common economic market or financial zone for dealing international business. The recent global economic recessions, have put in a question mark to have global currency system or to have a poly currency system, which can play a better economic procedure in case of any financial or economic recessions. UAE introduced dirham as its currency nearly four decades ago. The currency became popular across the globe, with the development of international trade and business across the nations. Latter-on nations started emerging as a better place for international trade and started fixing the currency against dollars for much better monetary advantage. The global economic recessions across the world made the financial consultants to have a rethinking on the pegging system and its disadvantages against the gains the county can be benefitted through free float of the currency in the market [30]. Presently a significantly large portion of the world trade is being conducted in US dollars. However, studies shows that pegging currency against US dollars brings both advantages and disadvantages to the country under consideration. On positive side this help in accurately predicting business profits in addition to brining stability in international financial and commodity markets. Consequently, confidence among partners increases

in terms of finance and trade volume. Reference [30] further explains that the correlation between the US dollar, euro and independent float revealed that even though there existed a decrease in the revenue of UAE economy, still there existed a better correlation between UAE dirham and US dollar. Hence, based on the contemporary international business environment, pegging UAE dirham with USD will bring significant benefits. Although independent float can be considered as the purpose of currency exchange, it needs to gain the investors' confidence over UAE dirham, seemed to be much important. It remains practically impossible to determine the market gain against currency float value in terms of UAE dirham, leading to any situation of overvaluation of the currency in the existing market. This can even bring in a situation of financial suicide for the currency as well as the international trade market. Also determining the value of UAE dirham as independent float would be difficult and there could be situation where the currency value is overvalued.

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Received: 10 September 2019. Accepted: 12 October 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5378–5383, 2019

RESEARCH ARTICLE

Development of an Automated Compressor Unit for Gas Compression at the Periodic Connection of an Ejector

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The authors developed a new scientific approach for gas compression using ejector compressor units. A new patented technical solution opens up the prospect for the effective use of ejector compressor units when compressing various gases to pressures of 10...40 MPa. The goal of the research work is the development of automation systems using new scientific principles for gas compression. A new scientific approach is associated with the improvement of the ejector compressor unit, with the provision of conditions for the periodic connection of the ejector as part of the implementation of the cyclic low-frequency workflow. The results of scientific research can be used to create energy-efficient technologies for compressing and transferring various gases; it can be methane, associated petroleum gas, nitrogen, carbon dioxide, air, hydrogen or other gases. There is the prospect of using ejector compressors to create new internal combustion engines. Creating cheaper and more economical compressors will allow solving actual production problems in remote Arctic oil and gas fields.

Keywords: Oil and Gas Extraction, Ejector, Compressor, Well, Producing Layer.

1. INTRODUCTION

New and more efficient compressor technology is urgently needed for cost-effective oil and gas production in Arctic conditions. Due to the high cost of compressors, the practical use of such technologies as compressor-assisted gas lift, gas flooding technology into the producing layer for enhanced oil recovery, air flooding technology into the production layer for implementing oxidation processes within improving oil recovery, pumping technology for fluid-gas mixtures, is limited [29]. Expensive volumetric type compressors can be replaced with ejector compressor units, which are distinguished by high reliability and low price [1, 2]. Normally opportunities to change the flow of the power pump are provided for controlling the mode of operation. Besides, an adjustable ejector is used to change the cross-sectional area in the flow channel at the nozzle [3–9]. In some cases, the cyclic mode of working medium outflow through the nozzle of the jet apparatus is considered [5, 10–14]. However, such workflows have so far been poorly studied. With the development of computer technology, new opportunities are opening up to automate ejector systems when cyclically changing the values of operating parameters [5, 15–20, 30, 31]. In this regard, works on the automation of ejector systems can be entirely regarded as relevant.

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2. CONCEPT HEADINGS

The goal of the research work is the development of automation systems using new scientific principles for gas compression. A new scientific approach is associated with the improvement of the ejector compressor unit, with the provision of conditions for the periodic connection of the ejector as part of the implementation of the cyclic low-frequency workflow.

3. RESULTS

The conducted comprehensive studies [1–5, 17–20, 21–25] in the field of pumping and compressor technologies made it possible to outline a new scientific direction related to the periodic connection of the ejector. When implementing such an operation, the ejector compressor unit's efficiency is increased. New technical solutions are developed and patented [3, 4]. These new technical solutions open up broad prospects for the effective use of ejector compressor units when compressing various gases to pressures of 10…40 MPa. The developed ejector systems relate to the field of compressor machines and can be used in the oil and gas extraction on land or at sea, including in the process of implementing gas-lift technology. The technical problem addressed by the presented development is to increase the reliability of the compressor installation and increase the level of safety during its operation. The achievable

1546-1955/2019/16/5378/006 doi:10.1166/jctn.2019.8586

technical result is to exclude the ingress of gas into the flow part of the liquid pump. The liquid is prevented from entering the high-pressure gas pipeline [28]. The technical result is achieved by synchronizing the operation of the pump with the operation of the liquid–gas separator when the liquid level in the separator fluctuates [26, 27].

Figure 1 shows the developed compressor unit design.

The compressor unit contains a working chamber (1) and an ejector with a mixing chamber (2) connected to a liquid pump (3), an overflow pipe (4), a suction gas valve (5), and a discharge gas valve (6) that separate the cavity of the working chamber (1) from the low pressure gas pipeline (7) and the high pressure gas pipeline (8), respectively. Liquid pump (3) is made in the form of a reversible pump. The working chamber (1) is made in the form of a liquid–gas separator. The mixing chamber (2) of the ejector communicates with the reversing fluid pump (3) through the nozzle (9) of the ejector. The entrance to the nozzle (9) of the ejector is hydraulically connected to the source of the working fluid (10). The entrance to the mixing chamber (2) of the ejector is connected through a suction gas valve 5 with a low-pressure gas pipeline (7). The bypass pipeline (4) connects the exit of the mixing chamber (2) of the ejector with the upper part of the liquid–gas separator (1). An injection gas valve (6) separating the liquid–gas separator (1) from the high-pressure gas pipeline (8) is located in the upper part of the gas-liquid separator (1). Reversible liquid pump (3) is equipped with an adjustable electric drive (11) with a frequency regulator (12). A reversing valve (13) is installed between the ejector nozzle (9) and the reversing fluid pump (3), which allows flow in the direction from the reversing fluid pump (3) to the ejector nozzle (9), while the reversing fluid pump (3) continually communicates with the source of working fluid (10). A pipeline through which the working fluid continuously circulates, as shown in the figure, can be used as a source of working fluid (10). The upper part of the liquid–gas separator (1) is filled with gas, the lower part of the liquid–gas separator (1) is filled with the working fluid, the Figure shows the section (14) between the gaseous phase and the liquid phase. The liquid–gas separator (1) is equipped with a level gauge bypass chamber (15), which hydraulically connects the upper and lower parts of the liquid–gas separator (1). The chamber (15) contains the float gauge (16), and the outer wall of the chamber (15) contains two level sensors (18) and (19) installed at a distance from each other, corresponding to the minimum and maximum allowable lower and upper positions of the liquid level in the liquid–gas separator (1). The level sensors (18) and (19) are connected via information communication lines (20) and (21), respectively, to the control unit (22), which is connected via the control line (23) to the frequency controller of the electric drive (12). An option of the compressor installation is possible when a permanent magnet (17) is attached to the float gauge (16), the level gauge remote chamber (15) is made of a non-magnetic material, and the level sensors (18) and (19) are made in the form of sealed contact reed relays. The location of each level sensor is chosen from the condition of ensuring the synchronous operation of the liquid–gas separator and the reversible liquid pump. Such synchronous operation should eliminate the manifestations of hydraulic shocks at the upper position of the liquid level in the working chamber (1). In this case, gas breakthroughs into the reversible liquid pump (3) should also be excluded when the liquid level in the working chamber (1) is in the lower position. This increases the reliability of the installation and its level of safety, eliminates emergencies during operation. The compressor unit works as follows. Reversible liquid pump (3) operates in a cyclic mode with a change in the direction of flow in each half cycle. Reversible fluid pump (3) delivers the working fluid from the working chamber (1) through the reversing valve (13) into the nozzle (9) of the ejector, while partially working fluid enters the pipeline (10). Due to the energy of the liquid jet at the inlet of the mixing chamber (2) of the ejector, the pressure decreases and gas from the low-pressure gas pipeline (7) enters the mixing chamber (2) through the open suction gas valve (5). At the exit of the mixing chamber (2) of the ejector increases the pressure in the flow of the mixture of liquid and gas due to the conversion of the kinetic energy of the liquid into potential energy, which is accompanied by an increase in pressure when the flow velocity of the liquid–gas flow decreases. Through the bypass pipeline (4) compressed gas together

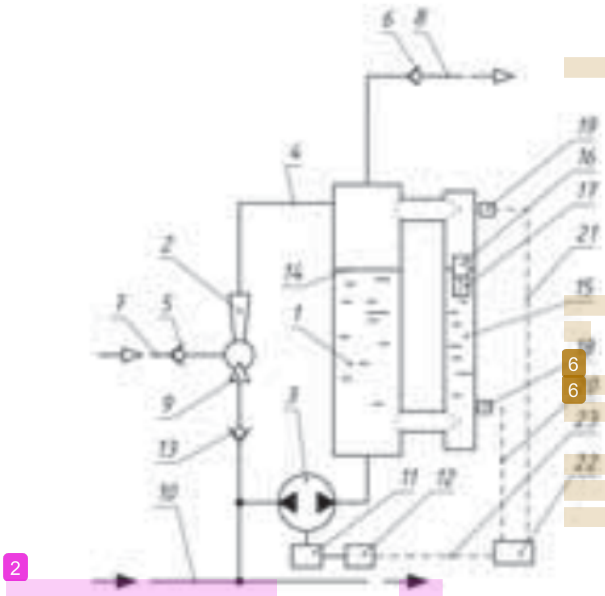

Fig. 1. Compressor unit design.

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with the liquid enters the working chamber (1), where the separation process is carried out with the separation of the liquid–gas mixture into liquid and gas phase. The liquid accumulates in the lower part of the working chamber (1), and the gas in the upper part, as in the well-known gravity separators. Compressed gas accumulates in the upper part of the working chamber (1), which leads to the displacement of the section (14) in the downward direction. The liquid from the working chamber (1) is displaced by a reversing fluid pump (3) in the pipeline (10). When the boundary of section (14) approaches the minimum permissible lower position of the liquid level in the working chamber (1), the float gauge (16) will drop in the level gauge chamber (15) to the appropriate level, where the lower level sensor (18) is located. After that, a signal is transmitted from the level sensor (18) via the information communication line (20) to the control unit (22), and then a signal is sent through the control communication line (23) to the frequency controller (12) to turn off the liquid pump (3) or to change the direction of rotation of the electric drive (11). In the latter case, the compressor unit will continue to work, and the liquid from the pipeline (10) will begin to be pumped by the reversing fluid pump (3) towards the working chamber (1). This will lead to a pressure increase in the working chamber (1), respectively, the reversing valve (13) will close, and the suction gas valve (5) will also close. The flow in the mixing chamber (2) of the ejector stops. Thus, the ejector is switched off while the working chamber is filled with liquid. At this time, the boundary of section (14) will begin to shift in the upward direction. The working chamber (1) will keep compressing the gas, which is accompanied by a corresponding increase in pressure. With the displacement of section (14) upwards, a moment will come when the pressure in the working chamber (1) becomes equal to the pressure in the high-pressure gas pipeline (8). Such a pressure equalization will open the discharge gas valve (6). With the further displacement of the section (14) upward, the compressed gas from the working chamber (1) is forced into the high-pressure gas pipeline (8) through the open gas discharge valve 6. The end of the gas displacement cycle is caused by moving the float gauge (16) to the upper-level sensor (19), the location of which corresponds to the maximum permissible upper position of the liquid level in the working chamber (1). After that, a signal is transmitted from the level sensor (19) via the information communication line (21) to the control unit (22) and further through the control communication line (23) to the frequency controller (12). The electric actuator (11) changes the direction of rotation of the rotor of the liquid pump (3) and, accordingly, changes the direction of fluid flow in the liquid–gas separator (1) in the opposite direction. Then the operating cycle is repeated. The advantage of the inventive device is to increase the reliability and safety level of operation of the compressor unit since it ensures synchronous operation of the liquid–gas separator (1) and the reversible liquid pump (3) when the liquid level in the liquid–gas separator (1) fluctuates. This prevents the displacement of the boundary of section (14) below the minimum acceptable value when the level sensor (18) is triggered. The ingress of gas into the reversing liquid pump (3) is eliminated. The ingress of liquid into the high-pressure gas pipeline (8) is prevented when the section (14) is displaced in the upward direction when the level sensor (19) is triggered in the maximum permissible upper position of the liquid level. In addition to improving the safety of work when using the claimed device provides a higher quality compressible gas according to the moisture content in the gas. Pressure sensor readings were recorded in the course of the experimental work: fluid pressure at the inlet to the ejector nozzle (P0), the gas pressure at the inlet to the ejector (P1), the gas pressure at the outlet of the ejector (P4). Moreover, also, the parameter called the relative head pressure, $h = (P4 - P1)/(P0 - P1)$, was calculated to assess the working conditions of the ejector.

4. DISCUSSION

Within the framework of the applied research and experimental development, the new scientific principles have been developed to compress the gas to pressures of 10…40 MPa using ejector systems, working in impulse mode at low frequencies. The study considers new possibilities of controlling an ejector system while regulating outflow conditions at the nozzle unit outlet, using high-speed systems for controlling the flow of fluid or gas. New directions for researching jet compressor installations have been outlined, where low-frequency and high-frequency impulse processes are combined. The authors carried a series of research tests of a new compressor unit. During the tests, the ejector was put into operation periodically, for pre-compression and gas transfer. Some results, obtained after processing the experimental data, are presented in Figure 2.

When the ejector operated, the relative head pressure was maintained at the level of $h = 0.2$. Moreover, after

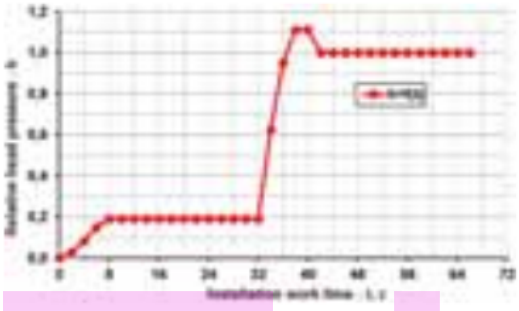

Fig. 2. The test results of the experimental compressor unit.

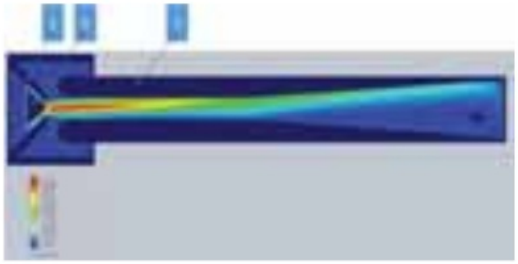

Fig. 3. Results of computer simulation of an ejector equipped with an adjustable nozzle: 1—Nozzle; 2—Regulating needle; 3—Mixing chamber.

switching the fluid circulation system, the ejector was switched off and stopped pumping gas. At the same time, the power pump continued to pump fluid into the separator, and the gas pressure continued to increase. The relative head pressure increased to the level $h = 1$. At the same time, the final gas pressure is five times higher than the gas pressure recorded during the operation of the ejector. The scientific and technical literature relatively weakly covers the issues of regulating the mode of operation of the ejector by changing the direction of the jet leaving the nozzle. The scientific and practical interest lies in the question of expanding the possibilities for controlling the operation of the ejector. In this connection, questions of improving the system for regulating an ejector. The working process in the ejector's mixing chamber primarily depends on the working fluid flow direction at the ejector. The parameters of the working fluid flow can be considered as control parameters for controlling the ejector's operation. By changing the working fluid flow direction, the ejector's operation mode can be changed as well. Figure 3 shows the individual results of the computer simulation of an ejector. This example shows an ejector equipped with a conical nozzle (1). Inside the nozzle (1) is placed a

Fig. 4. Adjustable nozzle for experimental ejector: 1—Nozzle; 2—Regulating needle.

Fig. 5. 3D model of the regulating needle.

regulating needle (2) having an outer conical surface when the longitudinal displacement of the needle (2) changes the cross-sectional area of the annular flow channel formed between the inner surface of the nozzle (1) and the outer surface of the needle (2). At the radial displacement of the needle (2), the direction of flow changes at the exit of the nozzle (1).

In the presented example, in Figure 3, the jet of liquid, after exiting the nozzle (1), deviated to the upper wall of the mixing chamber (2). The mobility of the regulating needle in three planes can be achieved through the use of a spherical hinge, as shown in Figure 4.

Additive technology was used for the manufacture of experimental samples of the ejector. Figure 5 shows one of the options for the regulating needle.

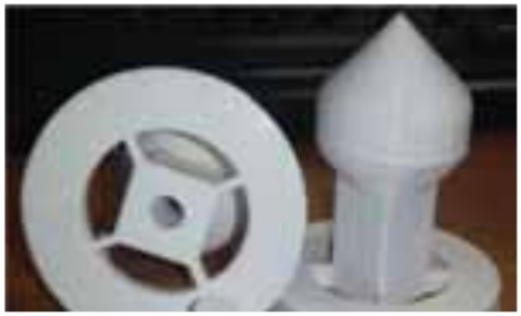

Fig. 6. Regulating needle printed on a 3D-printer.

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Fig. 7. The printed adjustable nozzle.

The regulating needle and other details of the experimental ejector are made on a 3D-printer. Photos of the printed parts are shown in Figures 6 and 7.

The presented examples show that the regulating needle can be displaced not only along the longitudinal axis of the nozzle but also in the radial direction relative to this longitudinal axis of the nozzle. In this case, the possibilities for regulating the ejector are greatly expanded. In this case, it is possible to regulate not only the working fluid flow rate, but it is also possible to control the direction of the working fluid jet flowing out the nozzle. Adjusting the ejector with consideration of changes in the working fluid jet direction is still understudied. The modern computer technologies allow for appearing additional opportunities for studying the ejector's working process, taking into account changes in the direction of the working fluid jet. The individual results of the work done can be used in other industries, including the creation of inkjet control systems for unmanned aerial or sea-based unmanned vehicles. Today, unmanned vehicles are widely used in the performance of research, rescue or search operations. One of the promising areas of development for the ongoing research is associated with internal combustion engines, where the combustion of the air-and-fuel mixture is carried out at a constant volume or constant pressure [5, 19].

5. CONCLUSION

The authors developed a new scientific approach to improve ejector compressor units. The manuscript considered the task of ensuring the conditions for the periodic connection of the ejector in the framework of the implementation of the cyclic low-frequency workflow. This technical solution opens up the prospect for the effective use of ejector compressor units when compressing various gases to pressures of 10…40 MPa. In this design, cheaper jet compressors are capable of replacing expensive volumetric type compressors. The authors developed options for automated systems to control the compressor unit when using new scientific principles for gas compression. The manuscript considered some ways of adjusting the nozzle apparatus, where it is possible to regulate not only the flow rate of the working fluid but also control the direction of the jet of working fluid flowing through the nozzle. In this regard, the individual results of the work done can be used in other industries, including the creation of inkjet control systems for unmanned aerial or sea-based unmanned vehicles. One of the directions of development of work may be associated with the area of internal combustion engines, where the combustion of the air-and-fuel mixture is carried out at a constant volume, or at constant pressure, as part of a program to create new technology for Arctic conditions.

Acknowledgments: The work is carried out with the financial support of the state represented by the Ministry of Education and Science of the Russian Federation. Unique identifier of works (project) is RFMEFI57417X0152.

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Received: 1 January 2019. Accepted: 11 March 2019.

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Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5384–5395, 2019

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Spelling Checker of Words in Rejang Language Using the N-Gram and Euclidean Distance Methods

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Spelling mistakes of words in writing Rejang words are often found so it is difficult to understand. The method used in correcting word errors (spelling checkers) has been carried out by several researchers. In this research, words were improved in Rejang words based on the morphology of the Reajang language using the N-gram and Euclidean Distance methods. The process begins with forming the word practice with the N-gram method in cutting a number of words. In the testing process, the pre-process stages are carried out first and the training words are checked based on the existing dictionary. Words that are assumed to be wrong are corrected by looking for words similar to Euclidean Distance. The results of the lowest word resemblance are adjusted to the word training, if it is not appropriate then the word with the highest similarity is considered the correct word to be improved. In this study the experimental results of the words tested produce similarity levels of 20 words and the smallest 3. The results from the calculation of similarity can be directly to correct the wrong word. The results of the study can be seen that word improvement is very dependent on the dictionary word unigram and existing training words. This shows that the N-gram and Euclidean Distance methods are good in spelling checker Rejang language.

Keywords: Rejang, Spelling Checker, N-Gram, Euclidean Distance.

1. INTRODUCTION

Rejang Language is a regional language used by more than 200,000 native speakers who live in Rejang Lebong Regency and surrounding areas in Bengkulu Province and South Sumatra Province. Basically the Rejang language belongs to the Malay or Indonesian family. The syntax structure follows the DM law, the element explained (D) followed by the explaining element (M). For example, umeak le '(large house): umeak, as the explained element (D) followed by lei, as the explaining ang element (M). Rejang also has its own system. In the system there are verbs consisting of one morpheme, for example temot "sitting," bedan "stop" [1–4]. Wrong meaning of writing is caused by an error in writing the spelling of words. Errors in writing are caused by errors in typing words that do not match the correct spelling of the words. The correct spelling of words is formed based on the proper morphological process. Repairing the words that are done is an important thing to do to avoid word spelling mistakes. However, in practice this is rarely done because of repeated checks that take time and effort to get the correct spelling of words. One solution to solve this problem is to use a system that is able to fix words automatically. In this study the method used in correcting the wrong word is using N-gram and Euclidean Distance. This study aims to apply the method used in word improvement in Rejang language documents and see the accuracy of these methods in this system [5–7]. It is expected that the system can produce the correct spelling of words in the Rejang language with the Euclidean Distance method in accordance with the original words contained in the Rejang dictionary.

2. RESEARCH AND METHODS

Spelling checker is the process of checking words for detecting misspelled words and giving candidates the correct words. The spelling checker looks for any type of errors contained in the document which then warns the document writer about the error made and gives some suggestions to correct the error. There are two main methods used to build a spelling checker application, namely identification (Error Detection) and correction (Error Correction) [8, 9].

Spelling mistakes there are two categories, namely:

a. Non-word error

Non-word spelling errors are mistakes that focus on words formed generally by typographical errors. These

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1546-1955/2019/16/5384/012 doi:10.1166/jctn.2019.8607

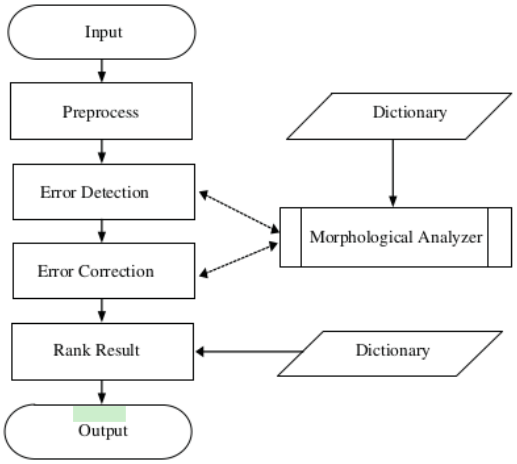

Fig. 1. Word repair process.

non-spelling errors produce words that don't make sense. These errors include errors due to mechanical failure or slip or slip of the hand or finger, and also arise due to the ignorance of the author such as spelling errors. Typographical errors can be caused by fingers pressing two adjacent keyboard keys simultaneously.

b. Real-word error

True word errors are mistakes that emphasize handling the placement of words in sentences. Word errors that actually produce other legitimate words.

In Non-word errors the process of checking excessive letters and spelling of words will repeatedly continue to make an infinite list to check one by one. While Real-word errors, problems occur in the process of grammar or grammar recognition in each sentence [10]. Including ambiguity and words that are not in the dictionary or commonly called Out of Vocabulary (OOV).

The design of the spelling checker process is carried out, namely:

1. Pre-processing text
2. Then check each word whether the word is wrong or not.
3. The next step is to correct the word to get the correct word.

The stages in carrying out the spelling checker process are as follows:

1. Pre-process
2. Error detection

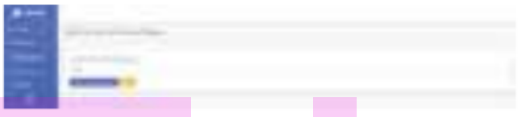

Fig. 2. Display of spelling checker (word input).

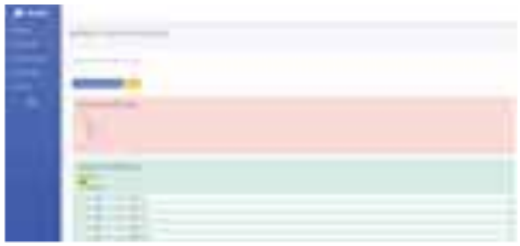

Fig. 3. Display of the spelling checker (similarity).

3. Error correction
4. Checkup result

The word improvement process is shown in the image below (Fig. 1).

2.1. Testing Process

In the process of testing the stages are carried out namely preprocessing text, checking misspelled words and correcting misspelled words. At the time of examination of words misspellings and corrections of words using the results of the training process in the form of words, words before and after words to be adjusted. When checking a misspelled word if the word in the test word matches the results of the training data then the word is considered true and if it is not checked into the word dictionary. At the time of repairing the word, if the candidate word matches the word results from the training data, then the word is corrected [11–15].

2.2. Training Process

Stages of the training process are preprocessing text and cutting per word to get the words, the before and after words used in the testing process (Figs. 2 and 3).

3. RESULTS AND DISCUSSION

Testing is done using the REJANGS algorithm. Then the results are seen based on the accuracy of the level of similarity and distance using the N-gram and Euclidean Distance methods. The image below is the interface of the Rejang language spell checking application [16–18].

The trial results are shown in Table I below.

In Table I it can be seen that the results of spell checking using the N-gram and Euclidean Distance methods are words that have the most similarities are the words "invite" i.e., 20 words and the smallest similarity are the words "amak," "ajat," "ajak." These results are obtained from Ref. [19]:

C1 = GUPEAK
C2 = GUPUAK

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Table I. Spell check trial results.

Number	Word name	Similar to words	Total
1.	Gupeak	Peak, degupeak, gemupeak, guneak, gupea, gupuak, kupeak, nupeak, peak, supeak, tupeak, upak, upeak	13
2.	Gupuak	Gupuak, lupuak, puak, upak, upua	5
3.	Gurek	Gutek, curek, gulek, gurek, guret, gutek	6
4.	Gureng	Gureng, cureng, gemureng, genureng, gureng, ureng	6
5.	Aman	Aman, aman, amang, jamang, mamang, saman, tamang	7
6.	Amang	Adang, alang, aman, amang, apang, jaang, jaman, jamaing, laang, mamng, mange, maung, saang, saman, sambang, setamang, siamang, taang, tamang	19
7.	Amau	Ama, amau, bamau, mau, jamau, jambau, mau	7
8.	Amal	Ama, amal, bamal	3
9.	Belangai	Bagai, beang, belang, belangai, belangea, belangei, belangia, benai, beranai, beang	10
10.	Belangea	Banea, bangea, beang, belang, belangai, belangea, belangei, belangeh, belangia, benea, bengea, langea, langea, nelangea, bang	15
11.	Belangei	Bagei, banei, bangei, beang, belalei, belang, belangai, belangea, belangeh, belangia, belei, benei, nelngei, beang	14
12.	Belangah	Beang, belang, belangai, belangea, belangeh, belangia, beang	7
13.	Ajak	Aja, ajak, anjak, bajak, gajeak, gajeak, jak, kajak, kajoak, kajuak, majak, majoak, majuak, najak, najoak, najuak, pajoak, pajuak, sajak, bajak	20
14.	Ajal	Aja, ajal, ganjal	3
15.	Ajat	Aja, ajat, hajat	3
16.	Ajoa	Aja, ajoa, kajoa, kajoak, majoak, najoa, najoak, pajoak, tanjoa	9
17.	Badak	Andak, babak, badak, badat, badok, badut, bagak, bajak, balak, banak, bapak, bedak, budak, dadak, bajak, begadoak, begaduak	17
18.	Badang	Adang, badang, bajang, bakang, bandang, banding, bang, barang, batang, bayang, dang, kadang, kandang, madang, nadang, bediang	16
19.	Badat	Adat, badak, badat, bakat, barat, basak	6
20.	Baco	Baco, bacuo, nebaco, baco	4
21.	Bagai	Agai, bagai, bagak, bagei, bagoi, bajai, balai, batai, belangai, dagai, jagai, magai, nagai, sagai	14
22.	Bagak	Agak, ageak, agiak, babak, badai, bagak, bageak, bagiak, baguk, bajak, balak, banak, bapak, cagak, bajak	15
23.	Bageak	Agak, agea, ageak, anggea, bagak, bageak, bagiak, bakeak, baleak, bangea, bareak, beak, gageak, kageak, mageak, nageak, pageak, tageak, tangeak	19
24.	Bagei	Agei, bagai, bagei, bagen, bagoi, bajei, belei, banei, bangei, belangei, dagei, magei, nagei, sagei	14

C3 = GUREK
C4 = GURENG

	C1	C2	C3	C4
C1	0	1.41	1.73	2.44
C2	1.41	0	2.44	2.82
C3	1.73	2.44	0	1.73
C4	2.44	2.82	1.73	0

1. C1, C1 = gupeak, gupeak

	G	U	P	E	A	K
C1	1	1	1	1	1	1
C1	1	1	1	1	1	1

$$\begin{aligned} \text{C1, C1} &= (1-1)^2+(1-1)^2+(1-1)^2+(1-1)^2 \\ &\quad +(1-1)^2+(1-1)^2 \\ &= 0+0+0+0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

2. C1, C2 = gupeak, gupuak

	G	U	P	E	A	K
C1	1	1	1	1	1	1
C2	1	2	1	0	1	1

$$\begin{aligned} \text{C1, C2} &= (1-1)^2+(1-2)^2+(1-1)^2+(1-0)^2 \\ &\quad +(1-1)^2+(1-1)^2 \\ &= 0+1+0+1+1+0+0 \\ &= 2 \\ &= 1.41 \end{aligned}$$

3. C1, C3 = gupeak, gurek

	G	U	P	E	A	R	K
C1	1	1	1	1	1	0	1
C3	1	1	0	1	0	1	1

$$\begin{aligned} \text{C1, C3} &= (1-1)^2+(1-1)^2+(1-0)^2+(1-1)^2 \\ &\quad +(1-0)^2+(0-1)^2+(0-1)^2 \\ &= 0+0+1+0+1+1+0 \\ &= 3 \\ &= 1.73 \end{aligned}$$

4. C1, C4 = gupeak, gureng

	G	U	P	E	A	K	R	N	G
C1	1	1	1	1	1	1	0	0	0
C4	1	1	0	1	0	0	1	1	1

$$\text{C1, C4} = (1-1)^2+(1-1)^2+(1-0)^2+(1-1)^2 +(1-0)^2+(1-0)^2+(0-1)^2 +(1-0)^2+(1-0)^2 = 0+0+1+0+1+1+1+1+1 = 6 = 2.44$$

5. C2, C2 = gupuak, gupuak

	G	U	P	A	K
C2	1	2	1	1	1
C2	1	2	1	1	1

$$\text{C2, C2} = (1-1)^2+(2-2)^2+(1-1)^2 +(1-1)^2+(1-1)^2 = 0+0+0+0+0 = 0 = 0$$

6. C2, C3 = gupuak, gurek

	G	U	P	A	K	R	E
C2	1	2	1	1	1	0	0
C3	1	1	0	0	0	1	0

$$\text{C2, C3} = (1-1)^2+(2-1)^2+(1-0)^2+(1-0)^2 +(1-0)^2+(0-1)^2+(1-0)^2 = 0+1+1+1+1+1+1 = 6 = 2.44$$

7. C2, C4 = gupuak, gureng

	G	U	P	U	A	K	R	E	N	G
C2	1	2	1	1	1	1	0	0	0	0
C4	1	1	0	0	0	1	1	1	1	1

$$\text{C2, C4} = (1-1)^2+(2-1)^2+(1-0)^2+(1-0)^2 +(1-0)^2+(0-1)^2+(0-1)^2(0-1)^2 +(0-1)^2 = 0+1+1+1+1+1+1+1+1+1 = 8 = 2.82$$

8. C3, C3 = gurek, gurek

	G	U	R	E	K
C3	1	1	1	1	1
C3	1	1	1	1	1

$$\text{C3, C3} = (1-1)^2+(1-1)^2+(1-1)^2 +(1-1)^2+(1-1)^2 = 0+0+0+0+0 = 0 = 0$$

9. C3, C4 = gurek, gureng

	G	U	R	E	K	N	G
C3	1	1	1	1	1	0	0
C4	1	1	1	1	0	1	1

$$\text{C3, C4} = (1-1)^2+(1-1)^2+(1-1)^2+(1-1)^2 +(1-0)^2+(0-1)^2+(0-1)^2 = 0+1+0+0+0+1+1+1 = 3 = 1.73$$

10. C4, C4 = gureng, gureng

	G	U	R	E	N	G
C4	1	1	1	1	1	1
C4	1	1	1	1	1	1

$$\text{C4, C4} = (1-1)^2+(1-1)^2+(1-1)^2+(1-1)^2 +(1-1)^2+(1-1)^2 = 0+0+0+0+0+0 = 0 = 0$$

C1 = AMAN
C2 = AMANG
C3 = AMOU
C4 = AMAL

	C1	C2	C3	C4
C1	0	1	1.41	1.41
C2	1	0	2.23	1.73
C3	1.41	2.23	0	2.23
C4	1.41	1.73	2.23	0

1. C1, C1 = aman, aman

	A	M	N
C1	2	1	1
C1	2	1	1

$$\begin{aligned} C1, C1 &= (2-2)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

2. C1, C2 = aman, amang

	A	M	N	G
C1	2	1	1	0
C2	2	1	1	1

$$\begin{aligned} C1, C2 &= (2-2)^2+(1-1)^2+(1-1)^2+(0-1)^2 \\ &= 0+0+0+1 \\ &= 1 \\ &= 1 \end{aligned}$$

3. C1, C3 = aman, amau

	A	M	N	U
C1	2	1	1	0
C3	2	1	0	1

$$\begin{aligned} C1, C3 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

4. C1, C4 = aman, amal

	A	M	N	L
C1	2	1	1	0
C4	2	1	0	1

$$\begin{aligned} C1, C4 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

5. C2, C2 = aman, amang

	A	M	N	G
C2	2	1	1	1
C2	2	1	1	1

$$\begin{aligned} C2, C2 &= (2-2)^2+(1-1)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

6. C2, C3 = amang, amou

	A	M	N	G	O	U
C2	2	1	1	1	0	0
C3	1	1	0	0	1	1

$$\begin{aligned} C2, C3 &= (2-1)^2+(1-1)^2+(1-0)^2+(1-0)^2 \\ &\quad +(0-1)^2+(0-1)^2 \\ &= 1+0+1+1+1+1 \\ &= 5 \\ &= 2.23 \end{aligned}$$

7. C2, C4 = amang, amal

	A	M	N	G	L
C2	2	2	1	1	0
C4	2	1	0	0	1

$$\begin{aligned} C2, C4 &= (2-2)^2+(1-1)^2+(1-0)^2 \\ &\quad +(1-0)^2+(0-1)^2 \\ &= 0+0+1+1+1 \\ &= 3 \\ &= 1.73 \end{aligned}$$

8. C3, C3 = amou, amou

	A	M	O	U
C3	1	1	1	1
C3	1	1	1	1

$$\begin{aligned} C3, C3 &= (1-1)^2+(1-1)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

9. C3, C4 = amou, amal

	A	M	O	U	L
C3	1	1	1	1	0
C4	2	1	0	0	1

$$C3, C4 = (1-2)^2+(1-1)^2+(1-0)^2 +(1-0)^2+(0-1)^2$$
$$= 1+0+1+1+1+1$$
$$= 5$$
$$= 2.23$$

10. C4, C4 = amal, amal

	A	M	L
C4	1	1	1
C4	1	1	1

$$C4, C4 = (1-1)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0$$
$$= 0$$
$$= 0$$

C1 = BELANGAI
C2 = BELANGEA
C3 = BELANGEI
C4 = BELANGAH

	C1	C2	C3	C4
C1	0	1.41	1.73	1.41
C2	1.41	0	1.73	1.41
C3	1.73	1.73	0	2
C4	1.4	1.41	2	0

1. C1, C1 = belangai, belangai

	B	E	L	A	N	G	I
C1	1	1	1	2	1	1	1
C1	1	1	1	2	1	1	1

$$C1, C1 = (1-1)^2+(1-1)^2+(1-1)^2+(2-2)^2(1-1)^2 +(1-1)^2+(1-1)^2$$
$$= 0+0+0+0+0+0+0$$
$$= 0$$
$$= 0$$

2. C1, C2 = belangai, belangea

	B	E	L	A	N	G	I
C1	1	1	1	2	1	1	1
C2	1	2	1	2	1	1	0

$$C1, C2 = (1-1)^2+(1-2)^2+(1-1)^2+(2-2)^2+(1-1)^2 +(1-1)^2+(1-0)^2$$
$$= 0+1+0+0+0+0+1$$
$$= 2$$
$$= 1.41$$

3. C1, C3 = belangai, belangei

	B	E	L	A	N	G	I
C1	1	1	1	2	1	1	1
C3	1	2	1	1	1	1	0

$$C1, C3 = (1-1)^2+(1-2)^2+(1-1)^2+(2-1)^2+(1-1)^2 +(1-1)^2+(1-0)^2$$
$$= 0+1+0+0+0+0+1$$
$$= 3$$
$$= 1.73$$

4. C1, C4 = belangai, belangah

	B	E	L	A	N	G	I	H
C1	1	1	1	2	1	1	1	0
C4	1	1	1	2	2	1	0	1

$$C1, C4 = (1-1)^2+(1-1)^2+(1-1)^2+(2-2)^2 +(1-1)^2+(1-1)^2+(1-0)^2+(0-1)^2$$
$$= 0+0+0+0+0+1+1$$
$$= 2$$
$$= 1.41$$

5. C2, C2 = belangea, belangea

	B	E	L	A	N	G	A
C2	1	2	1	1	1	1	1
C2	1	2	1	1	1	1	1

$$C2, C2 = (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2 +(1-1)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0+0+0+0+0$$
$$= 0$$
$$= 0$$

6. C2, C3 = belangea, belangei

	B	E	L	A	N	G	I
C2	1	1	1	2	1	1	0
C3	1	2	1	1	1	1	1

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$$\begin{aligned}\text{C2, C3} &= (1-1)^2+(1-2)^2+(1-1)^2+(2-1)^2\\ &\quad+(1-1)^2+(1-1)^2+(0-1)^2\\ &= 0+1+0+1+0+0+1\\ &= 3\\ &= 1.73\end{aligned}$$

7. C2, C4 = belangea, belangah

	B	E	L	A	N	G	H
C2	1	2	1	2	1	1	0
C4	1	1	1	2	1	1	1

$$\begin{aligned}\text{C2, C4} &= (1-1)^2+(2-1)^2+(1-1)^2+(2-2)^2\\ &\quad+(1-1)^2+(1-1)^2+(0-1)^2\\ &= 0+1+1+0+0+1+0+0+1\\ &= 2\\ &= 1.41\end{aligned}$$

8. C3, C3=belangei, belangei

	B	E	L	A	N	G	I
C3	1	2	1	1	1	1	1
C3	1	2	1	1	1	1	1

$$\begin{aligned}\text{C3, C3} &= (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2\\ &\quad+(1-1)^2+(1-1)^2+(1-1)^2\\ &= 0+0+0+0+0+0+0\\ &= 0\\ &= 0\end{aligned}$$

9. C3, C4 = belangei, belangah

	B	E	L	A	N	G	I	H
C3	1	2	1	1	1	1	1	0
C4	1	1	1	2	1	1	0	1

$$\begin{aligned}\text{C3, C4} &= (1-1)^2+(2-1)^2+(1-1)^2+(1-2)^2\\ &\quad+(1-1)^2+(1-1)^2+(1-0)^2+(0-1)^2\\ &= 0+1+0+1+0+0+1+1\\ &= 4\\ &= 2\end{aligned}$$

10. C4, C4 = belangah, belangah

	B	E	L	A	N	G	H
C4	1	1	1	2	1	1	1
C4	1	1	1	2	1	1	1

$$\begin{aligned}\text{C4, C4} &= (1-1)^2+(1-1)^2+(1-1)^2+(2-2)^2\\ &\quad+(1-1)^2+(1-1)^2+(1-1)^2\\ &= 0+0+0+0+0+0+0\\ &= 0\\ &= 0\end{aligned}$$

C1 = AJAK
C2 = AJAL
C3 = AJAT
C4 = AJOA

	C1	C2	C3	C4
C1	0	1.41	1.41	1.41
C2	1.41	0	1.41	1.41
C3	1.41	1.41	0	1.41
C4	1.41	1.41	1.41	0

1. C1, C1 = ajak, ajak

	A	J	K
C1	2	1	1
C1	2	1	1

$$\begin{aligned}\text{C1, C1} &= (2-2)^2+(1-1)^2+(1-1)^2\\ &= 0+0+0\\ &= 0\\ &= 0\end{aligned}$$

2. C1, C2 = ajak, ajal

	A	J	K	L
C1	2	1	1	0
C2	2	1	0	1

$$\begin{aligned}\text{C1, C2} &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2\\ &= 0+0+1+1\\ &= 2\\ &= 1.41\end{aligned}$$

3. C1, C3 = ajak, ajat

	A	J	K	T
C1	2	1	1	0
C3	2	1	0	1

$$\begin{aligned}\text{C1, C3} &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2\\ &= 0+0+1+1\\ &= 2\\ &= 1.41\end{aligned}$$

4. C1, C4 = ajak, ajoa

	A	J	K	O
C1	2	1	1	0
C4	2	1	0	1

$$\begin{aligned} C1, C4 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

5. C2, C2 = ajal, ajal

	A	J	L
C2	2	1	1
C2	2	1	1

$$\begin{aligned} C2, C2 &= (2-2)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

6. C2, C3 = ajal, ajat

	A	J	L	T
C2	2	1	1	0
C3	2	1	0	1

$$\begin{aligned} C2, C3 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

7. C2, C4 = ajal, ajoa

	A	J	L	O
C2	2	1	1	0
C4	2	1	0	1

$$\begin{aligned} C2, C4 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

8. C3, C3 = ajat, ajat

	A	J	T
C3	2	1	1
C3	2	1	1

$$\begin{aligned} C3, C3 &= (2-2)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

9. C3, C4 = ajat, ajoa

	A	J	T	O
C3	2	1	1	0
C4	2	1	0	1

$$\begin{aligned} C3, C4 &= (2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2 \\ &= 0+0+1+1 \\ &= 2 \\ &= 1.41 \end{aligned}$$

10. C4, C4 = ajoa, ajoa

	A	J	O
C4	2	1	1
C4	2	1	1

$$\begin{aligned} C4, C4 &= (2-2)^2+(1-1)^2+(1-1)^2 \\ &= 0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

C1 = BADAK
C2 = BADANG
C3 = BADAT
C4 = BACO

	C1	C2	C3	C4
C1	0	1.73	1.41	2.23
C2	1.73	0	1.73	2.44
C3	1.41	1.73	0	2.23
C4	2.23	2.44	2.23	0

1. C1, C1 = badak, badak

	B	A	D	K
C1	1	2	1	1
C1	1	2	1	1

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$$\text{C1, C1} = (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0$$
$$= 0$$
$$= 0$$

2. C1, C2 = badak, badang

	B	A	D	K	N	G
C1	1	2	1	1	0	0
C2	1	2	1	0	1	1

$$\text{C1, C2} = (1-1)^2+(2-2)^2+(1-1)^2+(1-0)^2$$
$$+(0-1)^2+(0-1)^2$$
$$= 0+0+0+1+1+1$$
$$= 3$$
$$= 1.73$$

3. C1, C3 = badak, badat

	B	A	D	K	T
C1	1	2	1	1	0
C3	1	2	1	0	1

$$\text{C1, C3} = (1-1)^2+(2-2)^2+(1-1)^2$$
$$+(1-0)^2+(0-1)^2$$
$$= 0+0+0+1+1$$
$$= 2$$
$$= 1.41$$

4. C1, C4 = badak, baco

	B	A	D	K	C	O
C1	1	2	1	1	0	0
C4	1	1	0	0	0	1

$$\text{C1, C4} = (1-1)^2+(2-1)^2+(1-0)^2+(1-0)^2$$
$$+(0-1)^2+(0-1)^2$$
$$= 0+1+1+1+1+1$$
$$= 4$$
$$= 2.23$$

5. C2, C2 = badang, badang

	B	A	D	N	G
C2	1	2	1	1	1
C2	1	2	1	1	1

$$\text{C2, C2} = (1-1)^2+(2-2)^2+(1-1)^2$$
$$+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0+0$$
$$= 0$$
$$= 0$$

6. C2, C3 = badang, badat

	B	A	D	N	G	T
C2	1	2	1	1	1	0
C3	1	2	1	0	0	1

$$\text{C2, C3} = (1-1)^2+(2-2)^2+(1-1)^2+(1-0)^2$$
$$+(1-0)^2+(0-1)^2$$
$$= 0+0+0+1+1+1$$
$$= 3$$
$$= 1.73$$

7. C2, C4 = badang, baco

	B	A	D	N	G	C	O
C2	1	2	1	1	1	0	0
C4	1	1	0	0	0	1	1

$$\text{C2, C4} = (1-1)^2+(2-1)^2+(1-0)^2+(1-0)^2$$
$$+(1-0)^2+(0-1)^2+(0-1)^2$$
$$= 0+1+1+1+1+1+1$$
$$= 6$$
$$= 2.44$$

8. C3, C3 = badat, badat

	B	A	D	T
C3	1	2	1	1
C3	1	2	1	1

$$\text{C3, C3} = (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0$$
$$= 0$$
$$= 0$$

9. C3, C4 = badat, baco

	B	A	D	T	C	O
C3	1	2	1	1	0	0
C4	1	1	0	0	0	1

$$C3, C4 = (1-1)^2+(2-1)^2+(1-0)^2+(1-0)^2+(0-1)^2+(0-1)^2$$
$$= 0+1+1+1+1+1$$
$$= 5$$
$$= 2.23$$

10. C4, C4 = baco, baco

	B	A	C	C
C4	1	1	1	1
C4	1	1	1	1

$$C4, C4 = (1-1)^2+(1-1)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0$$
$$= 0$$
$$= 0$$

C1 = BAGAI
C2 = BAGAK
C3 = BAGEAK
C4 = BAGEI

	C1	C2	C3	C4
C1	0	1.41	1.73	1.41
C2	1.41	0	1	2
C3	1.73	1	0	1.73
C4	1.41	2	1.73	0

1. C1, C1 = bagai, bagai

	B	A	G	I
C1	1	2	1	1
C1	1	2	1	1

$$C1, C1 = (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0$$
$$= 0$$
$$= 0$$

2. C1, C2 = bagai, bagak

	B	A	G	I	K
C1	1	2	1	1	0
C2	1	2	1	0	1

$$C1, C2 = (1-1)^2+(2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2$$
$$= 0+0+0+1+1$$
$$= 2$$
$$= 1.41$$

3. C1, C3 = bagai, bageak

	B	A	G	I	E	K
C1	1	2	1	1	0	0
C3	1	2	1	0	1	1

$$C1, C3 = (1-1)^2+(2-2)^2+(1-1)^2+(1-0)^2+(0-1)^2+(0-1)^2$$
$$= 0+0+0+1+1+1$$
$$= 3$$
$$= 1.73$$

4. C1, C4 = bagai, bagei

	B	A	G	E	I
C1	1	2	1	0	1
C4	1	1	1	1	1

$$C1, C4 = (1-1)^2+(2-1)^2+(1-1)^2+(0-1)^2+(1-1)^2$$
$$= 0+1+0+1+0+1$$
$$= 2$$
$$= 1.41$$

5. C2, C2 = bagak, bagak

	B	A	G	K
C2	1	2	1	1
C2	1	2	1	1

$$C2, C2 = (1-1)^2+(2-2)^2+(1-1)^2+(1-1)^2$$
$$= 0+0+0+0$$
$$= 0$$
$$= 0$$

6. C2, C3 = bagak, bageak

	B	A	G	E	K
C2	1	2	1	0	1
C3	1	2	1	1	1

$$C2, C3 = (1-1)^2+(2-2)^2+(1-1)^2+(0-1)^2+(1-1)^2$$
$$= 0+0+0+1+0$$
$$= 1$$
$$= 1$$

7. C2, C4 = bagak, bagei

	B	A	G	K	E	I
C2	1	2	1	1	0	0
C4	1	1	1	0	1	1

$$\begin{aligned} \text{C2, C4} &= (1-1)^2+(2-1)^2+(1-1)^2+(1-0)^2 \\ &\quad +(0-1)^2+(0-1)^2 \\ &= 0+1+0+1+1+1+1 \\ &= 4 \\ &= 2 \end{aligned}$$

8. C3, C3 = bageak, bageak

	B	A	G	E	K
C3	1	2	1	1	1
C3	1	2	1	1	1

$$\begin{aligned} \text{C3, C3} &= (1-1)^2+(2-2)^2+(1-1)^2 \\ &\quad +(1-1)^2+(1-1)^2 \\ &= 0+0+0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

9. C3, C4 = bageak, bagei

	B	A	G	E	K	I
C3	1	2	1	1	1	0
C4	1	1	1	1	0	1

$$\begin{aligned} \text{C3, C4} &= (1-1)^2+(2-1)^2+(1-1)^2+(1-1)^2 \\ &\quad +(1-0)^2+(0-1)^2 \\ &= 0+1+0+0+1+1+1 \\ &= 3 \\ &= 1.73 \end{aligned}$$

10. C4, C4 = bagei, bagei

	B	A	G	E	I
C4	1	1	1	1	1
C4	1	1	1	1	1

$$\begin{aligned} \text{C4, C4} &= (1-1)^2+(1-1)^2+(1-1)^2 \\ &\quad +(1-1)^2+(1-1)^2 \\ &= 0+0+0+0+0 \\ &= 0 \\ &= 0 \end{aligned}$$

The problem of finding spelling errors by machine is one of the issues discussed in natural language processing. After the advent of computer science and artificial intelligence issues, natural language processing has received much attention. In general, natural language processing is one of the most important branches in the broad field of artificial intelligence, as well as in linguistic knowledge. The major effort in this field is to mechanize the process of understanding and understanding concepts expressed in a natural human language by machine. With the advent of the Internet and the spread of electronic texts, this science has become particularly important, with the result that it can extract specific information from a text, translate a text into another language, find specific documentation in a written database, query systems, and more. Human response to computers, automated customer service by phone, and voice control systems are noted. Efforts have also been made to implement various types of spelling errors, intelligent machine translators, speech processing and speech recognition software, and text-to-speech software.

4. CONCLUSION

1. The N-gram method works to cut the characters from the words entered with the generation of Uni-grams.
2. Calculation of similarity distance using the Euclidean Distance method shows that similarity values close to 0 will display words that are similar.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5396–5407, 2019

RESEARCH ARTICLE

Measurement of Readiness Levels for Adoption of Enterprise Resource Planning Clouds in Small Medium Enterprise with Net Ready Model

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Industry 4.0 has changed the way we live, work and interact, creating new opportunities and challenges. To deal with these challenges, SMEs need an application that can integrate and automate SME business processes. Small and Medium Enterprises are very important for Indonesia's economic growth. The 2016 economic census conducted by the Central Bureau of Statistics stated the rapid economic growth among MSMEs. The more rapid growth of the market, the greater the competition in the market coupled with the current digital era. The study was conducted to measure the readiness of small and medium enterprises in the Bogor area that are engaged in fashion for Cloud ERP adoption. Readiness measurement is done by the Net Ready method which has four variables, namely: Leadership, Governance, Competencies, Technology. The Net Ready method further assesses the readiness to the level of the organization and the results of measurements which each have different value contributions. Governance provides the biggest contribution in the assessment of Net Ready which has a score of 1.06. Competencies provide the second largest contribution which has a score of 0.77. Technology provides the third largest contribution which has a value of 0.72. Leadership makes the smallest contribution in this study which has a score of 0.58, lack of management awareness of integrated information systems to make new business strategies. The total score obtained from the summary of each variable total score produces a value of 3.12. The total score can be categorized as Bogor region SMEs engaged in fashion, quite ready to adopt Cloud ERP.

Keywords: SMEs, Cloud ERP, Net Ready.

1. INTRODUCTION

Information technology that is increasingly developing in this era makes things faster. This significant change made almost every company vying to improve the quality of the company's system. The use of a manual system is considered long because the system is not organized and difficult to monitor. So we need an organized information system to make it easier for companies to run the system. One of the information technologies specifically made to help companies is Enterprise Resource Planning (ERP) [1]. In economic development in Indonesia SMEs are always described as a sector that has an important role.

Regency or City of Bogor has a value of 8.09 percent of the number of businesses/companies outside the agricultural category of the West Java province which reached 4,214,901. Based on the portal bogor.go.id the potential in the Bogor region is large especially in the fashion sector. Cloud ERP based on Software a Service (Saas) is one of the good opportunities to help the competition of SMEs, especially in the Bogor area, especially in the fashion sector. According to Hartman [2], in his Net Ready book—Strategies for Success in the Economy. There are several readiness measurement variables at the organizational level. These variables are: Leadership, Governance, Competencies, Technology.

2. LITERATURE REVIEWS

2.1. Small Medium Enterprise (SME)

SMEs can play a role in increasing export opportunities through superior products produced generally based on local resources [3]. UKM acts as the backbone and driver of the country's economy through the control of most business sectors in various regions (see Fig. 1). While seen from a social perspective, SMEs have made important and large contributions in providing employment and income

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1546-1955/2019/16/5396/012 doi:10.1166/jctn.2019.8609

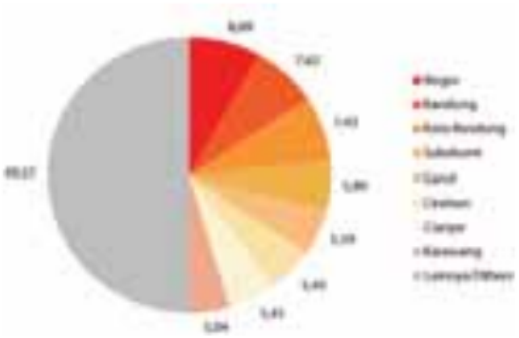

Fig. 1. Business distribution/company of West Java province.

for the people of Indonesia. Therefore, empowerment and sustainable development need to be done so that small and medium enterprises do not only grow in large numbers but also develop in the quality and competitiveness of the products produced.

3. CLOUD COMPUTING

Cloud computing is not a technology, but a computational model. In this model, all servers, networks, applications and other elements related to the data center are provided by vendors for their users via the internet.

3.1. Cloud ERP

Cloud ERP offers an easy and inexpensive way to implement ERP [4]. the KA model (Cloud Computing) emerged as a new technology that provides services to end users with service and network products through the provision of portals. Forms of service include Hardware, Platforms, Services, Networks, Storage Providers, Servers, etc. Companies that have offered KA (Cloud Computing) include Apple, Google, Amazon, Digital Ocean and Soft Layer.

3.2. Uji Validitas Dan Reliabilitas

According to, validity is a period that shows the level of validity of a research instrument. Validity test is intended to ascertain how well an instrument measures concepts that should be measured, with the following conditions:
If r count positive, and r count > r table, then the data is valid (presented in Table I).

Table I. Croonbach's alpha rule of thumb.

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Table II. Measurement items.

Construction	Indicator variable	Prior research
LEADERSHIP	LRS1 = the importance of management being aware of the opportunities and challenges facing the digital economy	Hartman, Sifonis and Kador [5]
	LRS2 = the importance of information system integration activities is our business strategy	
	LRS3 = Information sharing in organizations	
	LRS4 = Cloud ERP Adoption Plan for the next 6 to 12 months	
	LRS5 = Cloud ERP innovation leads to the creation of new businesses	
GOVERNANCE	GVN1 = Roles and responsibilities of each person in charge	Hartman, Sifonis and Kador [5]
	GVN2 = Authority to take Cloud ERP adoption decisions	
	GVN3 = Possible changes are made to Cloud ERP Adoption	
	GVN4 = Defines business cases for Cloud ERP Adoption	
	GVN5 = Business processes will be systematic with Cloud ERP	
COMPETENCIES	CPT1 = Following the speed of changes in information systems	Hartman, Sifonis and Kador [5]
	CPT2 = Can define information system solutions	
	CPT3 = Having knowledge of information systems	
	CPT4 = Using the internet in carrying out business processes	
	CPT5 = Have experience	
	CPT6 = Can make and complete forms of cooperation quickly	
TECHNOLOGY/ TEKNOLOGI	TEC1 = IT infrastructure standards in organizations	Hartman, Sifonis and Kador [5]
	TEC2 = Availability of internet networks, to adopt Cloud ERP	
	TEC3 = IT infrastructure can accommodate changes	
	TEC4 = IT systems are able to change in meeting customer needs	
	TEC5 = The essence of the new system leads to effectiveness	

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If r count positive, and r count $< r$ table, then the data is invalid.
the method used for validity testing is Pearson Correlation Coefficient (r count) greater than r table. r table can be obtained from the formula

$$\frac{t}{\sqrt{df + t^2}}$$

states that reliability is an index that shows the extent to which measuring devices can be trusted or reliable. Reliability can indicate the extent to which the measurement results remain consistent if measurements are taken twice or more for the same symptoms with the same measuring instrument. Reliability testing is done to determine the internal consistency between variables in the instrument. One technique for testing reliability is to use the Cronbach's Alpha methodology. According to, the Cronbach's Alpha methodology was introduced into the system to measure internal consistency of the questionnaire to look at deficiencies in the design of the proposed questionnaire, and provide advice to help researchers design the questionnaire the best in the survey that is being carried out. There are also similarities from Cronbach's Alpha which can be seen in the following formula:

$$\alpha = \frac{n}{n}\left(1 - \frac{\sum V_i}{V_{\text{test}}}\right)$$

Information: n = the number of questions asked, V_i = variant of the score on each item, V_{test} = the total variant of the overall score in the test.

The range of alpha (α) ranges from zero (0) to one (1). The acceptable level is each time the alpha value is greater than 0.70. The value to be obtained will be large if the Vtest value is greater than Vtotal.

3.3. Net Ready

Net ready is one way to measure the level of readiness of users in using and empowering technology [5]. According to the book called Net Ready - Strategies for Success in E-conomy states, many companies are trying to automate their business processes and implement various types of information technology systems to help business processes to be run more modern, faster, more efficient and more flexible. Automating business processes can be done both in the company's external (as a profit earner) and in the company's internal (as a management system a data management, business and company information). An important pillar for organizations to be able to develop business approaches that are more organizational in nature is that a company will be successful if they can focus on these four important pillars: Leadership: Leadership is one of the main points that can influence an organization and the readiness of the organization itself in utilizing technology to support the strategic or business plan of an organization. A leader must also be able to unite three other components in order to work as a unit [6–9]. Governance: Corporate governance has an important role here. An organization that has good governance by implementing GCG (Good Corporate Governance) tends to be able to utilize its resources, both in terms of infrastructure and human resources. Competencies: The competency values of a company also play an important role in advancing a business of the organization. An organization or company that is competent and has competent human resources, can take advantage of all available resources in facing business competition, one of which is by having a high level of readiness. Technology: Technology has a very vital role in the success of an organization in carrying out its business strategy. Technology also plays an important role in achieving an organization's vision, mission and goals in the face of business competition. the four points above can be important keys to the success of an organization in facing the business competition map. The four points above can also be a reference in measuring the level of readiness of an organization in facing business competition. The role of Net Ready here is to provide an assessment, how ready or how can a company be successful in running its business processes that are run more modern with improved technology better like Cloud ERP than what has been used before. The readiness measurement items are as follows:

The readiness category of the Net Ready model is as follows.

Table III. Net ready categories.

Score	Description
>5.0	Net Visionary. The organization has shown the highest level of readiness of Net Readiness and is ready to implement IT.
5.0–4.1	Net Leader. At this level, the Net Ready of an organization is considered very good, but there are still a few important things that need to be improved.
4.0–3.1	Net Savvy. The organization shows good knowledge about IT and Net Ready.
3.0–2.0	Net Aware. At this level, organizations need improvements to increase Net Ready users in order to have an understanding of IT and good Net Ready
<1.0	Net Agnostic. The IT sector and IT policy have not become the priorities and concerns of the organization. The IT implementation carried out is considered to be in vain because of a lack of understanding of IT and the impact of IT implementation on the organization.

4. METHODOLOGY

This research was carried out with the following steps (see Fig. 2):

Data collection was carried out in this study using the questionnaire method. The respondent is the person who provides answers to the questions and statements made. So that answers can be measured then the respondent's answer is scored [10–13]. In giving the score using a Likert scale. The Likert scale is a scale that is widely used

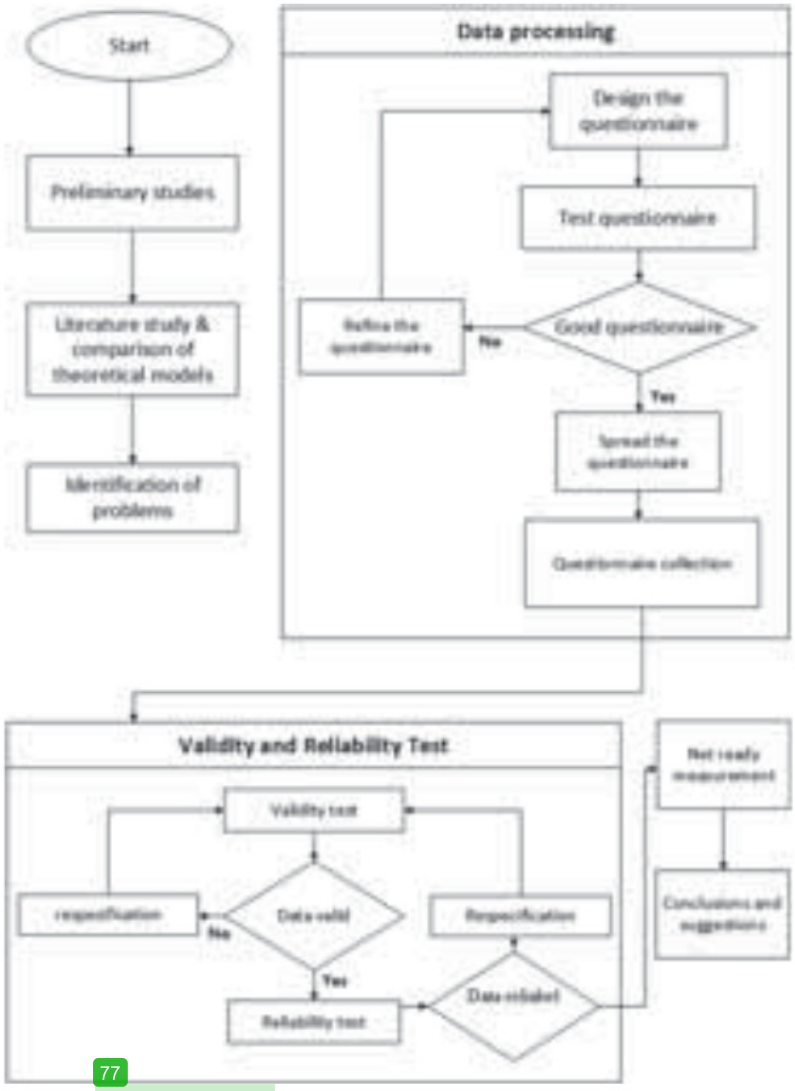

Fig. 2. Research methodology.

which asks respondents to mark the degree of agreement or disagreement with each of a series of statements regarding the stimulus object. Non Probability Sampling technique researchers use accidental sampling methods (accidental side). According to Santoso and Tjiptono accidental sampling (convenience sampling) is a sampling procedure that selects samples from people or units that are most easily found or accessed. Whereas according to accidental sampling is taking respondents as a sample based on coincidence, that is, anyone who accidentally meets with a researcher can be used as a sample, if people who happen to be found are suitable as data sources with the main criteria being SME owners in Bogor engaged in fashion. The reason for using this method is because the unknown population size of this method is very appropriate for this study. This research was conducted when researchers submitted a questionnaire to a fashion shop in the Bogor area Based on the distributed questionnaire, get the following information [14–17].

The average respondent is seen from Figure 3, the largest percentage is accessories which reached 77 percent and second place was footwear which reached

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Table IV. Respondent information.

Information	Frequency
Selling products	
Clothing (clothes, pants, jackets, etc.)	23
Footwear (shoes, sandals)	3
Accessories (hats, bracelets, necklaces, watches, bags)	4
Business criteria	
Micro	0
Small	6
Middle	24
Business entity	
CV	15
Firm	7
Cooperative	3
PT (integrated company)	0
Number of employees	
<10 People	11
10–50 People	19
51–100 People	0
>100 People	0
Age of SMEs	
<3 Year	2
3–7 Year	22
8–15 Year	6
>15 Year	0
Accounting aids	
Bookkeeping	4
Manual with Excel	23
Other applications or software	3
Buy/Sell online	
Yes	28
No	2
Devices for the internet	
Handphone	26
Computer	4
Cable internet provider	
Biznet home	3
First media	8
Indie home	2
MNC media	7
Do not use	10
Cellular internet provider	
Telkomsel	22
XL	2
Smartfreen	1
TRI	0
Indosat	2
Do not use	3
Knowing cloud computing	
Yes	20
No	10
Know the integrated information system	
Yes	22
No	8

13 percent. And third place is clothing that reaches 10 percent.

Meanwhile, if seen in Figure 4, the highest percentage is medium enterprises which reach 80 percent, and small businesses reach 20 percent.

Judging from Figure 5, the average number of respondents is CV which has a percentage value of 50 percent.

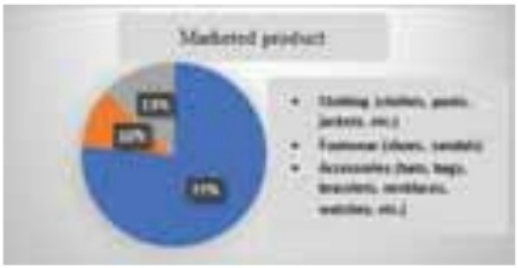

Fig. 3. Products marketed.

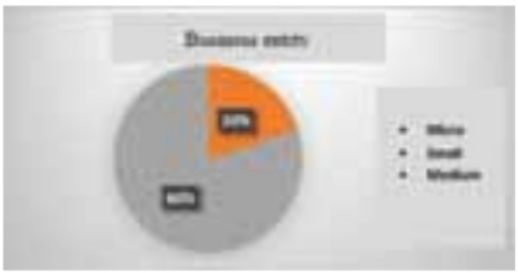

Fig. 4. Business criteria.

Perseorang has a percentage value of 17 percent, Firm has 23 percent, cooperatives have 10 percent and PT 0 percent.

Judging from Figure 6, the average number of employee respondents ranges from 10–50 people who have a percentage value of 63 percent and the remaining <10 people.

Viewed from Figure 7, the average age of the establishment of UKM is 3–7 years which has a percentage value of 73 percent. 8–5 years has a value of 20 percent. The remaining <3 years.

The average tool for accounting activities already uses Ms Excel which has a percentage value of 70 percent. Open records have a percentage value of 13 percent and the rest use other applications/software that have a percentage value of 10 percent.

Fig. 5. Business entity.

Fig. 6. Number of employees.

Fig. 7. Age of SMEs.

Fig. 8. Tools for accounting activities.

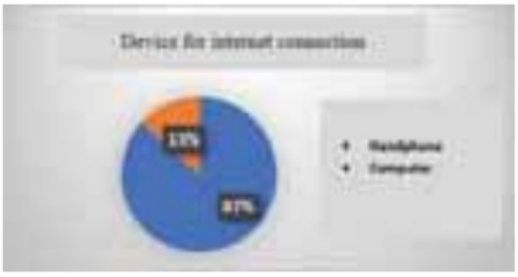

Fig. 9. Internet connection device.

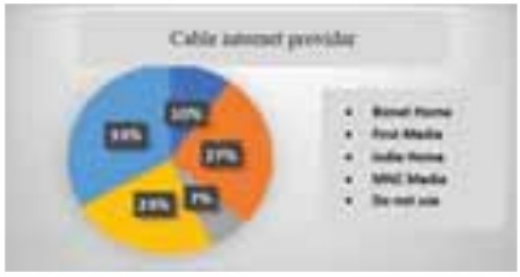

Fig. 10. Cable internet provider.

The device for using the cell phone which has a percentage value of 87 percent and the rest using a computer (see Figs. 8, 9).

Viewed from Figure 10, the average respondent answered that he did not use a cable internet provider that reached 33 percent and Biznet Home reached a percentage value of 10 percent, First media reached a percentage value of 27 percent, Indie Home reached a percentage of 7 percent, MNC media reached 23 percent.

The cellular internet providers used by respondents on average are Telkomsel, which reached a percentage of 73 percent, then 10 percent said they did not use, 7 percent answered using Indosat providers, 7 percent answered using smart providers, and 3 percent answered using XL providers (see Fig. 11).

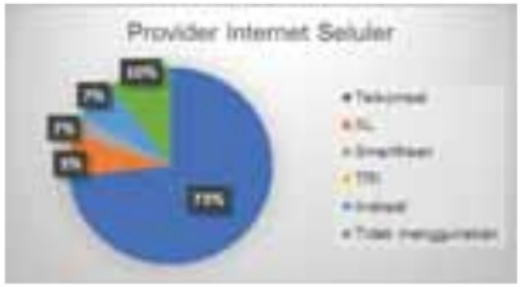

Fig. 11. Cellular internet provider.

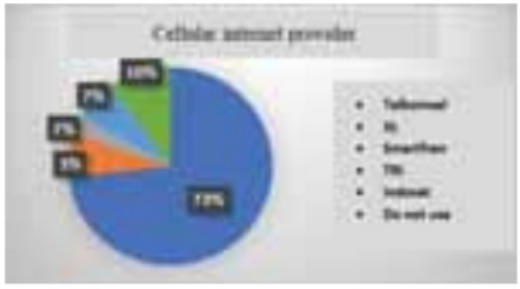

Fig. 12. Selling/buying online.

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Fig. 13. Get to know cloud computing.

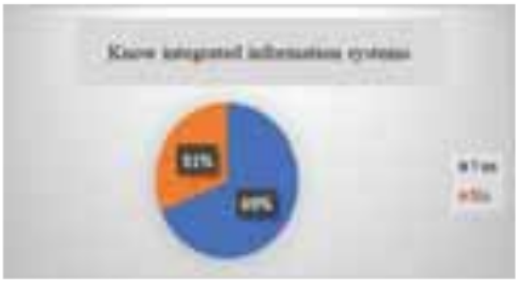

Fig. 14. Get to know integrated information systems.

Judging from Figure 12, the average SME respondent has made an online sale/purchase transaction which has a percentage value of 90 percent and the remaining 10 percent of SMEs have not implemented their business processes online.

Viewed from Figure 13, the average respondent also knows Cloud Computing. Respondents who knew Cloud Computing reached 86 percent while the remaining 14 percent did not know Cloud Computing.

Viewed from Figure 14, the average respondent knows integrated information systems that reach a value of 69 percent and the rest do not recognize an integrated information system [18–19].

5. RESULTS AND DISCUSSION

5.1. Hypothesis

The following below is a hypothesis that will be tested for validity and reliability using the SPSS application. The hypothesis is structured by the Net Ready model.

Leadership

In this variable there are 5 hypotheses containing leadership as follows:

"H1: the importance of management being aware of the opportunities and challenges facing the digital economy has a significant influence on adopting Cloud ERP (L1)."

"H2: the importance of information system integration activities into our business strategy has a significant influence on adopting Cloud ERP (L2)."

"H3: Information sharing in organizations has a significant influence on adopting Cloud ERP (L3)."

"H4: Cloud ERP 6 Adoption Plan for the next 12 months has a significant effect on adopting Cloud ERP (L4)."

"H5: Cloud ERP initiation leads to the creation of new businesses that have a significant influence on adopting Cloud ERP (L5)."

Governance

In this variable there are 5 hypotheses that contain governance as follows:

"H6: Roles and responsibilities of each person in charge have a significant influence on adopting Cloud ERP (G1)."

"H7: The authority to make decisions has a significant influence on adopting Cloud ERP (G2)."

"H8: Changes in governance have a significant effect on adopting Cloud ERP (G3)."

"H9: Defining business cases has a significant influence on adopting Cloud ERP (G4)."

"H10: Systematic business processes have a significant influence on adopting Cloud ERP (G5)."

Competencies

In this variable there are 6 hypotheses which contain the following competencies:

"H11: Following the speed of changes in information systems has a significant effect on adopting Cloud ERP (C1)."

"H12: Can define information system solutions have a significant effect on adopting Cloud ERP (C2)."

"H13: Having knowledge about information systems has a significant influence on adopting Cloud ERP (C3)."

"H14: Using the internet in carrying out business processes has a significant influence on adopting Cloud ERP (C4)."

"H15: Having experience has a significant influence on adopting Cloud ERP (C5)."

"H16: Can make and complete forms of cooperation quickly have a significant influence to adopt Cloud ERP (C6)."

Technology

In this variable there are 5 hypotheses that contain technology as follows:

"H17: IT infrastructure standards in organizations have a significant influence on adopting Cloud ERP (T1)."

"H18: Availability of internet networks has a significant influence on adopting Cloud ERP (T2)."

"H19: IT infrastructure can accommodate change has a significant influence to adopt Cloud ERP (T3)."

"H20: IT systems capable of changing in meeting customer needs have a significant influence on adopting Cloud ERP (T4)."

"H21: The essence of the new system leads to effectiveness having a significant influence on adopting Cloud ERP (T5)."

5.2. Uji Validitas

Validity Test in this study was conducted to find out and measure what data should be measured. In this study, the method used for validity testing is Pearson Correlation Coefficient (r count) greater than r table. For rtabel obtained from the formula $= \frac{t}{\sqrt{df+t^2}}$ Based on the formula above obtained r table of 0.36 r count must be greater than r table so that it can be declared valid. In this study the validity test is done by measuring the data from respondents for all elements of the statement variable (Leadership, Governance, Competencies, Technology). In this study all statements are declared valid because they have a calculated r value greater than r table [20–24].

In Table V, in testing the validity of leadership variables, it shows all the statements L1, L2, L3, L4, L5 towards the total, showing the number r calculated greater than r table, which is 0.36 with a significant level of 0.05.

In Table VI, in testing the validity of leadership variables, it shows all the statements G1, G2, G3, G4, G5 towards the total, indicating the number r calculated is greater than r table which is 0.36 with a significant level of 0.05.

In Table VII, in testing the validity of leadership variables, it shows that all statements C1, C2, C3, C4, C5, C6 to the total show the number r calculated greater than table which is 0.36 with a significant level of 0.05 [25–26].

In Table VIII in testing the validity of leadership variables, it shows all the statements T1, T2, T3, T4, T5 towards the total, indicating the number of r count is greater than r table which is 0.36 with a significant level of 0.05. Based on the overall validity test of all statements from 4 variables with 21 statements having a calculated r value greater than r table 0.36 then all statements are declared valid and can be used for this study [27–28].

Table V. Leadership variable.

Correlations	Sum_Lead
L1	
Pearson correlation	.789**
Sig. (2-tailed)	.000
N	30
L2	
Pearson correlation	.789**
Sig. (2-tailed)	.000
N	30
L3	
Pearson correlation	.848**
Sig. (2-tailed)	.000
N	30
L4	
Pearson Correlation	.477**
Sig. (2-tailed)	.008
N	30
L5	
Pearson Correlation	.778**
Sig. (2-tailed)	.000
N	30

Note: **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table VI. Governance variable.

Correlations	Sum_Gove
G1	
Pearson correlation	.954
Sig. (2-tailed)	.000
N	30
G2	
Pearson Correlation	.954
Sig. (2-tailed)	.000
N	30
G3	
Pearson correlation	.779
Sig. (2-tailed)	.000
N	30
G4	
Pearson correlation	.777
Sig. (2-tailed)	.000
N	30
G5	
Pearson correlation	.376
Sig. (2-tailed)	.041
N	30

5.3. Reliability Test

Based on the results of the reliability test the results are as follows:

Table VII. Competencies variable.

Correlations	Sum_Comp
C1	
Pearson correlation	.448
Sig. (2-tailed)	.013
N	30
C2	
Pearson Correlation	.677
Sig. (2-tailed)	.000
N	30
C3	
Pearson Correlation	.567
Sig. (2-tailed)	.001
N	30
C4	
Pearson Correlation	.677
Sig. (2-tailed)	.000
N	30
C5	
Pearson Correlation	.547
Sig. (2-tailed)	.002
N	30
C6	
Pearson Correlation	.474
Sig. (2-tailed)	.008
N	30

Table VIII. Technology variable.

Correlations	Sum_Tech
T1	
Pearson correlation	.450
Sig. (2-tailed)	.013
N	30
T2	
Pearson correlation	.640
Sig. (2-tailed)	.000
N	30
T3	
Pearson correlation	.486
Sig. (2-tailed)	.006
N	30
T4	
Pearson correlation	.470
Sig. (2-tailed)	.009
N	30
T5	
Pearson correlation	.584
Sig. (2-tailed)	.001
N	30

Reliability test to see the consistency of data taken through questionnaires distributed by researchers. The method used to test reliability here is using Cronbach's alpha. In this study the data were declared reliable if the Cronbach's alpha coefficient was more than 0.6. In this study, the Cronbach's alpha coefficient from the research data shows the number 0.849 which means that the data are reliable and can be used for research [29–32].

5.4. Net Ready Measurement

Net Ready measurements are carried out to analyze tea data taken by researchers from the respondents to then answer the research questions. The data from the questionnaire statement are grouped into 4 research variables so that the overall value of the variable can be obtained in the form of a mean value. The method of calculating the Net Ready value is calculated from the mean value of the foreign questionnaire multiplied by the weight of each statement. Each variable has a total weight of 25%. The weight of the total is divided by the number of statements from each variable. After obtaining the weight of each statement *n*, then the mean value of the statement is multiplied by the weight of each statement. The Net Ready total score is derived from the total number of total scores for each statement [33].

It can be seen in Table X that the first largest contribution is in statement No. 4 worth 0.2. Statement No. 4 is that management will have plans to adopt Cloud ERP for the next 6 months to 12 months after SMEs know the benefits and work systems of Cloud ERP. The second largest contribution is in statements no. 1, 2, 3 which give a value of 0.1. Statement No. 1 is that management has realized the opportunities or challenges in the digital era, this indicates that management is aware of intense competition and must utilize information systems for its business strategy. Statement No. 2 is that management has integrated information system activities for business processes. Statement No. 3 is that management is aware of the importance of information culture in an organization. The last smallest contribution is statement number 5 which has a value of 0.1. Statement No. 3 is that management is aware that Cloud adoption ERP leads to new business processes that are more efficient. Respondents have sufficient leadership views on challenges and intense competition in the current digital era. One important thing is that SMEs will have an ERP Cloud adoption plan for the next 6 months to 12 months after getting an explanation of Cloud ERP [33]. In Table XI shows the same score that is equal to 0.2 starting from statement No. 1 to statement No. 5 indicates SMEs have excellent governance to lead to adoption of

Table IX. Reliability statistics.

Reliability statistics	
Cronbach's Alpha	N of Items
.849	21

Table X. Total leadership score.

	The answer					
Statement no.	*f*	*n*	Fxn	Mean	Scale (%)	Score
1	1	5	5	2	5	0.1
	2	21	42			
	3	3	9			
	4	1	4			
	5	0	0			
Total		30	60			
2	1	5	5	2	5	0.1
	2	21	42			
	3	3	9			
	4	1	4			
	5	0	0			
Total		30	60			
3	1	5	5	2	5	0.1
	2	22	44			
	3	2	6			
	4	0	0			
	5	1	5			
Total		30	60			
4	1	0	0	4	5	0.2
	2	7	14			
	3	9	27			
	4	0	0			
	5	14	70			
Total		30	111			
5	1	6	6	2	5	0.1
	2	23	46			
	3	0	0			
	4	1	4			
	5	0	0			
Total		30				
		Score total				0.6

Table XI. Total governance score.

Statement no.	The answer f	n	Fxn	Mean	Scale (%)	Score
1	1	0	0	4	5	0.2
	2	1	2			
	3	4	12			
	4	11	44			
	5	14	70			
Total		30	128			
2	1	0	0	4	5	0.2
	2	1	2			
	3	4	12			
	4	11	44			
	5	14	70			
Total		30	128			
3	1	0	0	4	5	0.2
	2	1	2			
	3	4	12			
	4	14	56			
	5	11	55			
Total		30	125			
4	1	0	0	4	5	0.2
	2	0	0			
	3	7	21			
	4	9	36			
	5	14	70			
Total		30	127			
5	1	0	0	4	5	0.2
	2	0	0			
	3	4	12			
	4	15	60			
	5	11	55			
Total		30	127			
		Score total				1,1

Cloud ERP. the statement on this variable has a large total contribution to the total Net Ready score.

In Table XII there are 6 items of statements and can be seen the biggest contribution is in statements no. 2 and 4 which have a value of 0.2. Statement No. 2 is that our SMEs can make good use of information systems to support business processes. This indicates that SMEs will be able to use Cloud ERP for business process interests if it has been adopted. Statement No. 4 is that all employees in SMEs are familiar with the internet. This indicates the opportunity to adopt Cloud ERP because the adoption of Cloud ERP is closely related to the internet. The second largest contribution is in statement No. 6 which has a value of 0.2. Statement No. 6 is SMEs we can have good and fast cooperation in running business processes. This indicates that good cooperation will provide smooth business processes because Cloud ERP requires good cooperation between the parts that hold their respective responsibilities. The third largest contribution is in statement No. 1 which has a value of 0.1. Statement No. 1 is that our SMEs are able to face the rapid development of ongoing technology. This indicates that SMEs are able to move quickly towards the digital era and are currently developing rapidly

Table XII. Score of total competencies.

Statement no.	The answer f	n	Fxn	Mean	Scale (%)	Score
1	1	5	5	2	4.2	0.1
	2	18	36			
	3	6	18			
	4	1	4			
	5	0	0			
Total		30	63			
2	1	0	0	4	4.2	0.2
	2	0	0			
	3	7	21			
	4	9	36			
	5	14	70			
Total		30	127			
3	1	11	11	2	4.2	0.1
	2	13	26			
	3	6	18			
	4	0	0			
	5	0	0			
Total		30	55			
4	1	0	0	4	4.2	0.2
	2	0	0			
	3	7	21			
	4	9	36			
	5	14	70			
Total		30	127			
5	1	10	10	2	4.2	0.1
	2	15	30			
	3	3	9			
	4	2	8			
	5	0	0			
Total		30	57			
6	1	0	0	4	4.2	0.2
	2	0	0			
	3	5	15			
	4	14	56			
	5	11	55			
Total		30	126			
		Score total				0.8

Cloud Computing, SMEs can keep up with the times and have the opportunity to make Cloud ERP an integrated information system tool to run its business processes. And the last biggest contribution is in statements no. 3 and 5 which have a value of 0.1. Statement No. 3 is that SMEs have knowledge of integrated information systems. This indicates that SMEs can be prepared for Cloud ERP adoption. Statement No. 5 is that SMEs have good experience in using information systems. This indicates that SMEs are not too closed to technological progress and have the opportunity to adopt Cloud ERP.

In Table XIII, there are 5 items of statements and the biggest contribution can be seen in statements no. 2 and 4 which have a value of 0.2. Statement No. 2 is that the internet makes it easy for our SMEs to carry out business processes. This indicates that SMEs use the internet to run their business processes and this is in line with the resources needed for Cloud ERP. Statement No. 4 is

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Table XIII. Total technology score.

Statement no.	The answer *f*	*n*	Fxn	Mean	Scale (%)	Score
1	1	5	5	2	5	0.1
	2	18	36			
	3	6	18			
	4	1	4			
	5	0	0			
Total		30	63			
2	1	0	0	4	5	0.2
	2	0	0			
	3	7	21			
	4	9	36			
	5	14	70			
Total		30	127			
3	1	11	11	2	5%	0.1
	2	13	26			
	3	6	18			
	4	0	0			
	5	0	0			
Total		30	55			
4	1	0	0	4	5	0.2
	2	1	2			
	3	4	12			
	4	11	44			
	5	14	70			
Total		30	128			
5	1	12	12	2	5	0.1
	2	11	22			
	3	6	18			
	4	0	0			
	5	1	5			
Total		30	57			
		Total score				0.7

that SMEs can change the latest information systems to meet customer needs. The second biggest contribution is in statement No. 1 which has a value of 0.1. Statement No. 1 is that SMEs feel that we need IT infrastructure standards in terms of safety and comfort. The third largest contribution is in statement No. 5 which has a value of 0.1. Statement No. 5 is that our SMEs prioritize information systems that are more effective and more affordable in terms of costs. This indicates that Cloud ERP is very suitable for SMEs. And the last biggest contribution is in statement No. 3 which has a value of 0.1. Statement No. 3 is that our SMEs can accommodate changes to adopt Cloud ERP [34].

Table XIV. Skor total net ready.

Variable	Score
Leadership	0.6
Governance	1.1
Competencies	0.8
Technology	0.7
Total	3.1

When viewed from the categorization carried out by the Net Readiness Index, Bogor region SMEs have a level of readiness at the Net Savy level with a value of 3.12 categories. It is concluded that Bogor area SMEs in the fashion sector are quite ready to adopt Cloud ERP because the Bogor area SMEs in fashion have shown good knowledge of integrated information systems specifically Cloud ERP.

6. CONCLUSION

Based on the results of data analysis, in getting the Net Ready score for SMEs in the Bogor region in the fashion field is 3.1. From these values, it shows the level of readiness that is quite ready because the Bogor area UKM engaged in the fashion sector is quite knowledgeable about integrated Cloud ERP information systems. each variable contributes differently to the total net ready score. The results using the Net Ready method get a different total value for each variable. Governance provides the largest contribution in the assessment of Net Ready, which has a score of 1.0, indicating that SMEs have good governance in their business processes. Competencies provide the second largest contribution that has a score of 0.8, indicating that the Bogor SMEs have sufficient competency to adopt Cloud ERP. Technology provides the third largest contribution which has a value of 0.7, wherein the Bogor area SMEs have an openness to technology and do not cover the possibility of adopting Cloud ERP. Leadership provides the smallest contribution in this study which has a score of 0.6, lack of management awareness of integrated information systems to make new business strategies. Suggestions for this study are the samples and indicators used must be more so that the results are better and use other variables besides the variables found in this study.

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Received: 1 January 2019. Accepted: 11 March 2019.

RESEARCH ARTICLE

Journal of
Computational and Theoretical Nanoscience
Vol. 16, 5408–5415, 2019

RESEARCH ARTICLE

Genomic Research in International, European, and Russian Jurisprudence

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Modern science achievements contribute to the development of international and national ethical and legal approaches in the field of genome research while respecting human rights, ensuring safety, and maintaining the potential for scientific and technological progress. At the same time, there are no legal documents devoted exclusively to biomedicine and genomic research. This situation has led to the development of international standards either through the general principles of protecting human rights or through "soft law" norms. In addition, a significant regulatory gap exists caused by the lack of security measures in international jurisprudence. A similar trend occurs at the regional level. At the same time, in the framework of the Council of Europe, a single international treaty has been adopted that is directly devoted to bioethics and genomic research. The Convention for the Protection of Human Rights and Dignity of the Human Being with regard to the Application of Biology and Medicine: Convention on Human Rights and Biomedicine was adopted by the Council of Europe in April 1997 in Oviedo. The active development of biomedicine and genomic research caused conflicts between ethics and law. These issues became cases in highest judicial instances, including supranational structures, in particular, the Council of Europe and the European Court of Human Rights (ECHR). The ECHR influences Russia through the so-called "non-prohibitive practice." Nevertheless, despite the law's imperfections, Russia develops its own approach to the existing system of international standards that admit national uniqueness in this sphere. Despite attempts to restrict the influence of supranational judicial institutions on the Russian legal order in the middle of this decade, the practice of the ECHR as a source of Russian law influences the practice of Russian courts even in this sphere (Russian judges refer to the decisions of the ECHR).

Keywords: Council of Europe, Russia, Genomic Research, DNA, ECHR, International Standards, Judicial Practice, Medicine.

1. INTRODUCTION

Breakthroughs in the study of the human genome have produced problems for legal regulation. The unprecedented leap forward in genetic engineering and gene therapy has resulted in a number of ethical and legal issues connected with the invasion of personal privacy related to the functioning living organisms [1]. Modern scientific developments can alter people and the environment. As a result, they have an impact on human society [3]. On the one hand, the availability of new genetic technologies, such as TALEN or CRISPR/Cas9, opens up new avenues for the treatment of various diseases and breakthroughs in pharmacology. On the other hand, they can introduce dangers, including unpredictable side effects and the use of technology for criminal purposes [2]. These new achievements challenge humankind. Such new challenges require a response from both particular states and the world community at large to provide modern ethical and legal approaches to ensure control in the field of genome research while respecting human rights and guaranteeing security for scientific and technological progress. These problems are particularly relevant in the regard to the Russian approach to the large-scale genomic research [4]. The purpose of this work is to study the ethical and legal principles that regulate genomic research at the international level, and their treatment in the Russian legal system. The objectives of the study are:

1. to analyze international and European standards of genomic research within the framework of the European Court of Human Rights (ECHR), and

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1546-1955/2019/16/5408/008 doi:10.1166/jctn.2019.8608

2. To study the approaches to Russia legal regulation and judicial practice.

2. INTERNATIONAL AND EUROPEAN STANDARDS OF BIOETHICS

2.1. Legal Principles at the International Level

At the international level, ethical and legal aspects in medicine in general, and in genomic research in particular, are based on universal human rights instruments. These documents are not aimed at regulation or enactment. However, they contain basic principles, create guarantees, and recommend the development of special regulations in this sphere. The Universal Declaration on the Human Genome and Human Rights, was adopted by acclamation on November, 11, 1997 and approved by the UN General Assembly on December, 9, 1998. These recommendations for handling the problems inherent in human genome research are presented as "soft law," and have been adopted at a universal level. These acts do not contain legal norms; their provisions are only advisory. They offer guidelines in the absence of fully functional legal regulations. In this regard, it is worthy to note the Universal Declaration on the Human Genome and Human Rights, adopted by acclamation on November, 11, 1997 and approved by the UN General Assembly on December, 9, 1998. The First Article of the Declaration states that "The human genome underlies the fundamental unity of all members of the human family, as well as the recognition of their inherent dignity and diversity. In a symbolic sense, it is the heritage of humanity." The provisions of Article 1 of the Declaration are based on the purpose of its adoption, including the prohibition to transfer the information about the human genome to the ownership of other persons. The most significant provisions of the Declaration are:

- The respect for the dignity and rights of each person, regardless of their genetic characteristics, and the interconnected principle of non-discrimination of a person in terms of such characteristics (Articles 2 and 6 of the Declaration);
- The inadmissibility of using the human genome in its natural state for revenue generation (Article 4 of the Declaration);
- The freedom of scientific research as an integral part of freedom of thought;
- The informed consent to interfere in the human body (Article 5 of the Declaration).

Despite the UN and UNESCO efforts at the universal level, there is still no specific legal document for biomedicine and genomic research. Standards are accumulated either through the general principles of protecting human rights, or are reflected in recommendations. Obviously, international legal regulation based on human rights protection causes gaps in regulation and protection from potential biological danger, as a result of genomic research and practical implementation of their results. Therefore, ethical and legal issues of precaution and hygiene in the framework of genomic research are very acute. Unfortunately, the current risks of biological danger, including those resulting from a breakthrough in scientific studies of the human genome, are not adequately evaluated. Moreover, in international practice, there are successful mechanisms of protection against human activities. The experience of the UN, IAEA and the International Commission on Radiation Protection (ICRP) can be very useful. The authors point out the conceptual approaches and principles, providing radiation safety and protection from radioactive impact. In particular, the researchers highlight the concept of "levels of concern," included into the recommendations of the ICRP, or means of determination of the adverse biological effect that may result in uncontrolled genetic mutations [5]. In addition, existing experience in the field of radiation security at the international level can be used for formulation of the international principles for assessing the risks from genomic research, as well as responsibility and compensation for their negative influence.

2.2. Legal Principles at the Regional (European) Level

A similar situation with bioethics, biomedicine, and genomic research issues is observed in documents at the regional level. There exists only one international treaty, the provisions of which are directly devoted to the question, and it was adopted under the authority of the Council of Europe. This document was developed by European countries and considers the ethical side of the genomic research revolution in the late 1990s. It is based on the widely declared project for the study and decoding of the human genome [6].The peculiar feature of the Oviedo Convention is the fundamental provisions concerning certain aspects of protecting human rights and human dignity in various fields of medical science. The priority of the individual over the exclusive interests of science or society is proclaimed as the main postulate (Article 2). Another fundamental principle of the Oviedo Convention is the prohibition of discrimination of an individual in any form due to his or her genetic heritage (Article 11). This implies the human right to freely give or withdraw consent for any interference (Article 5). The Oviedo Convention establishes the right to keep health information confidential (Article 10) and proclaims the freedom of scientific research in the field of biology and medicine, which is justified not only by the right of mankind to receive knowledge but also by the fact that their results can improve the patient's health and well-being (Article 15). The Convention prohibits:

- Conducting prognostic tests that are not related to human health (Article 12).
- Conducting medical scientific research even with the consent of the person concerned (Article 12).
- Interventions aimed at making any changes to the genome of descendants (Article 13).

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Thus, the authors point out that on the one hand, the Oviedo Convention allows interference in the human genome with the aim of modifying it, but on the other hand, it is restricted by the preventive, diagnostic, and therapeutic goals. However, the list of goals is so wide that almost any modification of the genome can be brought under it. The Oviedo Convention provides protection for people undergoing research (Article 16). In addition, it contains the basic condition for people not able to consent, namely the potential to produce real and direct benefit to his or her health. Moreover, such a benefit should meet the following criteria:

- Reality.
- Benefit should follow from possible research results.

Thus, the Convention, although it restricts experiments with the human embryo, does not prohibit them in general. Article 32 provides the establishment of a special Committee on Bioethics, which studies the implementation of the Convention and the development of new technologies in this sphere. It is worth noting that the Oviedo Convention, adopted within the framework of the Council of Europe, is closely connected to the fundamental document of the European Convention for the Protection of Human Rights and Fundamental Freedoms of 1950 (ECHR). These international treaties contain homogeneous ethical and legal principles and concepts. Thus, the provisions of the Oviedo Convention develop a number of principles enshrined in the ECHR (prohibition of discrimination, the right to liberty and security of person, the right to respect private and family life). On the one hand, both documents declare the necessity to protect human dignity as the main value that should be protected at the international level. On the other hand, individuals' security becomes insignificant. In addition, in accordance with Article 29 of this document, the European Court of Human Rights, being a special judicial body within the Council of Europe, may interpret and consider violations of the ECHR; it is also empowered to interpret the Oviedo Convention.

3. ECHR PRACTICE

3.1. The Development of ECHR Practice in the Sphere of Bioethics and Genome Research

The rapid development of biomedicine and genomic research caused conflicts between ethics and law, which became the subject of consideration in the highest judicial instances, including the supranational structures. In this case, the practice of the ECHR is of particular interest. This is the international judicial body with jurisdiction that extends to all members of the Council of Europe that have ratified the ECHR. It deals with all the aspects of the interpretation and application of the Convention (including state-to-state disputes and complaints by individuals). In its practice, the ECHR has repeatedly considered issues related to the regulation of genomic research. A number of ECHR judgments touch upon the field of bioethics, biomedicine, and genomic research, in particular the ethical and legal aspects of the modification of the human genome, including the deliberate editing of the human germinal cells, as well as the problems of genetic testing. Tikoz and Gulyaeva point out that among the decisions of the ECHR in this area, we should distinguish the actual violations of the ECHR and subsidiary violations of the Oviedo Convention and the recommendations of the Committee on Bioethics of the Council of Europe [7]. The latter, in particular, will not have legal significance for Russia since it does not participate in the Oviedo Convention. At the same time, the practice of the ECHR has not yet developed a common approach to the compensation for people affected by the genetic research, in contrast to the practice of the ECHR in cases of people exposed to radiation as a result of nuclear tests [8] or accidents at nuclear stations [9].

3.2. The Case Evans v. United Kingdom

The practice of the ECHR, like any judicial practice, reflects the necessity to regulate social situations. In particular, in a number of ECHR cases, the questions of the genetic identification of parents appeared 15 years ago [10]. More complex issues began to arise with the implementation of genomic research achievements into practical life. Thus, in the Judgment *Evans v. United Kingdom* of April, 10, 2007 [11], the ECHR considered only the genetic link between the IVF embryo and the donor. The subject of consideration was the compliance of Articles 2 and 14 of the legislation of the United Kingdom with the ECHR (the right to life and the prohibition of discrimination) in the framework of the impossibility of carrying out the *in vitro* fertilization procedure due to the consent of former partner withdrawal to the storage and use by her of embryos created jointly by them. The applicant, who was diagnosed with ovarian cancer, underwent an IVF procedure together with her partner before the operation to remove her ovaries. As a result of the procedure, six embryos were created, which were consigned to storage. Since after some time the couple broke up, the former partner withdrew his consent to the use of embryos resulting from IVF. In accordance with British Law, in this case, the embryos must be destroyed. The applicant complained that the norms of the law of the United Kingdom had effectively deprived her of the opportunity to have a genetically related child. Since the issues of the procedure touch upon a number of moral and ethical aspects in the context of the dynamic development of science and medicine, the Court admitted the necessity to restrict the discretion for the Member States in this area. Taking into consideration the specifics of the sphere, the Court concluded that the limits for the Member States discretion should be sufficiently broad. In addition, in the adjudication under review, it was necessary to establish whether there was a fair balance of interests of the

parties. The court analyzed the British national legislation for the IVF procedure, as well as the relevant jurisprudence of the ECHR [12]. As a result, it noted that the norms of national law "the culmination of an exceptionally detailed examination of the social, ethical and legal implications of developments in the field of human fertilization and embryology, and the fruit of much reflection, consultation and debate" [13–14]. At the same time, the Court noted that in the present case, the medical institution followed the obligation of the national law to explain the consent provisions of consent to a person embarking on IVF treatment. The court supported the applicant with regard to the importance of the possibility of having a genetically related healthy child. At the same time, he took into account the lack of common European consensus on this issue, indicating that there should be a fair balance between the applicant's right and her former partner's right to decide on the birth of a genetically related child. This decision could not reverse the common European legislative and judicial practice in this area, but it affirmed the right of each Member State of the Council of Europe to adopt normative acts in such a sensitive area, basing on its own ethical, cultural and religious ideas. The lack of a common European consensus requires the necessity to be careful in making "revolutionary" decisions that can change the understanding of human rights, including the equal rights to dispose the genetic material applied for the IVF procedure.

3.3. The Case Costa and Pavan v. Italy

In the case *Costa and Pavan v. Italy* of August, 28, 2012 [14] the ECHR touched upon the issues of genetic screening and parents' attempts to prevent the transmission of genetic diseases to the descendants. In the framework of this case, the correlation of the national legislation (in this case Italy) with the right to respect for private and family life according to Article 8 of the ECHR, were examined.

The applicants pointed out that Italian law violates their rights under Article 8 of the ECHR (the right to respect for private and family life). It was highlighted the inconsistency of the Italian legislation. The ban on embryonic screening was surprisingly combined with the possibility of an abortion if the fetus was affected by fibrosis. In order to have a healthy child, the applicants could either choose natural fertilization as the only possible in this case, or terminate the pregnancy if the fetus is a carrier of the disease. The situation was complicated by the fact that the fetus was already at a developed stage. The Italian side appealed to the necessity to protect the health of the "child." However, the Court noted that "embryo" and "child" are different concepts. In this case, the Court cannot but take into account that there was a clear threat of her unborn child's illness due to the absence of the possibility of carrying out embryonic screening. The court indicated the necessity to take into account the suffering of a woman who would be faced with the choice of abortion, if the screening results confirmed the aforementioned disease of the fetus. Accordingly, the Court considered Italian laws regarding embryonic screening to be disproportionate and inconsistent, violating the applicants' right to respect for private and family life, as approved by Article 8 of the ECHR. The decision under consideration contributed to the equalization of the legal status of the embryo conceived in a natural way and the embryo conceived with the help of assisted reproduction technology. At the same time, the Court drew attention to the fact that, despite the fairly broad possibility of discretion in the matter of legislative consolidation of the legal status of the embryo and the related rights and obligations of other participants in legal relations (including the right to terminate pregnancy if the embryonic screening detected serious genetic diseases in the fetus), states should be consistent and follow the European practice according to the Case. A similar situation took place in the Judgment of September, 24, 2014 in the case of *A.K. v. Latvia* [15].

3.4. The case Parrillo v. Italy

The issue of the ECHR judgment of the August, 27, 2015, in the case *of Parrillo v. Italy* [16] was a ban on scientific donating the embryos after the death of the partner. The applicant, born in 1954, with her partner used *in vitro* fertilization in 2002. She had five embryos placed in cryopreservation. Parrillo's partner died in 2003, and she did not want to become pregnant and made a decision to donate them for scientific research. However, she was refused on the ground of the Italian Law no. 40/2004. As the case examined the compliance of the provisions of the national legislation of Italy with Article 8 of the ECHR, the Court needed to answer the question, whether the concept of "private life" includes the right to use embryos obtained using the IVF procedure for scientific research donation, in contrast to other cases where such embryos were intended for implantation [16]. The Court came to the following conclusions:

1. Since there is a connection between the applicant who used the IVF procedure and the embryos obtained as a result of this procedure, Article 8 of the ECHR is fully applicable in this case, and regarding the aspects of "private life" in particular. The court judged that embryos are part of the applicant's genetic material and biological identity; thus, she can decide for herself what to do with them.
2. Regarding the purpose of the application, the Court noted that "protecting the life potential of the embryo" is quite comparable with the goal of protecting morality, the rights and freedoms of other people. However, the Court considers the question whether the term of "other people" can mean "human embryos."
3. The court admitted the fact that donating embryos for scientific research is not one of the fundamental rights protected by Article 8 of the ECHR. Thus, the Italian Republic should have wide discretion as to the legislation

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in this area ("on sensitive moral and ethical issues"). In this regard, the ECHR respects the wide discretion of the Member States. The "public morality" is determined at the national level. In addition, it is necessary to take into account the lack of common law enforcement and law-making practice on these issues. The Court also has no evidence that the applicant's partner, who at the time of the *in vitro* fertilization had the same rights to the embryos, expressed his consent to transfer his embryos for scientific research. Therefore, the actions of the Italian government cannot be considered as going beyond the margin of appreciation. Thus, the Italian authorities did not commit a violation of Article 8 of the ECHR.

4. In the judgment under the analysis, the ECHR highlights the fundamental disagreements between the Member States on the human genome study and the use of human embryos for the scientific researches. The court examined the legal regulation of this sphere in all Member States of the Council of Europe and came to the conclusion that there are absolutely opposite approaches to the regulation in different European countries. Russian legal regulation of these issues was characterized by the ECHR as "non-prohibitive practice."

In addition, in his Concurring Opinion on this case, Judge Dmitry Dedov made an interesting suggestion that if the Court had previously applied the approach to protect the right of an embryo to life, then, for example, above mentioned case *Evans v. The United Kingdom* would have been decided in favor of the applicant.

3.5. The Case A.K. v. Latvia

A curious case in the practice of the ECHR is the case *A.K. v. Latvia*. The issue was the compliance with the provisions of Article 8 of the Convention. The actions of a doctor who did not perform a prenatal examination (screening test) for the risk of diseases, including Down syndrome were examined. The applicant gave birth to a child with Down syndrome and claimed that she was refused to make a screening test, which meant that her right to timely and effective medical care was violated. According to a note in her medical record, she was prescribed to make alpha-fetoprotein ("AFP") screening, but she was unable to attend it because she was hospitalized. The applicant also claimed that she had never been notified of the screening tests. She insisted that the note in her medical record was falsified, and that even if she had been sent for testing, the prescription itself was too late, which was a direct violation of the requirements of Latvian law, as she was a patient of high risk because of her age. If the applicant had information about a congenital disease of her child, she would have decided to terminate the pregnancy. In this connection, the applicant claimed compensation for pecuniary and non-pecuniary damage, including for the loss of wages and the costs of maintaining her daughter. The doctor was imposed an administrative fine for not verifying whether the applicant had undergone proper testing. Although the court dismissed the claim, finding out that there was insufficient evidence that the doctor was guilty and that there was not a causal link between the actions of the doctor and the birth of the applicant's daughter. This intervention will be justified if it meets the following criteria:

- Compliance with the law;
- Democratic society based on the goals set out in the Convention (Article 8, paragraph 2).

In addition, according to Article 8, Member States of the ECHR must effectively respect the rights of the people under their jurisdiction. In this context, the states are required to adopt appropriate legislation aimed at providing legal protection against arbitrary interference by the public and authorities. The court noted that the doctor had inadvertently failed to comply with the requirements of Latvian law, and the Latvian National Court had not properly reviewed the applicant's requirements. The court found that there were factual discrepancies whether the applicant was prescribed the prenatal examination during the period of time specified in the relevant decision of the Latvian competent authority. The case is complicated by the lack of investigation of the applicant's medical record loss after a few months. Accordingly, it was established by the court that the domestic courts did not conduct a proper examination of the applicant's claim in violation of Article 8. In the present case, the Court did not focus on procedural defects. Therefore, the conclusion was not based on the "technical" aspects. However, in the case *AK v Latvia* the applicant's rights were in focus of domestic procedure, and some of the shortcomings were already considered at the national level of both substantive and procedural law (in particular, the issue of medical records). However, the Court did not establish the connection between the specific procedural defects and the failure to properly examine whether the applicant's right was violated.

4. IMPACT ON RUSSIA

4.1. The significance of the Oviedo Convention

As we have already noted, Russia does not participate in the Oviedo Convention and it is not connected with its provisions or the practice of the ECHR in its interpretation. On the whole, Russia's position in relation to the Oviedo Convention does not differ from the general approach of our country to the agreements adopted by the Council of Europe in the field of healthcare and medicine. Russia occupies the position of a passive observer, staying on the sidelines and not signing these agreements. It was adopted in Moscow in 2011 and it came into force in 2016. This document does not directly affect genomic research, but indirectly its scope is medications derived from genomic research and the use of biomedicine. At the same time,

Russia adopted the Federal Law on the temporary prohibition of human cloning in 2002 [17]. This law is absolutely consistent with the spirit of the Oviedo Convention and its Additional Protocol on the Prohibition of Cloning of 1998. Council of Europe standards and the practice of the ECHR have an impact on Russian development of legal regulation in this area.

4.2. "Non-prohibitive Practice"

Even if we take the ECHR formula ("non-prohibitive practice"), which characterizes legal regulation of genomic research and the perception of genetic technologies in Russia, this does not mean that there is no regulation at the national level. For all the imperfection of laws, Russia is developing its approach within the framework of the existing system of international standards that allows national uniqueness in regulating the relevant sphere. The system of legal and ethical principles in this field originates from the provisions of the Constitution of Russia of 1993. According to the second sentence of Part 2 of Article 21 "No one may be subjected to medical, scientific or other experiments without voluntary consent." However, that does not exclude the genetic code manipulation with the consent of the patient. Federal Law "On state regulation in the field of genetic engineering" was adopted in Russia in 1996 [18]. The basic provisions of the Law are:

- Safety of people and the environment;
- Safety of clinical tests of the genetic diagnosis methods and gene therapy at the level of somatic cells;
- General availability of information on the safety of genetic engineering activities;
- State registration of genetically modified organisms (Article 5).

Ethical aspects of the researches are touched upon in the Federal Law "Basics Health Protection of the Citizens in the Russian Federation" adopted November, 21, 2011 [19]. This law regards the participation of patients in the study of new, previously unused methods to confirm their effectiveness as "medical assistance in the framework of clinical testing." This kind of experimentation with the participation of patients requires the conclusion of the Ethics Committee and the Expert Council of the authorized federal executive body. The Ethics Committee determines whether the use of the methods is ethical and corresponds to the clinical trial protocol. The Expert Council gives permission for the provision of medical care in the framework of clinical testing.

Voluntary informed consent from a capable adult patient is required for participation in clinical trials (clinical testing). A number of categories of patients are prohibited to participate in trials: children, pregnant and lactating women, military personnel, persons with mental illness.

Federal Law "On Biomedical Cellular Products" was adopted and amended in Russia in 2018 [20]. In accordance with this law, the basic principles of the activities in the field of circulation of biomedical cellular products are the following:

(1) Voluntary and gratuitous donation of biological material.
(2) Medical confidentiality and other secrecy protected by law.
(3) The inadmissibility of the sale-and-purchase of biological material.
(4) The inadmissibility of creating a human embryo for the production of biomedical cell products.
(5) The inadmissibility of using biological material obtained by suspension or interruption of the development of a human embryo or fetus for the development, production and use of biomedical cell products.
(6) Compliance with biological safety requirements in order to protect the health of biological material donors, staff engaged in the production of biomedical cell products, medical personnel, patients and the environment.

The legal basis for genetic identification is developed in the Federal Law "On State Genomic Registration in the Russian Federation" [21]. This Law restricts the mandatory state genomic registration to certain categories, namely, dangerous criminals, unidentified persons, as well as unidentified dead bodies. Among the important ethical and legal principles for regulating this sphere, the authors highlight the criminalization of genotyping based on the inclusion of this category in the List of substances and (or) methods prohibited for use in sports for the purposes of Articles 230.1 and 230.2 of the Criminal Code of the Russian Federation [22]. Finally, this year the Decree of the President of the Russian Federation dated 11.03.2019 No. 97 provided Basic Principles of the State Policy Ensuring Chemical and Biological Safety and Security in the Russian Federation until 2025 and beyond [23]. The basic principles and objectives, as well as mechanisms for the implementation of state policy in the field of biological safety are developed in this Decree. This Law regards "the uncontrolled implementation of dangerous technogenic activities, including using genetic engineering technologies and synthetic biology technologies" as biological threats to modern Russian society (Paragraph 8.11).

4.3. The practice of Russian Courts

Compared with the practice of the ECHR, the practice of Russian courts in the field of genomic research and the implementation of their results is a "boring landscape" of identical cases, covering mainly the issues of genomic identification in criminal and family practice. At the same time, despite attempts to limit the influence of supranational judicial institutions on the Russian rule of law [24–25], undertaken in the middle of this decade, the practice of the ECHR, as a source of Russian law, influences the practice of Russian courts in this area. Thus, the Constitutional Court of the Russian Federation referred to the practice of the ECHR in its decisions for surrogacy.

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Thus, the Judge A.N. Kokotova referrers to the ECHR judgment of January, 24, 2017 in the case of *Paradiso and Campanelli v. Italy* (complaint No. 25358/12) [26] regarding the approach to the ethical side of mother-child relation during fetal development. In the determination of the Constitutional Court of the Russian Federation of 05.15.2012 No. 880-O [27], the constitutionality of the provisions of the Family Code of the Russian Federation governing the procedure of birth registration of a child born as a result of the surrogacy was examined. The Court referred to the decision of the ECHR of 11.24.2005 on the admissibility of application No. 16153/03 *Vladimir Lazarev and Pavel Lazarev v. Russia* [28–29] in terms of determining a fair balance between competing interests and recognizing the priority of the child's fundamental interests over similar interests of parents. In both cases the Russian Highest Court refused to accept the complaint related to the legal basis of such reproductive technology as surrogacy. However, the attempts to comprehend the European positive experience and apply it in Russian legal practice are significant. At the same time, the Russian Court positively assesses the judgments of the ECHR from an ethical point of view. It is observed in the dissenting opinion of Judge A.N. Kokotov mentioning the judgment of the ECHR in the case of *Paradiso and Campanelli v. Italy*. Such uniformity may indicate the development of the European approach in Russian judicial practice in this area.

5. CONCLUSIONS

Contemporary international standards in the field of genomic research provide wide discretion for national regulation and determination of the legal regime in this sphere. Thus, the approach of the world community in defining ethical and legal boundaries is to restrict national regulation with the postulates of International Human Rights Law, taking into account the guidelines designed specifically for the field of genomic research. A significant gap in international legal regulation of the issues under consideration is the lack of attention to security problems and the means of its maintenance. In this regard, the experience of international legal protection against radioactive exposure could be very useful. The European approach to regulation in the field of genomic research is restricted with the Convention of Council of Europe (Oviedo Convention) and the practice of the ECHR in interpretation of the ECHR and the Oviedo Convention. However, the Oviedo Convention enshrines the basic principles and rights in the field of human genome research, although the practice of the ECHR is more focused on specific ethical and legal situations in the implementation of the of Council of Europe norms and national law. The developing legal practice of genomic research in Russia fully corresponds to international standards in this field. Despite the fact that Russian legislation in this area is characterized as a "non-prohibitive practice," it has restrictions and prohibitions, including ethical ones. In Russian law, the first steps have been taken to ensure security in the field of human genomics. At the same time, a temporary ban on cloning, a ban on gene doping, and the restriction of obligatory genetic screening allow to conclude that Russian law complies with the norms and standards of the Council of Europe and the practice of the ECHR. In addition, Russian jurisprudence uses the precedents of the ECHR in substantiating ethical and legal positions.

Acknowledgments: This article was written in the context of RFBR projects No. 18-29-14078 mk, No. 18-29-14054 mk, No. 18-29-14074 mk.

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Received: 1 January 2019. Accepted: 11 March 2019.

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