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Simona-Maria Brînzaru, Assistant Professor, PhD in Accounting, Department of Accounting, Audit and Finance, Faculty of Economics, Administration and Business, Stefan cel Mare University of Suceava. Iasi, Romania. ORCID: 0000-0003-4777-6589.
Veronica Grosu, Professor, PhD in Accounting, Head of Department, Department of Accounting, Audit and Finance, Faculty of Economics, Administration and Business, Stefan cel Mare University of Suceava. Iasi, Romania. ORCID: 0000-0003-2465-4722.
Marian Socoliuc, Professor, PhD in Accounting, Department of Accounting, Audit and Finance, Faculty of Economics, Administration and Business, Stefan cel Mare University of Suceava. Iasi, Romania. ORCID: 0000-0001-6378-6686.
Corina Petrescu, Student PhD in Accounting, Faculty of Economics, Administration and Business, Stefan cel Mare University of Suceava. Iasi, Romania.

Stakeholders' trust in the global performance information of companies applying integrated reporting: pros and cons

Abstract: Integrated reporting (IR) is the latest form of corporate reporting that has radically changed the communication way with stakeholders by integrating financial and non-financial information into a single report. The main purpose of this paper is to evaluate stakeholders' trust in the global performance information provided by companies that have already adopted IR. The objectives of the paper are to establish the role of stakeholders in the context of IR adoption, assess the global performance of companies applying IR from the perspective of stakeholders and to identify possible causes that negatively affect stakeholders' trust in the performance information of companies applying IR. The results can be found in the conceptualization of seven econometric models in the form of indices that evaluate the credibility of stakeholders in the context of adopting IR from the perspective of evaluating the performance of these companies. These results are useful to stakeholders, companies that have adopted or will adopt IR because they provide an opportunity to assess the global performance of companies from a stakeholder perspective and involves the credibility of the information provided through an integrated report.

Keyword: integrated reporting, stakeholders, credibility, global performance.

Simona-Maria Brînzaru, Asistent universitar, Doctor în Contabilitate, Departamentul de Contabilitate, Audit şi Finanţe, Facultatea de Economie, Administraţie şi Afaceri, Universitatea „Ştefan cel Mare" din Suceava. Iaşi, România. ORCID: 0000-0003-4777-6589.
Veronica Grosu, Profesor universitar, Doctor în Contabilitate, Şef de departament, Departamentul de Contabilitate, Audit şi Finanţe, Facultatea de Economie, Administraţie şi Afaceri, Universitatea „Ştefan cel Mare" din Suceava. Iaşi, România. ORCID: 0000-0003-2465-4722.
Marian Socoliuc, Profesor, Doctor în Contabilitate, Departamentul de Contabilitate, Audit şi Finanţe, Facultatea de Economie, Administraţie şi Afaceri, Universitatea „Ştefan cel Mare" din Suceava. Iaşi, România. ORCID: 0000-0001-6378-6686.
Corina Petrescu, studentă doctorandă în Contabilitate, Facultatea de Economie, Administraţie şi Afaceri, Universitatea „Ştefan cel Mare" din Suceava. Iaşi, România.

Încrederea părţilor interesate în informaţiile privind performanţa globală a companiilor care aplică raportarea integrată: argumente pro şi contra

Abstract: Raportarea integrată (RI) este cea mai recentă formă de raportare corporativă care a schimbat radical modul de comunicare cu părţile interesate prin integrarea informaţiilor financiare şi nefinanciare într-un singur raport. Scopul principal al acestei lucrări este de a evalua încrederea părţilor interesate în informaţiile privind performanţa globală furnizate de companiile care au adoptat deja RI. Obiectivele lucrării sunt de a stabili rolul părţilor interesate în contextul adoptării RI, de a evalua performanţa globală a companiilor care aplică RI din perspectiva părţilor interesate şi de a identifica posibilele cauze care afectează negativ încrederea părţilor interesate în informaţiile privind performanţa furnizate de companiile care aplică RI. Rezultatele se regăsesc în conceptualizarea a şapte modele econometrice sub forma unor indici care evaluează credibilitatea părţilor interesate în contextul adoptării RI din perspectiva evaluării performanţei acestor companii. Aceste rezultate sunt utile pentru părţile interesate, pentru companiile care au adoptat sau vor adopta RI, deoarece oferă posibilitatea de a evalua performanţa globală a companiilor din perspectiva părţilor interesate şi implică credibilitatea informaţiilor furnizate prin intermediul unui raport integrat.

Cuvinte-cheie: raportare integrată, părţi interesate, credibilitate, performanţă globală.

Introduction

Integrated Reporting (IR) is the latest form of corporate reporting that has radically changed the way of communication with stakeholders, integrating financial and non-financial information into a single report, bringing together aspects regarding an organisation's strategies on corporate governance and social, enviromental and financial performance in a way that reflects the value creation process of the firm on short, medium an long term (*Songini et al., 2022*). According to IIRC, integrated reporting represents a more consistent and efficient approach of corporate reporting with the aim of improving the quality of information given to providers of financial capital in order to enable a more efficient and fruitful allocation of capital (*IIRC, 2021*). Moreover, IR is the most appropriate tool for presenting the effects of the COVID-19 pandemic on an company's business due to its „flexible approach and its ability to provide a holistic view of business management" (*García-Sánchez et al., 2020*), highlighting the company's level of resilience in a context of crisis and its ability to manage different risks in a turbulent economic environment. IR is therefore seen as an innovative corporate reporting tool anchored in the current economic context that changes the view of the company's performance if used appropriately (*Tanasă, 2020*) and moreover can counteract the effects of unforeseen situations such as the COVID-19 pandemic that affected business sustainability and the communication process with stakeholders.

The main *purpose of* the work is to assess the level of stakeholders' trust in the gloabal performance information provided by companies that have already adopted IR. In order to achieve this, we proposed there objectives as follows:

1. Establish the role of stakeholders in the context of IR adoption;
2. Assess the global performance of companies applying IR from the perspective of stakeholders;
3. Identify possible causes that negatively affect stakeholders' trust in the performance information of companies applying IR.

The results are translated into seven econometric linear regression models that allow the assessment of stakeholders' confidence in the performance information provided by the integrated reports. The research results are useful for stakeholders because they provide information on the level of trust for each category on global performance, fact that supports the decision-making process. The research results are also useful for companies as they can identify solutions to increase stakeholders' trust in the information provided through the IR which can contribute significantly to improving management performance.

The paper is structured in five sections where the next section presents a review of the literature on our topic. The third section describes the research methodology applied to achieve the main purpose of the paper and the fourth section presents the results of our research on stakeholders' trust. The conclusions of our research are presented in the last section, highlighting possible causes that negatively affect stakeholders' trust.

Literature review

The term stakeholders was looked at from a different perspective by Freeman in 1984 in order to emphasize his proposed new approach to the existing ones, namely that shareholders are the sole responsibility of an company. Stakeholders are represented by „any individual or group that can affect or is affected by the objectives of the company" (*Freeman, et al., 2010*). The stakeholder theory developed over time by Freeman argues that if the relationships between the business and the stakeholders who can affect or are affected by it are adopted as a whole, then we will have a better chance of dealing more effectively with the three problems set out as follows: the problem of value creation and the ever-changing trade in the context of business globalisation; the problem of the connection between capitalism and ethics; and the problem of how managers should approach ensuring value creation and the connection between business and ethics (*Parmar et al., 2010*). In the current economic context, stakeholders have a very important role to play in ensuring business sustainability and for this reason companies have been looking for innovative solutions on how to report the effects of the COVID-19 pandemic on business entities.

In the literature review, we identified the role of stakeholders in the context of IR as follows: Gianfelici and others demonstrate that the field of activity to which an company belongs is more important than their nationality in the context of the analysis of 64 integrated company reports from the IIRC pilot program (*Gianfelici et al., 2018*). Based on the results, we conclude that the role of stakeholders in IR is to quantify the impact of companies' social and environmental responsibilities on economic performance. From a stakeholder theory perspective, Stubbs and Higgins demonstrated that there is more support for the adoption of integrated reporting on a voluntary basis, suggesting that IR will become a regulated reporting norm as companies adopt it in practice (*Stubbs & Higgins, 2018*). Furthermore, Rabaya and Saleh have shown that voluntary ESG disclosures through IR contribute to better stakeholder understanding of companies' sustainability practices. Stakeholders therefore have a role to play in helping to improve IR by increasing demands on companies' sustainability and reporting, either separately or through integrated reporting (*Rabaya & Saleh, 2022*).

Research by Vitolla's group highlights that the national cultural system significantly influences IR quality (*Vitolla et al., 2019*). Thus, countries with a cultural system that is closer to

the people, having low uncertainty and collectivist and feminist in character, place more emphasis on sustainable development, ethics and good governance, which implicitly lead to higher quality of IR. In addition, stakeholder-driven cultures lead companies to provide high quality information on financial, social, environmental and governance issues in an integrated way. Same authors and Ciubotariu with co-authors have also shown that stakeholders' pressures have a significant and positive impact on increasing IR quality, implicitly on business sustainability (*Ciubotariu et al., 2021*). From the two studies, it appears that the role of stakeholders is to drive companies to focus on business sustainability and provide high quality of reported information. All this aspects, contribute to increasing stakeholders' trust in the information included in the integrated reports. Stakeholders also have a key role to play in the resilience of companies after the COVID-19 pandemic because informing them properly can make the difference between business failure or resilience. Thus, the results of Dyczkowska's and Ribeiro's groups show that IR is an optimal communication tool by producing a stakeholder-oriented report that responds to stakeholders' information needs in difficult conditions such as the health pandemic (*Dyczkowska et al., 2022*; *Ribeiro et al., 2022*). At the same time, IR is seen as a solution to implement the circular economy concept for a sustainable business model that contributes to value creation in the short, medium and long term (*Hassan et al., 2021*). *Thus, we have outlined the objective no. 1 of our research.*

Quantifying global performance or sustainability in the context of IR from a stakeholder theory perspective is a widely debated topic in the literature. For example, Mans-Kemp and Lugt found that IR enhances managerial effectiveness in the eyes of South African debt capital providers, while venture capital providers do not provide a clear signal of approval (*Mans-Kemp & Lugt, 2020*). Moreover, a high level of ESG performance is positively associated with a high quality of IR, which is closely related to stakeholders' expectations (*Cosmulese et al., 2019*; *Ciubotariu et al., 2021*; *Chouaibi et al., 2022*). The results of Shirabe and Nakano argue that IR could discourage short-term oriented behaviour of companies and promote long-term value creation, which is of interest to a wide range of stakeholders (*Shirabe & Nakano, 2022*). The results of Lueg are also important because they show that integrated reports tend to be published by large organisations in controversial industries with above average performance and only those that fully implement IR show associations with performance, as opposed to organisations that partially comply with IR principles (*Lueg, 2022*).

On the other hand, the lack of a system of integrated performance measurement indicators to help stakeholders better understand performance has attracted a number of criticisms of the IIRC framework such as favouring providers of financial capital, thus not meeting the information needs of all categories of stakeholders (*Flower, 2015*; *Katsikas et al., 2017*), or ambiguous explanations and valuations of non-financial capital leading to complexities in providing IR mechanisms and providing little incentive for sustainable behaviour by companies (*Brown & Dillard, 2014*; *Cheng et al., 2014*). All these criticisms have contributed to a decline in the credibility of IR and hence stakeholders' trust in the global performance information provided by integrated reporting. *Based on this information, we have established the objectives 2 and 3 of our paper.*

Research methodology

To assess the global performance of companies applying IR from a stakeholder perspective, we constructed 50 economic entities listed on international stock exchanges in different industries. The period of analysis was five years, namely from 2015-2019. Companies were selected based on their adoption of IIRC-compliant IR principles in 2019 as the baseline year, either in the form of an integrated report or a GRI-compliant sustainability report together with the annual report. Other criteria for inclusion in the sample were: included companies are only part of the Europe region; full availability of data for the analysed period of 2015-2019. Exclusion criteria were as follows: companies that at the time of data collection did not have published reports for 2019; companies in the banking or insurance sector; companies that are not publicly listed as well as those that published integrated reports in a language other than English. The application of the company selection criteria resulted in 50 of the 185 companies present and verified on the IIRC website under the „IR Reporters" and „Leading Practices" sections. The areas of activity covered by the selected companies are 10, as follows: Utilities, Industry, Consumer Goods, Extractive, Telecommunications, Technology, Services, Transport, Health, Construction and Materials.

The data that was collected from the published reports of the sample companies were initially processed using MS Excel 2016. Subsequently, seven econometric linear regression models were developed for each stakeholder category using Gretl version 2019a. The stakeholder categories selected in our research include, but are not limited to: potential investors (INV), customers and suppliers (C/S), financial creditors (FIN CRED), shareholders (SHARE), state authorities (ST AUT), employees (EMPL) and managers (MANAG) according to stakeholder theory. Table 1 shows all seven selected stakeholder categories together with the dependent and independent variables (ticked with✓) included in the developed econometric model (*Table 1*).

The results are embodied in the seven econometric models based on financial indicators presented in table 1 and developed through the GRETL statistical software version 2019a with the aim of determining the level of stakeholders' trust in global performance in the context of IR adoption.

Results and discussions

The issue of stakeholders' trust in the information provided through IR is presented in the literature from several perspectives refering at aspects such as overall company performance, external assurance of integrated reporting or the principle of information connectivity. Our research addresses stakeholder theory in the context of assessing the global performance of companies that have adopted IR. Thus, the empirical research was based on the following categories of stakeholders: potential investors (INV), customers and suppliers (C/S), financial creditors (FIN CRED), shareholders (SHARE), state authorities (ST AUT), employees (EMPL) and managers (MANAG). For each category we developed a linear regression econometric model based on financial indicators reflecting the degree of stakeholders' trust (ST) in the global performance information of companies that have adopted IR, presented in the second table (*Table 2*).

In the case of *potential investors*, the correlation analysis shows that the variables EBIT and EBITDA, in relation to stock market value have a significant level of correlation for EBITDA and less for EBIT, which shows that they pay more attention to the EBITDA indicator. From table 3 on the statistical significance tests of the model it can be seen that the p-value tends to 0 (<0.0001) which means that the data are homogeneous and highly statistically significant. There were no excluded variables and the whole sample allowed correlations to be made in order to attract new investors (*Table 3*).

Statistical representativeness is given by the R-squared coefficient which has a significance of 67% for the proposed model which gives the model a relevant statistical significance. Thus, from the point of view of potential investors, the degree of trust in the global performance information presented through the integrated reports satisfies their needs in a percentage less than 70%, on a variation of the indicator defined as independent variable in the closed range 0-2.

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 133,347 with p-value = P(Hi square(2) > 133.347) = 1.10694e-029	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 134,784 with p-value = 5.39428e-030

The histogram distribution (*Figure 1*) reflects the fact that the average stock market value in dynamics tends to stabilize at the maximum point of the Gaussian interval with representation at the point 0 of the graph and an asymmetry towards the downward side of the indicator which highlights its instability. The test of heteroskedasticity and the test of normality of the residuals confirm the rejection of the null hypothesis (in the null hypothesis the error is normally distributed), for Hi square(2) > 133 and p-value tends 0.

The correlation analysis of the second econometric model shows that the liquidity variables in relation to leverage have a significantly higher level of correlation than net profit, however the most semi significant correlation is with turnover. This shows that in the analysis of an company's financial situation, *customers and suppliers* place emphasis on liquidity and leverage. From the correlation table 4 it can be seen that the p-value of turnover is less than 0.0001 which means that the data have are homogeneous (in relation to this regression variable). As in the case of potential investors, no data were excluded from the sample here either.

The R-squared coefficient presented in table 4 shows a high statistical representativeness which indicates that the confidence of C/S can be accounted for 87.7% by the proposed linear regression equation, on a variation of the indicator defined as independent variable in the closed range -0.5-1.5 (*Table 4*).

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 72.8123 with p-value = P(Hi square(4) > 72.8123) = 5.78022e-015	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 326.66 with p-value = 1.16607e-071

The histogram distribution of the indebtedness ratio presented in figure 2 with the regression variables shows a homogeneous distribution of the model with accumulation on the slope of the Gaussian curve increasing towards the maximum point assimilated to the sample median (*Figure 2*). We also note a uniform trend for a standard deviation of 0.99 points for the whole analysed sample of 200 units. The homogeneity of the evolution of the indicators is thus demonstrated and for the studied phenomenon, the relationship between the dependent and independent variables shows that the liquidity indicators are more significant than the others.

The *financial creditors* take more into account in their decisions the ROA, NP and TE values when analysing goodwill (*Table 2*). Statistical representativeness is given by the R-squared coefficient (*Table 5*) which has a significance of 71% for the proposed model which gives the model a high statistical significance.

From the point of view of financial creditors, the trust expressed in the global performance information is less than 75% on a change in the indicator defined as an independent variable in the closed range 0.5-2. Therefore, company managers pay more attention to financial creditors than to the commercial segment (customers/suppliers) in the context of ensuring business sustainability, which may affect the perception of this category of stakeholders.

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 213,554 with p-value = P(Hi square(5) > 213.554) = 3.56928e-044	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 151,996 with p-value = 9.87145e-034

The histogram distribution shown in figure 3 demonstrates that the mean of goodwill in dynamics tends to stabilize at the maximum point of the Gaussian interval with the representation being at the point 0 of the graph and an upward sloping accumulation (*Table 3*).

From table 2, the econometric model related to *shareholders* shows that the independent variable net profit in relation to DPS has a significant level of correlation, followed by ROA and ROE, the other variables being at a lower level (*Table 2*). This shows us that shareholders emphasize net profit in the dividend payout decision making process. At the same time, it is observed that the p-value is <0.0001 which means that the data are homogeneous and with high statistical significance (*Table 6*).

The R-squared coefficient shows statistical representativeness which has a significance of 76% for the proposed model, reflecting a high degree of shareholders' trust in the global performance of companies applying IR, over a variation of the indicator in the closed range 0-2.5.

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 218.773 with p-value = P(Hi square(3) > 218.773) = 4.78728e-041	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 1518.65 with p-value = 0

From figure 4 it can be seen that the data are concentrated in the Gaussian maximum point, but there is an asymmetry with accumulation on the decreasing slope of the Gaussian curve and with a standard deviation of 0.99 which shows us that dividends were granted above the sample mean and there is a relatively homogeneous distribution (*Table 4*). The performed heteroskedasticity test rejects the null hypothesis and maintains the alternative hypothesis, confirming that in the null hypothesis heteroskedasticity is not present, for Hi-squared (3) > 218.7 and p-value tends 0.

From the perspective of the *state authorities*, there is a greater focus on long-term debt than on other indicators (*Table 2*). In addition, the table below shows that the p-value is in the range 0-0.8, which means that the data are relatively homogeneous and with medium to high statistical significance. There were no excluded variables and the whole sample allowed correlations in the interest of the state authorities.

The R-squared coefficient indicates a high statistical significance of 97.5% for the model developed using Gretl software. Therefore, IR satisfies the requirements of the state authorities in a percentage of more than 95% which shows us a desire for increased compliance of companies with legal regulations with the aim of providing qualitative information through a single report. The histogram from figure 5 shows us that the data distribution is homogeneous with accumulation on the increasing slope of the Gaussian curve near the point of maximum 0 (*Figure 5*).

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 163.481 with p-value = P(Hi square(5) > 163.481) = 1.79285e-033	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 74.3307 with p-value = 7.23246e-017

In the case of the econometric model related to *employees*, we observe that the variables turnover, gross profit and short-term liabilities in relation to labour productivity have a significant level of correlation for turnover and less for the other two indicators (*Table 2*). Thus, from the point of view of employees, their confidence is in percentage higher than 99% on a variation of the indicator defined as independent variable in the closed range 0.75-1.25 which shows

At the same time, from the correlation table 8, we observe that p-value <0.0001 which means that the data are homogeneous and statistically significant (*Table 8*). The whole sample allowed correlations to be performed in the interest of employees and there were no excluded variables.

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 51.7497 with p-value = P(Hi square(3) > 51.7497) = 3.38648e-011	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 236,556 with p-value = 4.29142e-052

The histogram of the dependent variable – WP shows a homogeneous data distribution with accumulation on the increasing slope of the Gaussian curve near the point of maximum 0 (*Figure 6*).

Finally, *managers*' perceived trust in the global performance of companies is 73% and they pay more attention to the EBIT indicator, which shows that managers focus on operational activity (*Table 2*; *Table 9*).

From the histogram representation of the dependent variable in figure 7, we observe that the median tends to 0, which means that there is a constant evolution of the median with a standard deviation of 0.99 and accumulation on the increasing slope of the Gauss curve near the point of maximum assimilated to the sample mean for GW (*Figure 7*).

Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity is not present Statistical test: LM = 42,2008 with p-value = P(Hi square(6) > 42.2008) = 1.67831e-007	Test for normality of residues - Null hypothesis: the error is normally distributed Statistical test: Hi square(2) = 1096.19 with p-value = 9.24716e-239

Thus, the highest values of the seven econometric models are found for employees and government, reflecting a very high degree of trust in the global performance information provided by companies applying IR. This may be due to existing legal regulations in these areas. A high degree of trust is observed in the category of customers and suppliers with a value of around 88%. This also includes shareholders, managers and financial creditors with values between 70-80%. The lowest level of trust is found in the case of potential investors with a value of less than 70% which we can say that is a surprise because the IIRC flexible framework has been criticised for favouring providers of financial capital. However, we observe that potential investors have the lowest level of trust in the information provided by the integrated reports, which demonstrates that the IR has not achieved its goal of providing a holistic picture that allows investors to allocate capital more efficiently and fruitfully. At the same time, it highlights some vulnerabilities due to the existence of stock market value volatility that may more easily influence the level of trust of potential investors.

On the other hand, the risks associated with voluntary disclosure of information may affect stakeholders' trust in IR from an global performance perspective. For example, Stacchezzini with the colleagues demonstrate that managers use techniques through which they provide limited information about sustainability management and also avoid providing sustainability information when their social and environmental performance is poor (*Stacchezzini et al., 2016*). In contrast, Lakshan's group shows that these risks lead managers to use certain strategies designed to provide more conservative forward-looking information that could undermine the usefulness of integrated reporting (*Lakshan et al., 2021*). Therefore, the way in which information on overall company performance is provided is very important for ensuring the credibility of IR.

Conclusion

Although the role of IR is to provide a more complete and clear picture of the companies' performance, we note that in terms of perception of global performance, stakeholders show a different degree of trust. We can say that one of the reasons for the different degree of trust perceived by stakeholders could be a low economic performance which is covered or which suffers from the desire of managers to increase or strengthen their performance related to the social and environmental pillar, in order to ensure a positive image among stakeholders. Therefore, a defining role is played by managers on how IR is implemented in companies' activity. They can influence the trust of other stakeholders through the quantity or quality of information provided in the context of IR. Other causes that can affect stakeholders' trust can be: oscillating dividend policies that do not meet shareholders' expectations in terms of dividend distributions; managers are not interested in increasing stakeholders' trust more than current regulations require; risks associated with voluntary disclosure of information; tendency to provide longer and less understandable integrated reports that will alienate stakeholders; lack of integrated performance indicators showing overall company performance, especially regarding the effects of non-financial (environmental and social) elements on financial ones.

The results of our research demonstrate that the different degree of stakeholders' trust perceived from the perspective of global performance information significantly influences the credibility of the information provided by IR. Therefore, in order to ensure a continuity of its role in the communication process of companies with different categories of stakeholders, the regulators of IR have to concentrate their efforts on optimising and updating its content structure and disclosure requirements accoring to current needs, so that the relation with the stakeholders is optimised through an increase in transparency and quality of the information provided in the integrated reports, boosting this way its creditibility and utility in the business environment.

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Appendix

Table 1. Variables included in the linear regression econometric models

No.	Independent variable		EBIT	EBITDA	GS	GL	IL	TU	GP	NP	TE	ROA	ROE	LTD	STD	CA
	Stakeholder	Dependent variable														
1	INV	SMV	✓	✓												
2	C/S	INDB				✓	✓	✓		✓						
3	FIN CRED	GW							✓	✓	✓	✓	✓			
4	SHARE	DPS								✓		✓	✓			
5	ST AUT	NCF			✓			✓	✓	✓				✓		
6	EMPL	WP						✓	✓						✓	
7	MANAG	GW	✓						✓				✓			✓

Where,

SMV - The stock market value;
INDB - The degree of indebtedness;
GW - Goodwill;
DPS - Dividend per share;
NCF - The net cash-flow;
WP - Work productivity;
EBIT - Earnings before interest and taxes;
EBITDA - Earnings before interest, taxes, depreciation and amortization;
GS - General solvency;
GL - General Liquidity;
IL - Immediate liquidity;
TU - Turnover;
GP - Gross profit;
NP - Net profit;
TE - Total expenses;
ROA - Return on assets;
ROE - Return on equity;
LTD - Long-term debt;
STD - Short-term debt;

Table 2. Stakeholders' trust in the global performance information of companies applying IR

Stakeholder category	The linear regression equation of the model	Results on ST in global performance information of IR
INV	^SMV = + 0.732*EBITDA + 0.312*EBIT (0,0859) (0,0599) n = 200, R-squared = 0.669 *(standard errors in parentheses)	$ST_{INV} < 70\%$ ➢ MEDIUM
C/S	^INDB = + 0.263*GL + 0.271*IL + 0.435*TU + 0.0252*NP (0,636) (0,620) (0,0802) (0,0241) n = 200, R-squared = 0.877	$ST_{C/S} < 90\%$ ➢ HIGH
FIN CRED	^GW = + 0.0889*GP + 1.24*NP + 1.02*TE - 4.14*ROE + 2.83*ROA (0,0574) (0,344) (0,0769) (3,49) (3,44) n = 200, R-squared = 0.713	$ST_{FINCRED} < 75\%$ ➢ HIGH
SHARE	DPS = + 1.64*NP - 7.07*ROE + 6.17*ROA (0,408) (4,17) (4,13) n = 200, R-squared = 0.768	$ST_{SHARE} < 80\%$ ➢ HIGH
ST AUT	^NCF = + 0.534*GS + 0.0620*TU - 0.00274*GP + 0.00849*NP + 0.411*LTD (0,0502) (0,0444) (0,0126) (0,0129) (0,0230) n = 200, R-squared = 0.976	$ST_{STAUT} < 100\%$ ➢ VERY HIGH
EMPL	^WP = + 0.919*TU + 0.0233*GP + 0.0281*STD (0,0194) (0,00573) (0,0179) n = 200, R-squared = 0.991	$ST_{EMPL} < 100\%$ ➢ VERY HIGH
MANAG	^GW = + 0.0326*EBIT - 0.0168*GB - 0.0504*ROE + 0.504*CA + 0.575*STD (0,0566) (0,0654) (0,0564) (0,209) (0,182) n = 200, R-squared = 0.734	$ST_{MANAG} < 75\%$ ➢ HIGH

Source: authors' own processing through GRETL software

Table 3. Model – OLS, using observations 1-200. Dependent variable: SMV

	Coefficient	Std. Error	t-ratio	p-value	
EBITDA	0,732275	0,0858778	8,527	<0,0001	***
EBIT	0,311911	0,0599091	5,206	<0,0001	***

Mean dependent var	1,270838	S.D. dependent var	1,012236
Sum of squares of residuals	174,4331	Standard error of the regression	0,938603
Uncentered R-squared	0,668948	Centered R-squared	0,144515
F(2, 198)	200,0469	P-value(F)	2,95e-48
Log-likelihood	-270,1101	Akaike criterion	544,2202
Schwarz criterion	550,8168	Hannan-Quinn	546,8897

Table 4. Model – OLS, using observations 1-200. Dependent variable: INDB

	Coefficient	Std. Error	t-ratio	p-value	
GL	0,263283	0,636293	0,4138	0,6795	
IL	0,271349	0,620028	0,4376	0,6621	
TU	0,435011	0,0802091	5,423	<0,0001	***
NP	0,0251610	0,0240818	1,045	0,2974	

Mean dependent var	1,057655	S.D. dependent var	0,357245
Sum of squares of residuals	30,63668	Standard error of the regression	0,395360
Uncentered R-squared	0,877022	Centered R-squared	-0,206306
F(4, 196)	349,4463	P-value(F)	5,52e-88
Log-likelihood	-96,17577	Akaike criterion	200,3515
Schwarz criterion	213,5448	Hannan-Quinn	205,6907

Table 5. Model – OLS, using observations 1-200. Dependent variable: GW

	Coefficient	Std. Error	t-ratio	p-value	
GP	0,0889026	0,0573777	1,549	0,1229	
NP	1,23970	0,343930	3,605	0,0004	***
TE	1,01528	0,0769495	13,19	<0,0001	***
ROE	-4,14418	3,49085	-1,187	0,2366	
ROA	2,83213	3,44378	0,8224	0,4119	

Mean dependent var	1,195814	S.D. dependent var	0,743622
Sum of squares of residuals	113,6388	Standard error of the regression	0,763389
Uncentered R-squared	0,713059	Centered R-squared	-0,032688
F(5, 195)	96,91660	P-value(F)	6,10e-51
Log-likelihood	-227,2585	Akaike criterion	464,5169
Schwarz criterion	481,0085	Hannan-Quinn	471,1908

Table 6. Model – Quantile estimates using observations 1-200. Dependent variable: DPS

	Coefficient	Std. Error	t-ratio	p-value	
Pn	1,64378	0,408349	4,025	<0,0001	***
ROE	-7,06792	4,16905	-1,695	0,0916	*
ROA	6,16849	4,13228	1,493	0,1371	

Median depend. var	1,040833	S.D. dependent var	1,656521
Sum absolute resid	138,8710	Sum squared residues	621,5477
Uncentered R-squared	0,768948	Centered R-squared	0,164715
F(2, 188)	210,0589	P-value(F)	3,97e-66
Log-likelihood	-265,6750	Akaike criterion	537,3501
Schwarz criterion	547,2450	Hannan-Quinn	541,3544

Table 7. Model 30: OLS, using observations 1-200. Dependent variable: NCF

	Coefficient	Std. Error	t-ratio	p-value	
GS	0,533819	0,0502278	10,63	<0,0001	***
TU	0,0620391	0,0443648	1,398	0,1636	
GP	-0,00274456	0,0126498	-0,2170	0,8285	
NP	0,00849359	0,0128911	0,6589	0,5108	
LTD	0,411004	0,0230433	17,84	<0,0001	***

Mean dependent var	1,074242	S.D. dependent var	0,228675
Sum of squares of residuals	5,814032	Standard error of the regression	0,172672
Uncentered R-squared	0,975896	Centered R-squared	0,441291
F(5, 195)	1578,983	P-value(F)	1,3e-155
Log-likelihood	70,01660	Akaike criterion	-130,0332
Schwarz criterion	-113,5416	Hannan-Quinn	-123,3593

Table 8. Model – OLS, using observations 1-200. Dependent variable: WP

	Coefficient	Std. Error	t-ratio	p-value	
TU	0,919065	0,0193772	47,43	<0,0001	***
GP	0,0232543	0,00573159	4,057	<0,0001	***
STD	0,0281300	0,0179002	1,571	0,1177	

Mean dependent var	1,025270	S.D. dependent var	0,246209
Sum of squares of residuals	1,913307	Standard error of the regression	0,098551
Uncentered R-squared	0,991393	Centered R-squared	0,841392
F(3, 197)	7563,857	P-value(F)	4,3e-203
Log-likelihood	181,1607	Akaike criterion	-356,3215
Schwarz criterion	-346,4265	Hannan-Quinn	-352,3171

Table 9. Model – OLS, using observations 1-200. Dependent variable: GW

	Coefficient	Std. Error	t-ratio	p-value	
EBIT	0,0325835	0,0565874	0,5758	0,5654	
GP	-0,0168132	0,0653958	-0,2571	0,7974	
ROE	-0,0503938	0,0564136	-0,8933	0,3728	
CA	0,504051	0,209464	2,406	0,0170	**
STD	0,575390	0,181613	3,168	0,0018	***

Mean dependent var	1,195814	S.D. dependent var	0,743622
Sum of squares of residuals	105,4655	Standard error of the regression	0,737317
Uncentered R-squared	0,733697	Centered R-squared	0,041587
F(6, 194)	89,08229	P-value(F)	4,80e-53
Log-likelihood	-219,7944	Akaike criterion	451,5887
Schwarz criterion	471,3786	Hannan-Quinn	459,5974

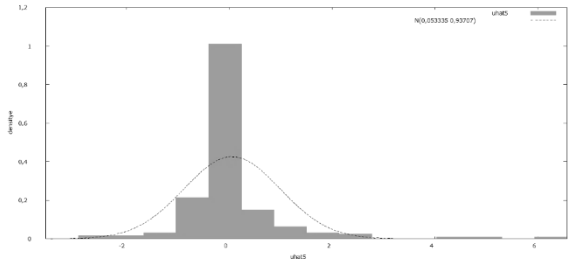

Figure 1. Histogram distribution of the dependent variable – stock market value. Source: Gretl version 2019a

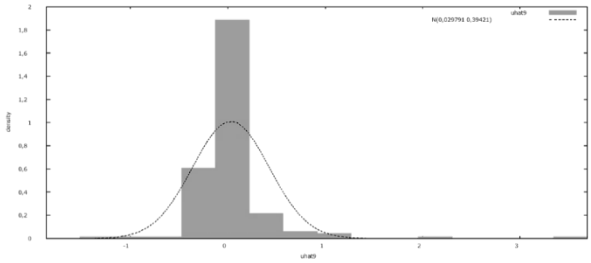

Figure 2. Histogram distribution of the dependent variable – Degree of indebtedness. Source: Gretl version 2019a

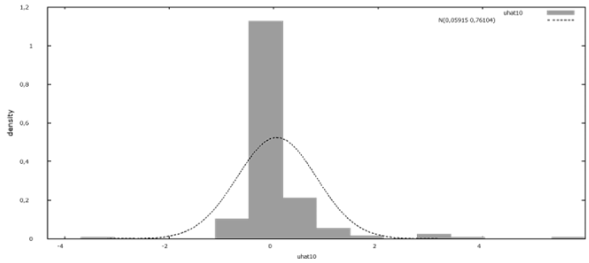

Figure 3. Histogram distribution of the dependent variable – goodwill. Source: Gretl version 2019a

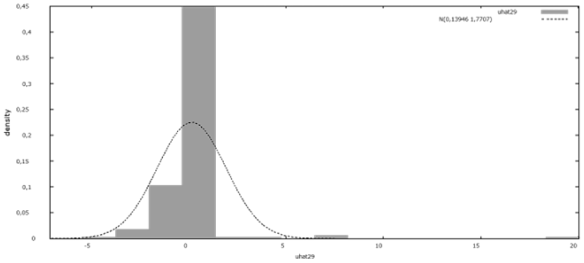

Figure 4. Histogram distribution of the dependent variable – dividend per share. Source: Gretl version 2019a

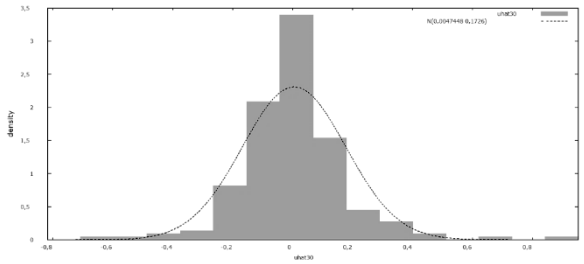

Figure 5. Histogram distribution of the dependent variable – net cash-flow. Source: Gretl version 2019a

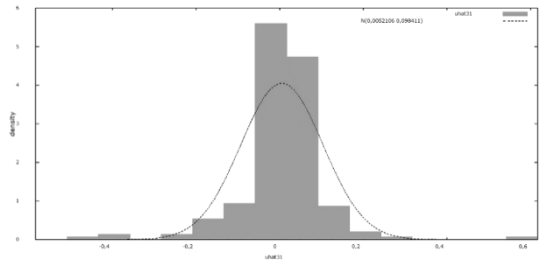

Figure 6. Histogram distribution of the dependent variable – work productivity. Source: Gretl version 2019a

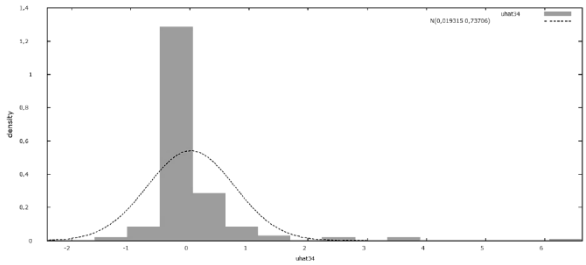

Figure 7. Histogram distribution of the dependent variable – goodwill. Source: Gretl version 2019a

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Neli Veselinova, PhD, Hauptassistenten, Lehrstuhl für sozial-ökonomische Geographie, Fakultät für Geologie und Geographie, Sofioter Universität „St. Kl. Ohridski“. Sofia, Bulgarien.
ORCID 0000-0002-6470-9786.

Die Natur als Faktor bei der geographischen Erklärung der bulgarischen historischen Geographie

Abstract: Die Verbindung zwischen Geographie und Geschichte als zwei der ältesten Wissenschaften beginnt noch am Anfang der wissenschaftlichen Erkenntnisse. Auch heute werden diese zwei Wissenschaften von vielen Wissenschaftlern nicht als untrennbar verbunden wahrgenommen. Die Versuche für eine getrennte Entwicklung haben sowohl zu ihrer Verzögerung, als auch zu der Unmöglichkeit für gegenseitige Unterstützung geführt. Die Studie zielt darauf ab, die Bedeutung der Geographie in der historischen Bildung und Praxis in Bulgarien aufzuzeigen. Die Studie erfordert die Verwendung bestimmter Methoden bei der Untersuchung natürlicher Merkmale und Phänomene. Die bei der Ausarbeitung verwendeten Methoden sind vielfältig und nicht unbedingt rein geografisch. Zu den wichtigsten gehören die deskriptive, vergleichende und historische Methode. Die Schlussfolgerungen beziehen sich auf die Notwendigkeit der Einführung geografischer Disziplinen in die Ausbildung von Geschichtsstudenten an Hochschulen im Land. Dies ist von größter Bedeutung. Sowohl in der schulischen als auch in der universitären Ausbildung im Land verfügen die zukünftigen Historiker über eine unzureichende geografische Ausbildung.

Schlüsselwörter: Geografie, Geschichte, historische Geografie, geographische Bildung, historische Bildung.

Neli Veselinova, PhD, Chief Assistant, Department of Socio-Economic Geography, Faculty of Geology and Geography, Sofia University “St. Kl. Ohridski”. Sofia, Bulgaria.
ORCID 0000-0002-6470-9786.

Nature as a factor in the geographical explanation of Bulgarian historical geography

Abstract: The relationship between geography and history as two of the oldest sciences dates back to the beginning of scientific knowledge. For many scientists, even today, these two sciences are not accepted as inextricably linked. Attempts to develop separately led to their backwardness and the inability to help each other. The research aims to show the importance of geography in historical education and practice in Bulgaria. The study requires the use of methods, which are diverse and not necessarily purely geographical. The most important are the descriptive, comparative, and historical methods. The conclusion is related to the introduction of geographical disciplines in history education in higher education institutions in Bulgaria. It is is very important. Historian students in their school and university education have insufficient geographical training.

Keywords: geography, history, historical geography, geographical education, historical education.

Нели Веселинова, д-р, главен асистент, Катедра „Социално-икономическа география“, Геолого-географски факултет, Софийски Университет „Св. Кл. Охридски“. София, България.
ORCID 0000-0002-6470-9786.

Природата като фактор при географското обяснение на Българската историческа география

Абстракт: Връзката между географията и историята като две от най-старите науки започва от самото начало на научното познание. За мнозина учени и днес тези две науки не се приемат като неразривно свързани помежду си. Опитите да се развиват отделно доведоха както до тяхното изоставане, така и до невъзможността взаимно да си помагат. Изследването има за цел покаже важността на географията в историческото образование и практика в България. Проучването налага използване на определени методи в изследването на природните дадености и явления. Използваните методи в разработката са разнообразни и не задължително чисто географски. Едни от най-важните са описателният, сравнителният и историческият метод. Изводите са свързани с нуждата от въвеждането на географски дисциплини при обучението на студентите по история във висшите учебни заведения в страната. Това е от изключителна важност. И в училищното образование и в университетското образование в страната бъдещите историци имат недостатъчна географска подготовка.

Ключови думи: география, история, историческа география, географско образование, историческо образование.

Einführung

In dieser Publikation betrachten wir hauptsächlich die Symbiose aus geographischer Sicht und müssen mitteilen, dass die Geschichte von Bulgarien sowohl lang, als auch kompliziert und manchmal sogar traurig ist. Es ist völlig verdient, dass die nationale Geschichte während unserer Wiedergeburt führende Positionen in der Gesellschaft hat. Auch heute sind vor allem die Geographen mit einer historischen universitären Ausbildung ständig Zeugen einer erheblichen Abweichung oder sogar der Unmöglichkeit der historischen Praxis, die historische Wahrheit zu erreichen. Für viele mag es eine Überraschung sein, aber in vielen Fällen liegt der Grund in der Geographie selbst oder genauer in ihrem Mangel bei den Historikern. Unserer Meinung nach müssen die zukünftigen Historiker in Bulgarien noch während ihres Studiums ein Minimum an geografischen Kenntnissen und Fähigkeiten beherrschen.

Seit langem sind die Meinungen von weltweiten Wissenschaftlern über die enge Verbindung von Geographie und Geschichte bekannt. Dies gilt auch für die bulgarische Situation. Vor kurzem wurde der 120. Jahrestag von der Gründung des ersten geographischen Lehrstuhls in Bulgarien gefeiert. Ganz objektiv hat diese Veranstaltung in der ehemaligen Fakultät für Geschichte und Geographie mit der spezifischen Unterstützung des bessarabischen Bulgaren Prof. Agura stattgefunden. Wir unterstützen die Meinungen, dass die Universitätsgeographie in den ersten 50 Jahren ihres Bestehens in einem unbestreitbaren Schwung war, als sie bei der Geschichte und den anderen Geisteswissenschaften war (*Boyadzhiev, 2019*). Leider gibt es in den Jahren nach 1944 keine solche einseitige Entwicklung. Und da die bulgarischen Historiker nicht das notwendige geografische Produkt von ihren Geographenkollegen erhalten, sind sie gezwungen, sich auf ihre Schulkultur und Lebenserfahrung zu verlassen.

Das Hauptziel, das wir uns gesetzt haben, ist es, die große Bedeutung der Geographie in der historischen Bildung und Praxis in Bulgarien zu beweisen. Diese Studie zielt auch darauf ab,

einige Unterschiede in der Erklärung der Natur in der Vergangenheit zu identifizieren und nachzuvollziehen. Ein weiteres Ziel ist es, die natürlichen Besonderheiten und ihren Einfluss auf die historischen Ereignisse in diesem Teil der Balkanhalbinsel und Bulgariens zu untersuchen.

Die verwendeten Methoden sind viel und unterschiedlich. Die historische Methode ist weit verbreitet, da sie fast jeder geographischen Studie innewohnt.

Von den qualitativen Methoden wurden die Feldforschung, das freie Gespräch, die Beobachtung und die Untersuchung von Dokumentation und von den quantitativen Methoden – die statistische Analyse verwendet.

Theorie und Methodologie

Die Aktualität und Bedeutung des Themas ergeben sich aus der Tatsache, dass in Bulgarien ein öffentlicher Bedarf an eingehenderen Untersuchungen zum Verhältnis von Geographie und Geschichte besteht.

Ein Teil unserer Untersuchung wurde durch das Werk von Ignat Penkov „Das Bild der bulgarischen Siedlungen" in „Notizen über die bulgarischen Aufstände" von Zahari Stoyanov unterstützt, das in der Zeitschrift „Mitteilungen der Bulgarischen geographischen Gesellschaft" veröffentlicht ist (*Penkov, 1941*). Penkov selbst verlässt sich auf Stoyanov für die Richtigkeit des historischen Materials und glaubt, dass dies „...eine Quelle der Geschichte und der Geographie unserer Städte und Dörfer ist..." (*Penkov, 1941*).

Eine weitere Untersuchung, die das vorliegende Werk auch unterstützt hat, widmet sich dem östlichen Teil des Sofioter Tals (*Veselinova, 2016*). Es befasst sich mit der Frage der historischen und geografischen Entwicklung des Untersuchungsgebiets und zeigt deutlich, dass keine Verbindung zwischen Geographie und Geschichte heute besteht.

Die Struktur dieser Ausarbeitung umfasst Einführung, Methodologie, Ergebnisse und Diskussion und Fazit.

Das Untersuchungsobjekt ist ein Teil der geographischen Kenntnisse und der Untersuchungsgegenstand ist ihr Einsatz als Faktor in der Geschichte.

Die zusammengesetzten Aufgaben, deren Lösung zur Zielerreichung beiträgt, sind konkrete Beispiele aus den geographischen Kenntnissen, bei denen die historische Geographie als Faktor unterschätzt oder direkt übersprungen ist. Das Ergebnis ist ein unvollständiges historisches Wissen.

Die Beschränkungen und die Probleme der Untersuchung ergeben sich aus dem heutzutage fehlenden Kontakt zwischen Geographen und Historikern in Bulgarien. Dieses Werk wird für eine breite Palette von Benutzern von Interesse sein – Akademiker, Lehrer und alle, die die Geografie und Geschichte mögen.

Ergebnisse und Diskussion

Die Ergebnisse zeigen, dass in Bulgarien in den letzten Jahrzehnten mehr als zwei Drittel der Geographiestudenten Geschichte als zweites Universitätsfach gewählt haben. Gleichzeitig beleibt die Geographie für die Geschichtsstudenten auch heute unbekannt. Vielleicht beginnt die unterbrochene Verbindung mit der Entfernung der Geographie von der ehemaligen Fakultät für Geschichte und Philologen und deren Einschließung zu den Naturwissenschaften und

Disziplinen nach sowjetischem Vorbild. Die Entwicklung der historischen Kenntnisse erfordert ständig sowohl die Human- als auch die Naturgeographie. Laut Boyadzhiev (*Boyadzhiev, 2016*) „… zeigt sich das sehr deutlich in den Ländern, in denen beide Wissenschaften jahrhundertealte Traditionen haben – Frankreich, Deutschland".

Wie entwickeln sich beide Wissenschaften und sind sie in Bulgarien miteinander verbunden? In unserer Realität wird Geschichte ohne Geographie geschrieben. Die unvermeidliche historische Geographie, deren Name als Semantik sehr klar ist, wird als historische Wissenschaft von sekundärer Nebenbedeutung dargestellt.

Gleichzeitig hat sich das Leben der menschlichen Gesellschaft jedoch weiterentwickelt. Der Mensch lebt immer komplizierter und immer länger. Seit langem ist er nicht mehr ein unschuldiges Kleinkind vor der Natur. Vorbei sind auch die Zeiten, in denen die Macht der Staaten an der Zahl ihrer Bevölkerung und der Fläche ihres Gebiets gemessen wurde, d.h. auf quantitativer Basis.

In Bulgarien hat die Befreiung am Ende des 19. Jahrhunderts eine interessante Schichtung der einzelnen ethnischen Gruppen nach der Meeresspiegelhöhe vorgefunden.

Die verschwundenen Jürücken und deren Nachfolger, die Karakatschanen, lebten in größerer Höhe. Es gibt keine Griechen, Armenier und Juden in den Bergen und nur einige von ihnen sind in einigen Dörfern äußerst selten vertreten. Die Gründung des Dritten Bulgarischen Staates ist mit der Flucht eines wesentlichen Teils der Muslime aus dem Land verbunden. Die geräumten Häuser, Grundstücke und Fluren ziehen Bulgaren aus den hohen Landesteilen an, so erfolgt eine Massenansiedlung in Gebieten mit geringerer Höhe. Zusammen mit den Türken, eingeschüchtert von Gerüchten, Imamen und Hodschas, flieht die überwiegende Mehrheit der bulgarischen Muslime in das restliche Osmanische Reich. Heute „weiß" der bulgarische Staat leider nicht, dass im thrakischen Teil von der Türkei über 1 Million bulgarische Muslime leben, deren Konversion zum Islam beendet ist. Aber ist es nicht dasselbe mit den Bulgaren in Griechenland und Rumänien, in Serbien passiert?

Das rasche Bevölkerungswachstum, die geringe Arbeitsproduktivität und die außergewöhnliche Extensivität der bulgarischen Wirtschaft erfordern eine schnelle und umfassende Anthropogenisierung der Naturlandschaften. Aus wild werden sie kulturell. Ihr Beitrag dazu leisten auch die Gebiete zum Ausbau der Siedlungen und der gründenden modernen Infrastruktur. Zentrale Rolle spielen hier auch die Straßen- und Schienenwege. Der Hauptgrund für das Austrocknen von Sümpfen und Mooren, für die Begradigung von Flussbetten und andere Hydromeliorationen ist die Notwendigkeit, die große Anzahl von Flüchtlingen zu landen, die die in Sklaverei geratenen bulgarischen Gebiete verlassen haben. Die letzten Wälder im Tiefland werden abgeholzt, Wiesen und Weiden werden gepflügt, die Hirten brennen ständig die Bergebenen nieder, um Weiden für ihre Herden zu gewinnen. Der Mensch drängt endgültig überall in die Natur ein: Von den Seehäfen bis zum Gipfel Musala.

Als Ergebnis unserer Studien haben wir Beispiele aus der Praxis ausgewählt, die den Zusammenhang zwischen einigen gesellschaftlichen Prozessen und Naturphänomenen zeigen:

In den bulgarischen Lehrbüchern für Geschichte der nicht bulgarischen Gebiete finden Sie fast nichts über den Zusammenhang zwischen bedeutenden sozialen Prozessen und außergewöhnlichen Naturphänomenen. Gleichzeitig werden im Ausland alle möglichen Theorien über die Auswirkungen von Vulkanausbrüchen, katastrophalen Erdbeben oder

Überschwemmungen erstellt und untersucht. Besonderes Augenmerk wird auf die Vereisung und ihre Folgen als Hauptfaktoren für das menschliche Leben und die Gesellschaft gelegt. Es gibt sogar Versuche für Parametrisierung der natürlichen Prozesse, um historische Prozesse und Ereignisse in der Entwicklung der Gesellschaft zu erklären. Der Russe Lew Gumiljow wurde weltberühmt für seine Theorie der Rolle natürlicher Bedingungen bei der Vertreibung von Menschen und der Bildung von verschiedenen ethnischen Gruppen. In der Regel haben Naturkatastrophen fast immer eine negative Auswirkung auf die menschliche Gesellschaft und Geschichte. Ein Beispiel dafür ist der Einfluss der letzten Vereisung. Historisch gesehen werden das Verschwinden der Imperien, die Entstehung und die Rolle von blutigen Kriegen und Revolutionen auch durch mögliche direkte Eingriffe der Natur erklärt. Natürlich mangelt es auch nicht an positiven Beispielen. Außergewöhnlich sind das Beispiel der Erscheinung Christi und der entsprechenden Himmelserscheinung ist, und das Beispiel des gefallenen Meteoriten in Russland entlang des Tunguska-Flusses.

Folgende Beispiele stammen aus der bulgarischen Praxis und zeigen einige Nichtübereinstimmungen zwischen bestimmten sozialen Prozessen und Naturphänomenen in Bulgarien.

In der Regel ist die Karte ein geografisches Produkt und kann je nach dem spezifischen Zweck wirtschaftlich, historisch, militärisch u.a. sein. Ein grundlegender Fehler ist die Verwendung des heutigen Gebietsumfangs in den historischen Karten von Bulgarien. Man darf nicht vergessen, dass die Geographie auch eine chronologische Wissenschaft ist, die sich entwickelt und durch die entsprechenden Symbole in der Kartographie dargestellt wird. Es kann nicht gestritten werden, dass Bulgarien aus der fernen Vergangenheit mit den heutigen geografischen Realitäten kartografisch nicht dargestellt werden sollte. Hier einige konkrete Tatsachen:

1. Die geografischen Koordinaten der Donau und ihr Einzugsgebiet sowie die Form des Flussbettes und seiner Zweige und andere Grundelemente sind in der fernen Vergangenheit in diesem Teil Europas und Bulgariens völlig unterschiedlich. Heute gibt es keine Sümpfe mehr, die es früher gab [1]. Sowohl aus geografischer als auch aus historischer Sicht wäre es in der Schulbildung besser, das über Khan Asparukh und seine Errungenschaften untersuchte Material besser zu organisieren und zu klären. Es wird über Onglos geschrieben und gesprochen. Dabei werden Hügel, Sümpfe und Moore dargestellt. Es reicht aus, auf die mittelalterlichen Karten zu schauen, um die fünf Zweige der Donau zu sehen, von denen heute zwei fehlen. Genau zwischen dem nicht mehr existierenden südlichsten Arm und den anderen nördlich davon gelegenen Armen des Deltas befand sich die Insel, auf der Asparuh mit der Unterstützung seiner Verbündeten dem byzantinischen Druck standhielt. Selbst der Name Onglos hat einen indogermanischen Ursprung und bedeutet hervorstehendes Land oder genauer gesagt – einen Winkel. Es ist interessant zu erwähnen, dass der Name des Dorfes Uglen in Bulgarien (wörtlich: winklig) eine ähnliche Bedeutung hat, was darauf hinweist, dass es sich an den Mäandern des Flusses Vit befindet.
2. Ein weiteres Beispiel für Nichtübereinstimmung kann mit dem großen römischen Lager in der Nähe des heutigen Dorfes Gigen, Gemeinde Gulyantsi, Bulgarien, angeführt werden. Wenn der vorurteilsfreie Bürger die Informationstexte liest oder den Vortrag des jeweiligen Reiseführers für diesen Teil des Territoriums hört, versteht er nicht, warum die Festung

den natürlichen Schutz der umliegenden Hügel nicht genutzt hat, sondern sich am möglichst niedrigen Ort befindet. Aus militärisch-geografischer Sicht befinden sich heute die Überreste der Festungsmauern an einem möglichst unangemessenen Ort. Das Lager befindet sich auf der Höhe der nahe gelegenen Flüsse Iskar und die Donau und um das Lager herum gibt es nur Wiesen und Weiden. Die Balken (hohe Hügel) liegen einige hundert Meter südlich. Der Fluss Iskar fließt in seiner aktuellen aufrechten Strömung einige hundert Meter westlich, und die große Donau liegt noch weiter nördlich. Für den intelligenten Touristen und den aufwachsenden Schüler oder Studenten der Geschichte und Archäologie bleibt die Wahrheit geheim. Welche ist sie? Tatsächlich erfahren Archäologen bei ihren Ausgrabungen aufgrund mangelnder geomorphologischer und Bodenkenntnisse nicht, dass sie auf der Suche nach Artefakten in einem alten Donaubett arbeiten und untersuchen. Früher haben die Römer ihr Lager an dieser Stelle nach den heute nicht mehr bestehenden natürlichen Merkmalen sehr richtig errichtetet. Die Festung war schwer zu erobern, da sie von Norden und Westen von dem Flusskomplex der heutigen Flüsse Iskar und der Donau umgeben war. Sie waren wasserreicher und ihre alten Betten und geerbten Sümpfe und Moore schlossen den Wasserring zu, der die größte Verteidigung der Festung darstellte. Diese geografische Lösung einer Festung entlang des Donaulimes ist nicht einzigartig. Ähnliche Lösungen gibt es auch anderswo am südlichen Ufer der Donau, wenn die Flüsse aus dem Süden einfließen und das Ufer nicht so hügelig wie in der Nähe von Nikopol, Ruse oder Silistra ist. Nicopolis ad Istrum ähnelt Bononia, Ratiaria, ist also nicht einzig. Auch nicht erwähnt werden die Donaubrücken auf den heutigen bulgarischen Gebieten, deren Bau Bewunderung erregen sollte. Ganz unterschiedlich ist auch die Natur heute südlich von der Donau auf dem Gebiet des heutigen bulgarischen Staates. Die natürliche Pflanzenwelt wurde mehrmals flächenmäßig reduziert und an ihrer Stelle werden Kulturpflanzen gepflanzt, die in der Landwirtschaft als Pflanzenzucht bezeichnet werden. Aus unterschiedlichen Gründen wurde auch die wilde Pflanzenwelt verändert. Dies zeigt sich am besten bei den Diskrepanzen zwischen der Realität und den Siedlungs- oder lokalen Namen. Wie viele Eichen gibt es in beiden Orten Dabnitsi (wörtlich: Ort der Eichen), wie viele Walnüsse gibt es in Oryahovo (wörtlich: Ort der Walnüsse), gibt es Ulmen in dem großen Dorf Brest (wörtlich: Ort der Ulmen), das sich neben dem bereits erwähnten Dorf Gigen befindet? Im Namen seiner landwirtschaftlichen Kultur hat der Mensch einen Großteil der ehemaligen Wasserflächen vernichtet. Der große Straldzha-Sumpf ist verschwunden.

3. Das nächste Beispiel bezieht sich auf das Sofioter Tal und einige Siedlungen rund um die Hauptstadt Sofia. Die Bewohner vom Sofioter Tal ahnen nicht, dass der Fluss Iskar heute und vor allem in der Vergangenheit durch mehrere Flussarme vertreten wurde. Die Dörfer Kasichene, Busmantsi, Krivina und ein Großteil des Ortes Gara Iskar befinden sich auf Fluss- und Seeablagerungen, die von einem alten See aus vergangenen geologischen Zeiten stammen. Das Geflecht aus Flussästen, Sümpfen und Mooren bestand bis zur Befreiung vom Sofioter Tal Ende 1877. Auf der erwähnten Karte war ein Großteil von dem östlichen Gebiet des Tals, der sich zwischen dem Fluss Iskar und dem Fluss Lesnovska befand, so durchnässt, schädlich und unzugänglich, dass er den klangvollen Namen Chumavoto (wörtlich: pestkrank) trug. Im Gegensatz zur Wahrheit wird das Sofioter Feld selbst in der

Zeit von Justinian, Konstantin, Khan Krum oder Vladislav Varnenchik gewöhnlich als sehr fruchtbar bezeichnet.

4. Es ist unmöglich, dass die Pässe, Hügel oder andere natürliche Merkmale nicht erwähnt werden, die in der Vergangenheit für einige historische Ereignisse entscheidend waren. Zum Beispiel werden in den Kämpfen am Gipfel Shipka für die Befreiung Bulgariens von der osmanischen Herrschaft für die Natur die Worte vom bulgarischen Schriftsteller Ivan Vazov wie „Steine und Bäume sind dort verschwunden" zitiert. In Bezug auf die Steine sind wir einverstanden, da das Relief felsig war und auch heute so bleibt. Aber woher kommen die Bäume auf den Felsen? Wenn Abweichungen in der Poesie erlaubt sind, ist dies in der Wissenschaft nicht erlaubt. Die Natur bestand nicht bei der Eroberung der Festung Edirne im Jahr 1913, der Fluss Aheloy wird nur als Name im Sieg von König Simeon erwähnt, es wird bei der Schlacht von König Kaloyan im Jahr 1205 nur über Sümpfe und Moore gesprochen.
5. Besonders interessant ist der Fall der mittelalterlichen Stadt Tarnovgrad. Der Leser hat immer den Eindruck, die Osmanen hätten eine Festung erobert. Wie ist dies möglich, wenn die Mäander des Flusses Yantra durch den Vorbalkan für die Hügel Tsarevets, Trapezitsa, Sveta Gora bekannt sind? Es heißt dann, dass Tarnovgrad eine Zusammensetzung aus mehreren befestigten Siedlungen war, und jede von denen neben ihren Besonderheiten auch eine Verteidigungsfestung darstellte.
6. Wenn wir nach der vielleicht größten Diskrepanz mit der Wahrheit suchen, finden wir diese im Museum des Dorfes Debelt, Bezirk Burgas, Bulgarien. Dies ist die alte Siedlung, die noch seit der Römerzeit bekannt ist. Wenn wir uns die heutigen Karten ansehen oder die Umgebung besuchen, stellen wir fest, dass die Entfernung zu den Stränden des Schwarzen Meeres einige zehn Kilometer beträgt. Überraschenderweise finden wir im Museum jedoch verschiedene Anker und andere Exponate rund um die Schifffahrt.
7. In der Regel befinden sich die zentralen Siedlungen in Bulgarien an Orten, an denen die natürliche Grenze eine gewisse Flexibilität bietet – Meer – Land, Gebirge – Tal usw. Die bulgarischen Gebiete befinden sich unter den Bedingungen eines idealen natürlichen Komforts, weshalb die Entwicklung des Landes von Norden nach Süden erfolgt. Im Falle einer Gefahr ändern sich jedoch die geografischen Prioritäten der Gesellschaft dramatisch. Das Schicksal von Bulgarien wurde in den Bergen und Pässen entschieden. Es ist aufschlussreich, dass das historische und geografische Gebirgsgebiet – Mazedonien – im schwierigsten Mittelalter eine ständige Bevölkerungsquelle ist, die die bulgarische Sprache in Thrakien und Moesia unterstützt hat, wo die Überlebensbedingungen viel schwieriger waren. Aus demselben Grund ging das Bulgarentum auch nördlich von der Donau in den walachischen und moldauischen Gebieten verloren.

Fazit

Wir müssen den ernsthaften Bedarf an dem Einsatz der Geographie in der historischen Praxis und in der historischen Ausbildung betonen. Die Zusammenwirkung zwischen der Geographie und Geschichte in Bulgarien hat vor 120 Jahren angefangen. Bis 1948 ist die Zusammenarbeit recht harmonisch verlaufen und bedeutende Ergebnisse wurden sowohl in der Wissenschaft als auch in der Bildung und in der öffentlichen Hand erzielt. Während der

kommunistischen Zeit ließ diese Beziehung allmählich nach. Ende des letzten Jahrhunderts, noch zu Beginn des demokratischen Wandels, sind alle offiziellen Kontakte unterbrochen. Daraus resultieren beiderseitige Verluste. Und einer davon bezieht sich auf die Geschichte und zwar der Mangel an Wissen über die bulgarische Natur in der Vergangenheit. Die Natur hat einen großen Einfluss auf die geographische Erklärung der bulgarischen Geschichte, aber die Geographie wird von Historikern kaum untersucht. Dies ist neben dem Bildungssystem vor allem auf das Missverständnis und die Verwendung der bulgarischen Natur zurückzuführen. Nicht weniger ernst ist das Problem mit dem historischen Kenntnisstand bei den Geographen. Eine Änderung in Richtung gegenseitiger Zusammenarbeit und gemeinsamer wissenschaftlicher Forschung zwischen beiden Wissenschaften ist erforderlich. Die Geographen sollten Produkte schaffen, die nicht nur den modernen Bedürfnissen der Geschichte entsprechen, sondern auch die Möglichkeiten der historischen Geographie aufzeigen.

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Fussnote:

[1] Nur der Sumpf in der Nähe des Dorfes Srebarna, Bezirk Silistra, bleibt auf bulgarischem Territorium, und das liegt daran, dass er bis 1940 unter rumänischer Besatzung war. Erst in der Zeit zwischen den beiden Weltkriegen und nicht während der Regierung des Landes

bis 1989 wurden die Donausümpfe und Flussbette ausgetrocknet und an deren Stelle gibt es fruchtbare Tiefländer. Bis vor wenigen Jahrzehnten wurden sie effektiv bewässert und boten landwirtschaftliche Produkte. Auch heute, wenn Bulgarien in Bezug auf den Anteil des bewässerten Ackerlandes seit langem nicht mehr weltweit an erster Stelle steht, und wenn mit der künstlichen Bewässerung fast aufgehört wird, ist die Landwirtschaft entlang der Donau weiterhin führend.

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Afful Ekow Kelly, Department of Information Technology, School of Science and Engineering Malaysia, Malaysia University of Science and Technology. Selangor, Malaysia.
ORCID: 0000-0002-8026-6436.
Sellappan Palaniappan, Professor, Dr., Head of Department, Department of Information Technology, School of Science and Engineering. Selangor, Malaysia. ORCID: 0000-0002-7650-8404.

A proposed approach to enhance user PIN in the mobile money ecosystem in Ghana

Abstract: The use of only numeric numbers as the base for the USSD PIN rather than alphanumeric was one of the security risks in the USSD mobile money services. The study objective is to assess the security threats posed by user PINs in the mobile money banking ecosystem and to enhance the service quality of the existing mobile money service with its high level of security threats prone to the mobile money industry. The study aims to shed light on the consumer acceptability requirements for mobile banking in particular areas of the consumer usage pattern, which will inform the industry players to strengthen such areas in consumer interest. This will help both the telecoms to understand the individuals and customise services based on the service needs of users of their product. This will aid the operators to cut costs and help improve the security infrastructure in other countries to cover to rope in more users, and to serve the unbanked in the hinterlands of the country. There is a growing demand for the adoption of mobile money services in Ghana. However, there is insufficient research to understand the risk associated with the adoption of the service. It is on this trend that, the study sought to reveal and understand the threat in the nature of user PIN used in the mobile money service. This study encapsulates, with the extension on demographic scope, which included workers, students, employed and unemployed who have adopted mobile money services the study adopted an exploratory method, to understand the main threats of the user PIN in relation to the mobile money application adopted in Ghana. This also included a survey question for users' responses on the nature of use. The study included 57 participants to uncover the vulnerability of users' PINs in mobile money services. The study's findings revealed that the length could be increased. The current size of the PIN stack was set to four for convenience and user-friendliness, with little thought given to the threat such a length could pose in financial transactions involving mobile money banking. The mobile money PIN solution provided will enable users not to be worried n about their accounts should users end up losing their handset and otherwise potentially harm their handsets because the merchandise is completely secure. The system is safeguarded by cutting-edge secure authentication, but also users' funds are always secure because each transaction requires a secured alphanumeric password. The mobile payment process delivers individual clients with enhanced security but also lowers the need of carrying physical money but also ensures easy prompt payment of transactions of utilities. Individuals utilizing such services will manage to pay one's bill payments from the comfort of their place of arbour and making it even easier to do so. The use of only a numeric key for PIN was far more convenient for users, but it also made them more vulnerable to attacks. The standard PIN length in the current USSD mobile money application was four numeric keys. The indication was that the PIN length was too simple for a simple system to break through. The study proposed solution where mobile money users can increase their user PIN to six characters, and include alphanumeric keys. The study will help reduce the increasing threat of mobile money fraud in the FinTech industry.

Keywords: mobile security, personal identification number, mobile money, unstructured supplementary service data, SMS threat, fraud.

Introduction

Ghana's mobile telecommunications industry (GMTI) is among the most competitive sectors in Africa, considering massive foreign actors in the telecoms industries (*Yeboah-Asiamah et al., 2016*; *De Luna et al., 2019*) and has also been generally viewed as the most influential aspect of Ghana's economy. Mobile telephone subscribers stood at 41 million at the end of 2021, depicting a 134 percent penetration rate in 2021, National Communication Authority – NCA (*National Communication Authority, 2021*). The emergence of mobile money has altered how businesses are conducted (*Madise, 2019*; *Jakhiya et al., 2020*). Customers are required to register with users' national identity card (Ghana card) to any selected telecoms across the country. The user's SIM is automatically registered for mobile money service when a user signs up, which is mandated by NCA for network operators (*Act, 769*). Users need not open a bank account before using the mobile money application because mobile applications do not require a bank account to function.

There is sufficient research on mobile money and mobile banking, in the areas of stakeholders' perspective (*Mullan et al., 2017*) individual performance (*Munoz-Leiva et al, 2017*) service quality (*Kaatz, 2020*; *Desmal et al, 2019*), security (*Wazid et al., 2019*; *Otor et al., 2020*), and as a financial tool in an emerging economy (*Malaquias & Silva, 2020*; *Tripathi, 2020*; *Mohamed & Nor, 2021*), indicate the impact on the financial growth it has brought to those countries, and most importantly the users of the mobile money banking service. Mobile money is challenged with fraudulent activities, thus the focus of the study, is the length of user PIN used in the mobile money service.

The direct interaction between the telecoms and handset is by use of a web portal and short message service (SMS), where SMS is through unstructured supplementary service data (USSD) however, the SMS is the most common medium (*Mallik et al., 2020*). SMS usage has grown in almost every sector of human development, from health care, e-government, education, agriculture, railways, mobile banking, and news alert to send reminders. These messages also include passwords and private information of users in 2018 (*Shital and Prakash, 2015*), more than 9.1 trillion SMS were sent across the globe, constituting 1 trillion dollars US in commercial value.

Mobile technology has successfully revealed itself as a digital platform for various activities, including online banking and mobile money services (*Khan et al., 2017*; *Lin et al., 2020*). While designing mobile applications, there are a few other issues to solve, including simplicity of the application, user friendly, security, and a well-established application referred to as a "killer application" (*Siau et al., 2003*). According to S. Hillman and C. Neustaedter (*Hillman & Neustaedter, 2017*), mobile application development is simply by virtue of whether such regulatory approval potentially makes service providers more reliable with their mobile application services (*Munoz-Leiva et al, 2017*; *Jagtiani & John, 2018*; *Bowers et al., 2017*; *Chen, 2019*). Transfer funds on the mobile application is more than yet another software on one's phone, but rather an embodiment of the institution's brand. However, according to S. Sarkar and A. Khare (*Sarkar & Khare, 2019*), users would be discouraged from establishing flaws in the applications they are using, as a result, mobile device architects must thoroughly examine the applications environment.

The usefulness of the mobile handset is becoming tough with various mobile devices, which have decreased in size and weight over time (*Venkatesh et al., 2012*). Moreover, the

conventional mobile applications' adaptability is still unsolved since the applications should be able to adjust to users' requirements and requests and ensure their mobility (*Anagnostopoulou et al., 2017*; *Wang et al., 2018*). Developing the technical support provided by information technology infrastructure is the primary difficulty in mobile apps and the user's ability to operate a smartphone application. On the other hand, the advent of numerous traditional financial misfortunes has highlighted the difficulties inherent in the mobile money system, which is used throughout the mobile payment transaction process (*Mega, 2020*; *Lee et al., 2018*).

A suitable system of payments through mobile devices is also a challenge in the evolution of mobile banking (*De Luna, 2019*; *Kim et al., 2020*; *Wang et al., 2021*), as mobile devices function as a strong medium in financial solutions also including mobile payments and mobile money services. Therefore, designing mobile money applications thoroughly to satisfy the needs of target users is highly significant (*Korableva et al., 2019*; *Ahmad et al., 2018*).

The use of mobile money has become very important in bridging the most critical services that also occurred during the Covid-19 pandemic (*Bryant et al., 2020*; *Beaunoyer et al., 2020*). The role of mobile money became a saviour in the financial sector during the covid-19 pandemic. The use of mobile money allows users to transfer money to anybody who also had a mobile device and is registered with any mobile money company. Those whose SIM is not registered to any mobile money service operator were allowed to use the token option, the mobile money banking services give room to users to settle bills, purchase prepaid airtime, check their bank balance, and buy products and services using the service (*Jakhiya et al., 2020*; *Gosavi, 2018*).

Research Problem

There is an adequate study on mobile money and mobile banking, including stakeholders, service quality, security and financial tool for an emerging economy (*Munoz-Leiva et al., 2017*; *Desmal et al., 2019*; *Otor et al., 2020*; *Malaquias & Silva, 2020*; *Tripathi, 2020*). These studies show the impact mobile money had on financial growth in those countries where it has been adopted, and most importantly, the mobile money service users. However, there is little scientific and empirical evidence as to what has led to the security threat related to mobile money services in Ghana.

The importance of the usage of USSD for mobile money should not elude stakeholders from overlooking the emerging security threats associated with mobile money services. It is on this score that the study is to highlight the weakness of the current user PIN used in the mobile money service and introduces an increased PIN length instead of the four numeric PINs currently used.

The threat to mobile money has become obvious, and fraudsters have taken advantage to wreak even more havoc on users, while service providers appear to do nothing to address the obvious issues, instead simply asking users to be cautious with how they handle their PIN. Third-party access to a user's PIN has become a common method for fraudsters to gain control of a user's account. However, there is no guarantee to protect users regarding how their accounts are operated, nor are there any security measures in place to ensure some level of safety on their accounts.

As a result, the study problem is to improve the user's security PIN of mobile money services and the threats that characterise the mobile money industry.

Literature

The review considers the structures associated with mobile money applications, as well as the security risk posed by USSD structures linked to mobile money services.

Mobile application issues

The problems of accepting mobile money have been widely studied and referenced based on one's geographical location and class of development associated with mobile money services (*Khalilzadeh et al., 2017*). There is a litany of challenges confronting the mobile money payment system. The challenges discussed by researchers are tailored toward the scope of their study and the purpose set for the study. The study, therefore, classified the challenges confronting mobile payment as; security, cost, standardisation, convenience and technology, and system quality (*Kang, 2018*). The fundamental taste of users to adopt technology varies. However, T. Dahlberg and N. Mallat indicate that the focus should be on safety and affordability to get customers to embrace the new payment system (*Dahlberg & Mallat, 2002*). The study considers in detail the challenges relating to the acceptance of mobile payment systems. Figure 1 summarises the challenges in mobile money applications, and any solutions proposed must attempt to address them (*Figure 1*).

Standardisation

Several academics suggest that the unavailability of a uniform approach poses apparent issues in the advancement of mobile payment services to attract users (*Verkijika & Neneh, 2021*). According to MeT, the usage of mobile banking current market is characteristic of either an emerging thing, first with a plethora of concepts and indeed ideas, which might or might not be interoperable (*MeT, 2001*). Also, with a standard interface since the shared knowledge and convenience of use are vital, all the customers' delight is getting a service that meets their requirements and service deployment at ease. Finally, one of the most pressing issues in mobile payments is a lack of standardisation, exacerbated by the mobile market's proliferation (*Hillman & Neustaedter, 2017*; *Yan, 2021*).

Trust

Trust in mobile payment services is mostly limited to devices, applications, operators, regulations, and network infrastructure (*Yeboah-Asiamah et al., 2016*; *Baganzi & Lau, 2017*). Trust encapsulates the fact that the user strongly expects that the data and transaction information that the operators and the banks primarily handle are not misused or trade-off but is kept safe (*Sharma & Sharma, 2019*; *Talwar et al., 2020*). This could be done when all the players put in appropriate measures to ensure and assume the trust needed.

System quality

Consumers obtain good impressions and adoption when they see that the service offers to them is of good quality (*Zhu et al., 2017*). The strength of third-party trustees, the crucial cryptography infrastructure to check secure transactions and the safeguard of privacy is an unquestionably crucial aspects in creating consumer adoption.

According to B.J. Corbitt and Y.T. Han, when customers find inadequate integrity, it may hinder their interest to use (*Corbitt & Han, 2003*). However, system quality should primarily put into perspective the user's demand to understand how it will ease their response to service demand.

Convenience

Convenience and ease of use are both significant factors incentivising all technological advancements (*Jibril et al., 2020*; *Pal et al., 2020*). Mobile user views of mobile payment convenience have a favourable impact on the acceptance of "mobile payment services" (*Humbani & Wiese, 2018*). Consequently, the accessibility of mobile payment systems is one of the reasons behind their popularity. However, in this age of rising hacking and cyber fraud, mobile money transactions come with the risk of financial and data loss. Compared to traditional financial service providers, the perceived benefit of the desire to use mobile payment is an appropriate basis to attribute the perceived usefulness of the intention to adopt mobile financial services (*Putritama, 2019*). According to W. Liu, X. Wang, and W. Peng, although mobile payment is convenient, it also introduces dozens of new payment security concerns, leading to our subsequent discussion on security (*Liu et al., 2020*).

Security

Security knowledge, privacy issues, and trust problems are all possible causes of factors to disrupt the gains made in mobile commerce (*Otor et al., 2020*; *Kang, 2018*). Thus "mobile commerce started with the establishment of cellphones equipped with advanced cards" (*Madden et al., 2017*), which provide security features not accessible through all the other e-commerce methods. The cell phone, with an embedded SIM card, is an ideal recipient for a public key infrastructure (PKI) system's secret key electronic signature (*Prakasha et al., 2019*).

However, this advancement is only possible if a tremendous amount of data security is ensured for the user's information and secured transactions (*Arun Prakash et al., 2018*; *Feng et al., 2017*). According to F. Gao, P.L.P. Rau, and Y. Zhang, the rising "adoption of mobile devices, as well as the development of digital systems" and applications, necessitates a human-centred approach to mobile data security (*Gao et al., 2018*). Privacy is a fundamental consumer prerogative, as users must not divulge their identity to other parties unless they are ready to provide that privilege (*Bowers et al., 2017*).

Cost

Another factor that keeps surfacing in the face of adopting mobile payment is the transaction cost associated with the services provided, and related charges have not been easy. This is supported by (*Abooleet & Fang, 2021*), according to them, most of these payment methods continue to face opposition due to a variety of factors, such as transaction costs. The acceptability of mobile money payment is completely dependent on those willing to pay the extra cost (*Liu et al., 2019*; *Shaw & Sergueeva, 2019*). It is, of course, not simple to convince clients to give more charges without good offerings. Operational expenses include both fixed but also payment system expenses, as well as user expenditures and technological infrastructure.

Cost, security, convenience, system quality, standardisation and trust are major factors for application development package standards for developers and users. The application issues associated with the development of mobile money services are the yardstick for developers and users in determining the application quality. These measures aid the success and failure in the acceptance of mobile money applications and services.

Security threats in SMS

Information security is the act of protecting information systems from unauthorised access for use any other than its original purpose. The distribution of SMS via a GSM system is not secured and is vulnerable to unauthorised access (*Donald & Favour, 2021*).

Common threats in SMS

The nature of the attack in a network system can be placed into two forms, thus internal and external; which could also be referred to as active and passive respectively (*Sudin et al., 2018*; *Ghannam et al., 2018*). We look closely at the specific attacks related to networks from which SMS is predominant in mobile money transactions. Figure 2, shows some SMS threats, these threats have become a challenge to most mobile money services (*Figure 2*).

1. Man-in-middle Attack: this happens when the user is falsely authenticated by the use of a false network system. Before any message or call gets through, the user has to be verified; this is where the attack happens, the man-in-middle turn to use a "false base transceiver station which uses the same network code of the subscriber", which makes it difficult to notice of the false authentication, as a result, turns to impersonate or commit any crime on the network.
2. Replay Attack: with a replay attack, the perpetrator uses the old messages between the user and the network to carry out such attacks. The user turns to trust the source and is ready to do anything such inquest this new message seeks to achieve.
3. Spamming: these are SMS messages which are sent as a nuisance or for an attack such as phishing or pharming. Several social marketers online turn to using SMS messages as a very legitimate marketing tool. But these turn out to be an inconvenience in some cases.
4. Denial of Service (DoS) Attacks: this happens when bulk and repeated SMS messages are sent to a target mobile phone user, with the primary intention to deny the user the use of their phone.
5. SMS Phishing: this uses the weakness in the SMS to send unsolicited information to a user with the main intention to cause harm.
6. Message Disclosure: SMS by default is not encrypted; the user's message is temporarily stored in SMSC as plain text. This makes the SMSC Centre venerable to an attack, as such messages are intercepted either deliberately or by a brute force attack. The information gotten could be used for a purpose which is not intended by the user. In some instances, the information could be of no use but viewed by a third party.

Figure 2 depicts the SMS threat associated with the USSD application in mobile money services (*Figure 2*).

Research Methodology

Research methodology is a system of methods used scientifically to solve the study problem. According to J.W. Creswell and J.D. Creswell, research must have a general framework; which aids in the design, structure and research strategy (*Creswell & Creswell, 2018*). The framework considered for this study is the research design and the data collection method and analysis to be used.

According to J.W. Creswell and J.D. Creswell, research designs are strategies and procedures spanning from presumptions to precise methods of data collection, process, and interpretation (*Creswell & Creswell, 2018*). The study adopted an exploratory design, thus exploratory sequential. This method first considered a qualitative aspect of the study then followed by a quantitative with the major aid in developing an intervention or designing an application to support the study (*Glyptis et al., 2020*).

The study first had a panel discussion with experts in the mobile money banking industry; these included professionals who had once worked with the mobile banking industry and the Telecoms. Moreover, the study team met the mobile money operators and agents in their capacity and not the institution. The reason for not meeting any of the telecoms officials was, they did not respond to the several letters requesting a meeting to have an overview understanding of the kind of security operations adopted by the telecoms in the mobile money service.

The study organised a focus group discussion and engaged a group of mobile money users through a purposive survey method to give insight into the PIN composition for mobile money services. The survey to get insight into users' PIN patterns was one of the most strenuous aspects of the study since most users were never willing to take part in the study. The outlook from the survey shows the kind of PIN users create. This revealed the weakness of the user PIN and how easily a third party through social engineering and social media can get access to the user PIN. Only 57 participants took part in the study. Table 1 shows the outcome of respondents' pattern of choosing and creating user PINs for mobile money (*Table 1*). The participants were asked to change their PIN after the survey.

The analysis of the study was to develop a mobile money application that will function just the same as the current mobile money application adopted by telecoms. The analysis adopted is to ensure that the study's mobile money application functionality solves the challenges set for the study's focus.

The scenario in Figure 3 enforces the kind of PIN used and its lengths, this is easier and simple for the user (*Figure 3*). However, it unveils how vulnerable it is to access a user's mobile money PIN (*Delahaye, 2019*).

The masking technique prevents the risk user is exposed to when using mobile money through shoulder surfing. Some users don't see the need to have a masked PIN, and most users in the study responded to the need not to mask their PIN. However, there are quite a number of research which the proposition to have a masked PIN is strong (*Agbezoutsi et al., 2021*; *Tiwari et al., 2020*). Figure 4 demonstrates the user PIN entered for a transaction; this also shows how easy it's for anyone to get hold of the user's PIN (*Figure 4*).

There are several methods used to overcome the masking of PIN. The two ways to implement the masking methods. First, there could be complete masking of the PIN, where the

user is not having any option of seeing what they are typing, but the user must know precisely the PIN required for that session. Secondly, the other choice is where the user is given an option; thus, a check option allows the user to see the PIN entered. There has been advertising use and implementation of the "Mobile PIN" concept where users can set their PINs (*Tiwari et al., 2020*; *Lakshmi et al., 2017*). However, this concept does not resolve the current threat related to the application's inability to mask the input PIN from the user. Therefore, the PIN adopted and used by the user through the USSD application remains a threat. In the case of the mobile money service application used by telecoms, none of the service providers implements PIN masking. This loophole in the mobile money service application has been exploited towards the disadvantage of mobile money users. This is not subject to any mobile money service providers; none of the service providers implores any masking options discussed.

Application development tools

The service tools used for the development of the mobile money application, first, a local host server was created to expose the codes to the Internet and AfricaTalk as simulation platforms. The study adopted Apache HTTP Server as the internal server host. Also, ngrok was used to help tunnel the service of the webserver (Apache). For, the webserver and ngrok not to delay in the kind of service it is rendering a Callback is used to support the flow of data access, this serves as stationery to where the webserver and external host can easily and continuously fetch its data for their use as and when it is needed.

Proposed User Pin Solution for USSD Mobile Money Service

The number of characters used as PIN authentication generally determines the PIN's strength. Using "mobile money" services as a case, all the telecom operators' PINs are limited to only four (4) numeric characters. This makes it easier for anyone mindful of accessing another user's PIN with minimum brute force attack or shoulder looking to get hold of an individual PIN quickly (*Delahaye, 2019*). In contrast, with that comes a gap this study would want to fill in the current security arrangement by the operator of the telecom of mobile money in Ghana.

This demonstrated that the PIN length could be broken in less than an hour using simple computer algorithms in a brute-force attack (*Delahaye, 2019*). The current size of the PIN stack was set to four for convenience and user-friendliness, with little thought given to the threat such a length could pose in financial transactions involving mobile money banking. This resulted in users not making any conscious effort to create PINs that were difficult to guess. In any case, given the length of available keys, users simply used any patterns that were as convenient to them, such as the last four digits of their current phone number or their year of birth, as was discussed earlier. As a result, the study implementation in order to increase the length of the PIN key was successful. This was increased to six characters on the basis that if a user loses or misplaces their phone, they will have a much greater window of opportunity to report it to the appropriate telecommunications operators. The latter will then block access to the phone to be used by the default new owner. As a result, it is a win-win situation for both telecoms and users.

Figure 5, illustrates the coding to increase the length to six characters from the current designated of four numbers (*Figure 5*). This introduction gives users the freedom to use any key combination of up to six characters, thus alphanumeric characters instead of only numeric ones.

This is not to say that users cannot continue to use the year of birth and other patterns discussed previously. However, users can add any additional characters to their existing keys. This makes the user's PIN length longer, and it is a little more difficult to brute-force attack the user's financial account on the mobile money platform. Figure 6 shows what the mobile money interface looks when a user enters their PIN in a transaction process (*Figure 6*).

Discussion

There are some participants who use "digits of their phone numbers" from the given phone number scenario (0244 906 732) for clarity. Some users used the last four (4) digits of their phone numbers (6732); others used the first four (4) digits (4906) apart from the phone code (024, 020, 054, 055, 027). Considering the perspective of gender, most females used their last digit as a PIN compared to males, and most males used the first four digits of their phone numbers as a PIN compared to females.

There was some diversity in the category for those who used "year of birth"; (1934). Some used their year of birth as the PIN code, and some also used the year of birth of their boyfriends, girlfriend, fiancées, parents and kids. With the same consideration about gender and their choice of these patterns for PIN codes, most females prefer using the year of birth compared to males.

The final category is those who used "other forms" of key combinations as their PIN. The PINs used by this category are grouped into two, those just by instincts and others by familiarity with some numbers; this includes generic numbers such as (1234, 7777, and 4321). The comparison based on gender indicates more males prefer using this method of randomly combining numbers for PIN than females. The above analysis clearly shows that, with this information at hand, anyone who has access to others' phones can break into their mobile money accounts without any trace.

The final results show that PIN masking is still a major challenge to the mobile money service. The reason for not meeting the outcome of PIN masking is that the USSD platform used for mobile money development was also limited. As a result, there is technically little the study could do to achieve this, which greatly aided in understanding the relationship between the industry and its stakeholders. There is a need for telecoms to consider adopting this concept to improve the security of the mobile money banking service.

The issue addressed in the use of USSD in mobile money transactions was the length of PIN keys. In the current USSD mobile money application, the standard PIN length was four characters. The indication was that the PIN length was too simple to break through in an hour with a simple computer system. According to the findings, it was possible to increase the length of the user PIN using the USSD application. However, this was never encouraged in the type of USSD application used by telecommunications companies.

Conclusion

The study objective is to assess the security threats posed by user PINs in the mobile money banking ecosystem and to enhance the service quality of the existing mobile money service with its high level of security threats prone to the mobile money industry.

The findings were based on the software development created for this study. In addition, the advancement was based on the exploration and quantitative study during the literature review period. These were focused on PIN length.

The simulation determination of increasing the length of the key used as a PIN for mobile money was achieved. The need and suggestion to increase the length of user PIN is to make the service more secure than what is currently used. According to Jean-Paul Delahaye, the duration of time needed to reveal the user PIN with the use of a computerised system in a brute force method is longer if the length of the key is longer (*Delahaye, 2019*). The current application key used by telecoms is four digits, this therefore clearly indicates the vulnerability associated with its use and the risk to access by fraudsters.

The outline of alphanumeric keys and the ability to increase the length of PIN in mobile money banking services will go a long way to reduce the rate of fraudulent activities on mobile money services. There is still clear evidence of a lack of collaboration between software developers and the industry in the areas of advancing the use of USSD mobile money with telecommunications companies. This was discovered by the USSD application development tool used by the telecoms for this study in the SMS sections of the USSD mobile money banking. In general, USSD was thought to be more secure than SMS in transactions (*Lakshmi et al., 2017*; *Nakibuuka et al., 2019*). Because the USSD does not keep track of the transaction histories of users. However, due to the lack of PIN masking, one major support offering the security nature of the USSD is weakened by the software development issue. According to the study reviews, masking the PIN would improve the physical security of transactions. This was done to ensure that anyone looking over their shoulder would not see the user's PIN. This singularity is still a problem for USSD mobile money banking; the platform is fixed, not allowing PIN masking.

The outcome of this study will enable decision-makers, academics and industry players to have prudent and ample reason on factors contributing to the rising numbers of threats to consumers' financial and personal data in the mobile money industry.

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Appendix

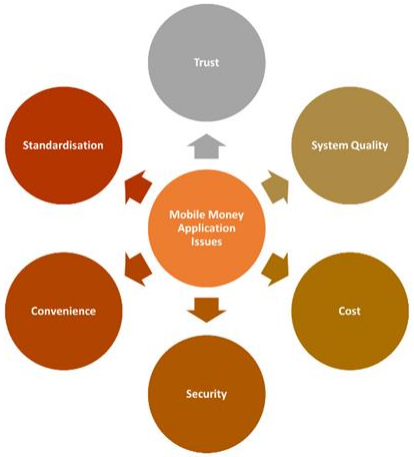

Figure 1. Mobile money application issues

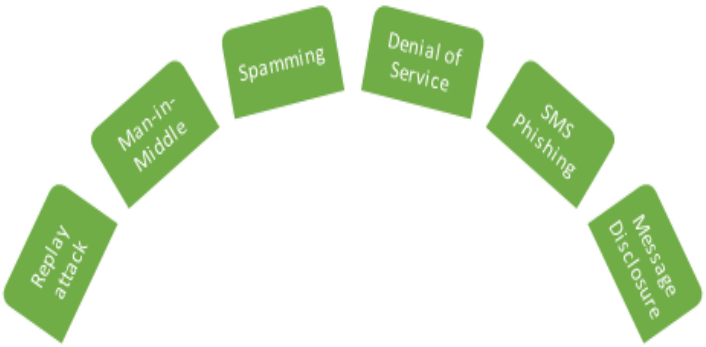

Figure 2. SMS threats

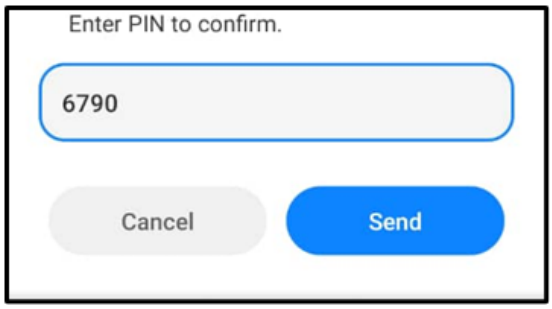

Figure 3. Length of PIN

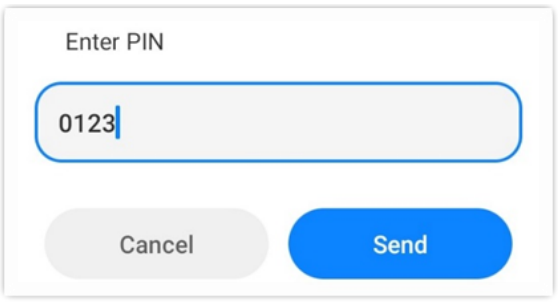

Figure 4. Unmasked PIN

```
class Accounts(db.Model):
id = db.Column('account_id', db.Integer, primary_key=True)
name = db.Column(db.String(50))  # user input
phone = db.Column(db.String(15))  # user input or from ussd_session
email = db.Column(db.String(100))  # user input
pin = db.Column(db.String(6))  # user input
bank = db.Column(db.String(100)) #user input
account_number = db.Column(db.String(30)) #user input
bank_branch = db.Column(db.String(50)) #user input
balance = db.Column(db.String(200))  # default 0, user input (teller)
retry_chances = db.Column(db.Integer)  # default 3
creation_date = db.Column(db.String(10))  # progam generated
```

Figure 5. Programming code for User PIN keys

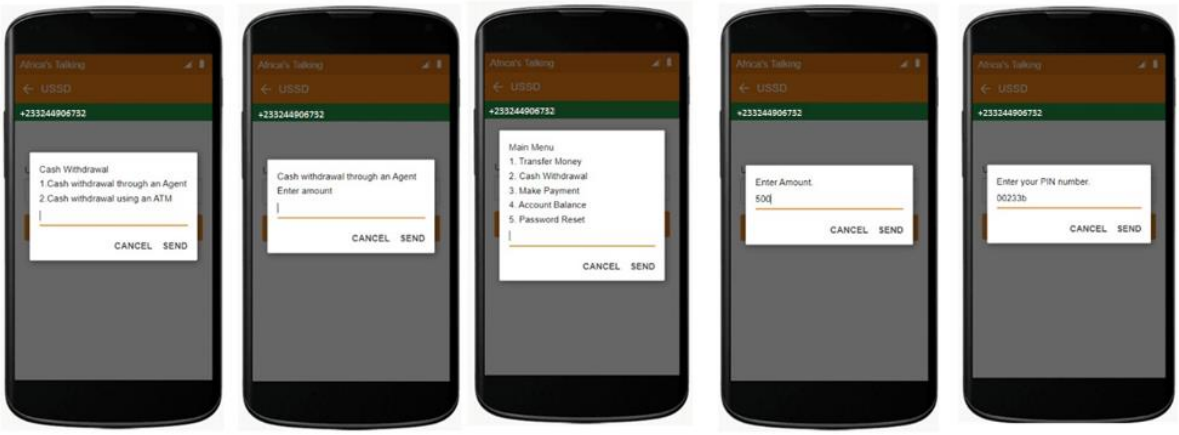

Figure 6. A summary of the user PIN of six characters

Table 1. Pattern of PIN used by users

Key M-Male F-Female	**Digit of phone numbers**		**Year of birth**		**Others**	
	15		23		19	
	F (9)	M(6)	F(15)	M(8)	F(6)	M(13)

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Alexander Buychik, Doctor of Science in Economics, PhD of Social and Political Sciences, Director for Sciences, Tuculart Holding. Ostrava, Czech Republic.
ORCID: 0000-0002-2542-4198, ResearcherID: AEV-6125-2022.
Peter V. Komissarov, Graduate of Postgraduate Studies, Admiral Makarov State University of Maritime and Inland Shipping. St. Petersburg, Russia.

Development of new mathematical methods and algorithms for verifying the adequacy of mathematical models of objects based on data from a natural experiment to determine the functional stability area

Abstract: The relevance of the development of applied mathematical modelling, which includes numerical methods and software packages in its problem area, its importance for the entire economic activity of the country as a whole, is due to the intensive digitalisation and computerisation of all technological chains of production processes. The integration of production support and various databases, as well as all parts of production and their effective management, require the development of comprehensive research of mathematical methods for modelling production processes. To date, mathematical modelling is applied to calculations of the financial stability point function, which does not fully reflect the variability of the predicted consequences, and consequently, the set of measures to preserve this stability. Due to the complication of production and economic relations, the need for modeling and calculating the area of financial stability, i.e., a set of marginal and non-marginal indicators, under which the economic condition of the enterprise will be considered to be acceptably stable, is actualised. The scientific problem is that mathematical modelling of production and economic processes does not provide for a wide variability (set) of indicators of financial stability as an area, which prevents flexivity in the economic activity of the enterprise. The scientific novelty of the work consists in the development of a method and algorithm for determining the financial stability area of an economic entity. The purpose of the study was to create a mathematical apparatus for calculating the financial stability of an enterprise. In the course of the study, the works of leading scientists and researchers in mathematical modelling and business processing, as well as the works of the authors of the article in this field were used. The authors presented a methodology for the development of quantitative indicators and, based on it, a methodology for mathematical modelling of calculating the financial stability area as a mathematical system that includes all eight main coefficients accepted as parameters of financial stability, and considers the limits that correspond to the economic indicators of the stability of the enterprise.

Keywords: financial stability area, mathematical modelling, business process, algorithmisation, automatisation of modelling calculations, financial stability of the enterprise.

Александр Буйчик, доктор экономических наук, PhD социальных и политических наук, директор по науке, Tuculart Holding. Острава, Чехия.
ORCID: 0000-0002-2542-4198, ResearcherID: AEV-6125-2022.
Пётр Вениаминович Комиссаров, выпускник аспирантуры, Государственный университет морского и речного флота им. адмирала С.О. Макарова. Санкт-Петербург, Россия.

Разработка новых математических методов и алгоритмов проверки адекватности математических моделей объектов на основе данных натурального эксперимента по определению области функциональной стабильности

Аннотация: Актуальность развития прикладного математического моделирования, включающая в свою проблемную область численные методы и комплексы программ, его значение для всей хозяйственной деятельности страны в целом, обусловлена интенсивной цифровизацией и компьютеризацией всех технологических цепочек производственных процессов. Интеграция производственного обеспечения и различных баз данных, а также всех звеньев производства и их эффективного управления, требуют развития комплексных исследований математических методов моделирования производственных процессов. На сегодняшний день математическое моделирование применяется к расчётам функции точки финансовой стабильности, что не отражает в полной мере вариативность прогнозируемых последствий, а следовательно, и комплекса мероприятий по сохранению данной стабильности. В связи с усложнением производственных и экономических отношений актуализируется необходимость моделирования и расчёта области финансовой стабильности, т.е., совокупности предельных и непредельных показателей, при которых экономическое состояние предприятие будет считаться допустимо стабильным. Научной проблемой является то, что математическое моделирование производственных и экономических процессов не предусматривает широкую вариативность (множество) показателей финансовой стабильности как области, что препятствует флексивности в экономической деятельности предприятия. Научная новизна работы заключается в разработке метода и алгоритма определения области финансовой стабильности экономического субъекта. Целью исследования было создание математического аппарата вычисления области финансовой стабильности предприятия. В ходе работы были использованы труды ведущих учёных и исследователей в области математического моделирования и бизнес-процессинга, а также работы авторов статьи в данной области. Авторы представили методологию разработки количественных показателей и на базе неё методологию математического моделирования расчёта области финансовой стабильности (устойчивости) как математической системы, которая включает в себя все восемь основных коэффициентов, принятых как параметры финансовой стабильности, и учитывает пределы, которые соответствуют экономическим показателям стабильности предприятия.

Ключевые слова: область финансовой стабильности, математическое моделирование, бизнес-процесс, алгоритмизация, автоматизация расчётов моделирования, финансовая стабильность предприятия.

Introduction

The relevance of the development of applied mathematical modelling, which includes numerical methods and software packages in its problem area, its importance for the entire economic activity of the country as a whole, is due to the intensive digitalisation and computerisation of all technological chains of production processes. The integration of production support and various databases, as well as all parts of production and their effective

management, require the development of comprehensive research of mathematical methods for modelling production processes.

Microeconomic processes, as well as business processes, are a basic component of the life cycle of any enterprise. To date, mathematical modelling is applied to calculations of the financial stability point function, which does not fully reflect the variability of the predicted consequences, and consequently, the set of measures to preserve this stability. Due to the complication of production and economic relations, the need for modeling and calculating the area of financial stability is actualized, i.e., a set of marginal and non-marginal indicators under which the economic condition of the enterprise will be considered to be permissible stable.

The scientific problem is that mathematical modelling of production and economic processes does not provide for a wide variability (set) of indicators of financial stability as an area, which prevents flexivity in the economic activity of the enterprise.

The object of the study was mathematical modelling of sets of production and economic indicators.

The subject of the study was methods and algorithms of mathematical modelling of production and economic indicators.

The purpose of the study was to create a mathematical apparatus for calculating the financial stability of an enterprise.

To achieve the purpose, it is necessary to solve the following study tasks:

- develop a model of algorithmisation and automation of calculations modelling the financial stability of the enterprise;
- design a methodology for the development of quantitative indicators;
- develop a methodology for mathematical modelling of calculating the financial stability area (FSA).

General scientific logical, historical, statistical, comparative methods, mathematical modelling, data analysis, and generalisation were used to achieve the purpose and solve problems in the course of the study.

The study's scientific novelty is the development of a method and algorithm for determining the financial stability area of an economic entity.

The study's theoretical significance is the development of a method for defining a new concept in the economic analysis of an enterprise – the field of financial stability.

The study's practical significance is the development of a new mathematical method and algorithm for verifying the adequacy of mathematical models of objects based on natural experiment data.

In the course of the work, the works of leading scientists and researchers in the field of mathematical modelling and business processing, e.g., L. Zadeh (*1965*), G.C. Chow (*1997*), C.W. Churchman (*1963*), D.N. Gujarati (*1992*; *1995*), M. Harzallah (*2007*), I., Hofacker and R. Vetschera (*2001*), K.-Y. Jeong (*2008*), M. Koubarakis (*2002*), K.I. Kurpayanidi (*2019*), S.G. Powell, M. Schwaninger and C. Trimble (*2001*), A.E. Teshabaev (*2018*), K. Vergidis and A. Tiwari (*2008*), L. Whitman and B. Huff (*1997*), as well as the works of the authors of the article in this field were used (*Buychik, 2021a*; *Buychik, 2021b*; *Komissarov, 2021a*; *Komissarov, 2021b*).

Development of models for algorithmisation and automatisation of calculations in financial stability of the enterprise

The first part of the article describes the development of models for algorithmisation and automatisation of calculations for modelling the financial stability of an enterprise and algorithms for their verification in EPC and IDEF0 notations, as well as using the ABC methodology (*Buychik, 2021a*).

Modelling in the EPC notation (event chain of processes) characterises the process of automating calculations as a set of sequential measures for the production of the final product – determining the indicators of the financial stability of the enterprise (*Figure 1*). Based on the model executed in EPC notation and tested on the experimental site of the enterprise, the microlevel processes of each stage of the EPC model were modeled in IDEF notation (*Business Process Model and Notation*) to create an algorithm of actions and minimise the risks of producing erroneous intermediate indicators, which are later used to obtain the area of financial stability (*Figure 2*).

To develop models of algorithmisation and automatisation of calculations for modeling the financial stability area, it is necessary to create an algorithm for providing initial (resource) data from the company's balance sheet.

1. The financial autonomy coefficient shows the share of equity and the reserve value of assets and is calculated by dividing equity by total assets. Consequently, the constituent components of equity in the company's balance sheet are:

- 1310 "Authorised Capital (share capital, authorised capital, contributions of associates)";
- 1320 "Own Shares Repurchased from Shareholders";
- 1340 "Revaluation of Non-Current Assets";
- 1350 "Additional Capital (without revaluation)";
- 1360 "Reserve Capital";
- 1370 "Retained Earnings (uncovered loss)".

Using IDEF notation, equity can be represented in the form of a diagram (*Figure 3*). Total assets are recorded on the left side of the balance sheet – its asset. The total amount of non-current assets is indicated in line 1100, current assets – in line 1200. Their amount on the balance reflects line 1600. Therefore, using IDEF notation, aggregate assets can also be represented in the form of a diagram (*Figure 4*). Thus, the algorithmisation and automatisation model of calculating the coefficient of financial autonomy can be represented by a consolidated algebraic scheme (*Figure 5*).

2. The coefficient of own and borrowed funds represents the share of borrowed funds in total sources of financing. The algorithm for calculating equity is shown in part 1. In the company's balance sheet, line 1410 "Credits, loans (long-term liabilities)" and line 1510 of the same name "Credits, loans (short-term liabilities)" are provided for reflecting borrowed funds. Therefore, using IDEF notation, borrowed funds can be represented in the form of a diagram (*Figure 6*). Thus, the algorithmisation and automatisation model of calculating the coefficient of own and borrowed funds can be represented by a consolidated algebraic scheme (*Figure 7*).

3. The coefficient of availability of own working capital provides an assessment of the availability of the company's own funds for financial support of current activities. In

mathematical terms, the calculation involves dividing the difference between equity and non-current assets by working capital. The algorithm for calculating equity is shown in part 1. The indicator of non-current assets in the company's balance sheet is reflected in nine lines. Therefore, using IDEF notation, non-current assets can be represented schematically (*Figure 8*). Current assets include six lines of the balance sheet. Therefore, using IDEF notation, current assets can also be represented schematically (*Figure 9*). Thus, the algorithmisation and automatisation model of calculating the coefficient of provision with own working capital can be represented by a consolidated algebraic scheme (*Figure 10*).

4. The financial stability coefficient provides a generalised or generalised analysis of the main sources of financing of the company's assets and is calculated by dividing the amount of own and long-term borrowed funds by the currency of the organisation's operations. The indicator of own funds (assets) is presented in part 1. The indicator of long-term borrowed funds is determined by line 1410. The indicator of the currency balance is determined by lines 1600 "Currency of the Balance of Assets" and 1700 "Currency of the Liabilities Balance". Therefore, using IDEF notation, the currency balance can be represented schematically (*Figure 11*). Thus, the algorithmisation and automatisation model of calculating the financial stability coefficient can be represented by a consolidated algebraic scheme (*Figure 12*).

5. The maneuverability coefficient of equity represents the level of total liquidity of the financial assets of the enterprise and represents the private difference of equity and non-current assets for the same equity. Thus, the algorithmisation and automatisation model of calculating the maneuverability coefficient of equity can be represented by a consolidated algebraic scheme (*Figure 13*).

6. The coefficient of the degree of solvency of a legal entity reflects the coefficient of the ability of the enterprise to pay its current obligations. The coefficient and is calculated by dividing the amount of current liabilities by the average monthly revenue. Thus, the algorithmisation and automatisation model for calculating the solvency coefficient can be represented by an algebraic scheme (*Figure 14*).

7. The short-term debt ratio shows the share of short-term sources of borrowed funds that generate risks to the financial stability of a legal entity. The coefficient is a quotient of short-term and total borrowed funds. Therefore, using IDEF notation, the short-term debt coefficient can be represented by an algebraic scheme (*Figure 15*).

8. The current liquidity coefficient shows the ability of an enterprise to direct current assets to repay its own short-term liabilities. The coefficient is the ratio of current assets and borrowed funds. Thus, the algorithmisation and automatisation model of the calculation of the current liquidity coefficient can be represented by an algebraic scheme (*Figure 16*).

Thus, the first part of the article presents the results of modeling the algorithmisation of all eight coefficients for calculating the financial stability of the enterprise. In the generalised version, the general algorithm can be represented by a business process diagram (*Figure 17*).

Methodology for the development of quantitative indicators

The second part of the article provides a methodology for the development of quantitative indicators that will be used to model the financial stability area.

The ABC (triplicity of indicators) methodology is used in modern financial management to determine extreme and median indicators, which are later used in production or strategic planning, as well as calculations in complex mathematical models of decision-making and obtaining results under uncertainty.

From the economic side of modeling innovative production and economic projects, which include the calculation of the financial stability area, the most important condition is the presentation of a model that can be determined during the relevant analysis. The analysis of the financial stability of the enterprise was performed using the calculation of the coefficients of eight multicomponent key indicators:

- the coefficient of autonomy (K_A),
- the coefficient of own and borrowed funds (K_{OBF}),
- the coefficient of the enterprise's own working capital (K_{EOWC}),
- the coefficient of financial stability (K_{FS}),
- the coefficient of equity's maneuverability (K_{EM}),
- the coefficient of solvency (K_S),
- the coefficient of short-term debt (K_{STD}),
- the coefficient of current liquidity (K_{CL}).

Consequently, the methodology for the development of quantitative indicators took into account the above indicators:

$$N = \sum K \times n_a, \qquad (1)$$

there:

N is sum of indicators,

$\sum K = \{K_A, K_{OBF}, K_{EOWC}, K_{FS}, K_{EM}, K_S. K_{STD}, K_{CL}\}$

n_a is number of alternatives.

Since eight indicators are used in the calculation, the following formula is used:

$$N = 8 \times n_a. \qquad (2)$$

In the course of modelling, the analysis of the inclusion of calculations of a set of key indicators for determining the financial stability of an enterprise in a set of criteria for choosing an alternative was performed. The criterion of indifference was excluded from the criteria, since the study was conducted considering the definition of a set of indicators of financial stability, in which an alternative with the maximum average result is calculated, which by definition is included in financial stability.

The remaining four criteria were used to construct the calculation of the set of alternatives:

$$M = 4N, \qquad (3)$$

there:

M is number of alternatives,

N is the sum of the indicators of each alternative.

The alternative assumes the presence of at least two options; therefore, the following formula is applicable in an expanded form:

$$M = 4 \times 8 \times n_a = 32 \times \sum_{i=2}^{n} n_a. \qquad (4)$$

Thus, if one scenario (a set of indicators) obtained under the conditions of modelling one situation, i.e., one set of parameters, is included in the calculations, at least 64 solutions are presented as a set of points of financial stability within the relevant area.

When considering the variation of the indicators of the share of equity and the reserve of the value of assets that issue as a private coefficient of financial autonomy, at least six options are generated, which, in turn, determine the appropriate number of alternatives. As part of the decision-making process to determine the point of financial stability, four criteria are applied for the financial stability area under conditions of uncertainty, which increases the number of alternatives:

$$M = 4 \times 8 \times n_a \times 6 = 192 \times \sum_{i=2}^{n} n_a. \qquad (5)$$

As a result of the use of a variety of options for only one of the financial stability coefficients, when it is limited exclusively to tenths, a variation that is a multiple of 192 when considering each subsequent alternative, arises.

When obtaining such a large set of indicators, it is proposed to introduce the triplicity principle of final indicators (ABC methodology) into the algorithm at each stage of calculations, i.e., the output of *maximax*, *minimin*, and *median* (*mid*) indicators. Thus, each of the eight coefficients in the final form is represented as three indicators, forming a more specific and optimal set of 24 final indicators of financial stability, forming areas of financial stability:

$$M = 8 \times n_a \times 3 = 24n_a. \qquad (6)$$

In the course of a natural experiment at the enterprise of the Viaduct LLC, specialising in the production of crackers, biscuits, and other breadcrumbs, the production of flour confectionery, cakes, pastries, pies, and biscuits intended for long-term storage, the minimum, median and optimal coefficients were used for calculations (*Table 1*).

To describe the development of quantitative indicators, it is necessary to present all the coefficients of financial stability of an enterprise in the form of mathematical expressions (*Table 2*).

Thus, the calculation of the total coefficients in the mathematical model can be represented as follows:

$$\sum k_{min} = k_{afs}^{min} + k_{rfs}^{min} + k_{pfs}^{min} + k_{jfs}^{min} + k_{mfs}^{min} + k_{sfs}^{min} + k_{dfs}^{min} + k_{lfs}^{min}, \qquad (7)$$

$$\sum k_{mid} = k_{afs}^{mid} + k_{rfs}^{mid} + k_{pfs}^{mid} + k_{jfs}^{mid} + k_{mfs}^{mid} + k_{sfs}^{mid} + k_{dfs}^{mid} + k_{lfs}^{mid}, \qquad (8)$$

$$\sum k_{max} = k_{afs}^{max} + k_{rfs}^{max} + k_{pfs}^{max} + k_{jfs}^{max} + k_{mfs}^{max} + k_{sfs}^{max} + k_{dfs}^{max} + k_{lfs}^{max}. \qquad (9)$$

Based on the total indicator of the minimum coefficients, the average indicator will be calculated as follows:

$$M_{min} = \frac{\sum k_{min}}{8}. \qquad (10)$$

Therefore, according to the economic indicators of financial stability, the average minimum indicator will be as follows:

$$M_{min} = \frac{\sum k_{min}}{8} = \frac{0.5 + 0.5 + 0.2 + 0.8 + 0.3 + 0.5 + 0 + 1}{8} = 0.475.$$

Based on the total indicator of the median coefficients, the average indicator will be calculated as follows:

$$M_{mid} = \frac{\sum k_{mid}}{n}. \qquad (11)$$

Therefore, according to the economic indicators of financial stability, the average median indicator will be as follows:

$$M_{mid} = \frac{\sum k_{mid}}{n} = \frac{0.6 + 0.6 + 0.3 + 0.9 + 0.45 + 0.6 + 0.1 + 1}{8} = 0.569.$$

Based on the total indicator of the maximum coefficients, the average indicator will be calculated as follows:

$$M_{max} = \frac{\sum k_{max}}{n}. \qquad (12)$$

Therefore, according to the economic indicators of financial stability, the average maximum indicator will be as follows:

$$M_{max} = \frac{\sum k_{max}}{n} = \frac{0.7 + 0.7 + 0.4 + 1 + 0.6 + 0.7 + 0.2 + 1}{8} = 0.663.$$

Accordingly, the financial stability area of the Viaduct LLC enterprise is within the range of indicators from 0.475 to 0.663, which will contain 24 indicators.

To calculate the limits of the conditions of the financial stability area, the sums of the extreme corresponding coefficients of the indicators and the remaining two averaged indicators are used.

To calculate the lowest extreme indicator of the financial stability area, it is used the formula:

$$M_{minimin} = \frac{k_{min}^{min} + M_{mid} + M_{max}}{3}. \qquad (13)$$

To calculate the extreme highest indicator of the financial stability area, it is used the formula:

$$M_{maximax} = \frac{k_{max}^{max} + M_{min} + M_{mid}}{3}. \qquad (14)$$

Consequently, further calculations of the extreme conditions of the area, based on the minimum coefficient indicators in each group of indicators, were made:

$$M_{minimin} = \frac{k_{min}^{min} + M_{mid} + M_{max}}{n} = \frac{0 + 0.569 + 0.663}{3} = 0.411,$$

$$M_{maximax} = \frac{k_{max}^{max} + M_{min} + M_{mid}}{n} = \frac{1 + 0.475 + 0.569}{3} = 0.681.$$

Consequently, the Viaduct LLC's financial stability area will be a set of 192 indicators that fall within the limits of indicators from 0.411 to 0.681.

These indicators and limits of the set are fully confirmed by the accounting financial stability of Viaduct LLC for the fiscal year 2021.

Thus, the second part of the article provides a methodology for the development of quantitative indicators that will be used to model the financial stability area. In the course of modelling, the analysis of including calculations of a set of key indicators for determining the financial stability of an enterprise in a set of criteria for choosing an alternative was performed. The criterion of indifference was excluded from the criteria, since the study was conducted considering the definition of a set of indicators of financial stability, in which an alternative with

the maximum average result, which by definition is included in the financial stability area, is calculated. When obtaining a large set of indicators, it is proposed to introduce the principle of triplicity of final indicators into the algorithm at each stage of calculations. Thus, in the final form, each of the eight coefficients is represented as three indicators, forming a more specific and optimal set of 24 final indicators of financial stability, forming the financial stability areas. The approbation of this methodology on the materials of the economic indicators of Viaduct LLC for the 2021 fiscal year confirmed its effectiveness and compliance with the financial analysis of the enterprise according to the accounting documentation.

Methodology of mathematical modelling of calculating the financial stability area

The third part of the article presents the methodology of mathematical modeling of calculating the financial stability area as a mathematical system.

When mathematically modelling a mathematical system for calculating the financial stability area, it is necessary to consider the areas of optimal variation in the indicators of each initially separately presented component, presented as a normative value, therefore, is the mathematical limits of the indicators of each component.

For the mathematical representation of economic indicators, the ratio of which the economic coefficients of financial stability are calculated, it is necessary to determine their mathematical designations (*Table 3*).

Based on this, the authors present the coefficients of the main components of the system and the formulas for their calculation with mathematical limits.

1. The autonomy coefficient shows the share of equity and the reserve value of assets and is calculated by dividing equity by total assets:

$$K_A = \frac{EQ}{TA}, \qquad (15)$$

there:

K_A is the coefficient of autonomy,

EQ is the indicator of equity,

TA is the indicator of total assets.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{afs} = \frac{i_{eq}}{i_{ta}}, \qquad (16)$$

there:

k_{afs} is the coefficient of autonomy,

i_{eq} is the indicator of equity,

i_{ta} is the indicator of total assets.

Based on the regulatory limits, this formula can be represented as $0.5 \leq K_A \leq 0.7$, or $0.5 \leq k_{afs} \leq 0.7$, i.e., $k_{afs}(0.5, 0.7)$.

2. The coefficient of own and borrowed funds represents the share of borrowed funds in total sources of financing:

$$K_{OBF} = \frac{BF}{FS}, \qquad (17)$$

there:

K_{OBF} is the coefficient of own and borrowed funds,

BF is the indicator of borrowed funds,
FS is the indicator of the source of funding.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{rfs} = \frac{i_{bf}}{i_{fs}}, \qquad (18)$$

there:
k_{rfs} is the coefficient of own and borrowed funds,
i_{bf} is the indicator of borrowed funds,
i_{fs} is the indicator of the source of funding.

Based on the regulatory limits, this formula can be represented as $0.5 \leq K_{OBF} \leq 0.7$, or $0.5 \leq k_{rfs} \leq 0.7$, i.e., $k_{rfs}(0.5, 0.7)$.

3. The coefficient of the enterprise's own working capital provides an assessment of the availability of the company's own funds for financial support of current activities. In mathematical terms, the calculation involves dividing the difference between equity and non-current assets by working capital:

$$K_{EOWC} = \frac{EQ - nCA}{CA}, \qquad (19)$$

there:
K_{EOWC} is the coefficient of the enterprise's own working capital,
EQ is the indicator of equity,
nCA is the indicator of non-current assets,
CA is the indicator of current assets.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{pfs} = \frac{i_{ec} - i_{nca}}{i_{ca}}, \qquad (20)$$

there:
k_{pfs} is the coefficient of the enterprise's own working capital,
i_{ec} is the indicator of equity,
i_{nca} is the indicator of non-current assets,
i_{ca} is the indicator of current assets.

Based on the regulatory limits, this formula can be represented as $0.2 \leq K_{EOWC} \leq 0.4$, or $0.2 \leq k_{pfs} \leq 0.4$, i.e., $k_{pfs}(0.2, 0.4)$.

4. The coefficient of financial stability provides a generalised analysis of the main sources of financing of the company's assets. It is calculated by dividing the amount of own and long-term borrowed funds by the currency of the enterprise's operations:

$$K_{FS} = \frac{FS + LBF}{CB}, \qquad (21)$$

there:
K_{FS} is the coefficient of financial stability,
FS is indicator of the source of funding,
LBF is indicator of long-term borrowed funds,
CB is indicator of currency balance.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{jfs} = \frac{i_{fs} + i_{lbf}}{i_{cb}}, \qquad (22)$$

there:

k_{jfs} is the coefficient of financial stability,

i_{fs} is the indicator of the source of funding,

i_{lbf} is the indicator of long-term borrowed funds,

i_{cb} is the indicator of currency balance.

Based on the regulatory limits, this formula can be represented as $0.8 \leq K_{FS} \leq 1$, or $0.8 \leq k_{jfs} \leq 1$, i.e., $k_{jfs}(0.8, 1)$.

5. The coefficient of equity's maneuverability represents the level of total liquidity of the financial assets of the enterprise and represents the private difference of equity and non-current assets on the same equity:

$$K_{EM} = \frac{EQ - nCA}{EQ}, \qquad (23)$$

there:

K_{EM} is the coefficient of equity's maneuverability,

EQ is the indicator of equity,

nCA is the indicator of non-current assets.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{mfs} = \frac{i_{eq} - i_{nca}}{i_{eq}}, \qquad (24)$$

there:

k_{mfs} is the coefficient of equity's maneuverability,

i_{eq} is the indicator of equity,

i_{nca} is the indicator of non-current assets.

Based on the regulatory limits, this formula can be represented as $0.3 \leq K_{EM} \leq 0.6$, or $0.3 \leq k_{mfs} \leq 0.6$, i.e., $k_{mfs}(0.3, 0.6)$.

6. The degree of solvency of a legal entity reflects the coefficient of the enterprise's ability to pay its current obligations. The coefficient and is calculated by dividing the amount of current liabilities by the average monthly revenue:

$$K_S = \frac{CLA}{AMR}, \qquad (25)$$

there:

K_S is the coefficient of solvency,

CLA is the indicator of the amount of current liabilities,

AMR is the indicator of average monthly revenue.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{sfs} = \frac{i_{cla}}{i_{amr}}, \qquad (26)$$

there:

k_{sfs} is the coefficient of solvency,

i_{cla} is the indicator of the amount of current liabilities,

i_{amr} is the indicator of average monthly revenue.

Based on the regulatory limits, this formula can be represented as $0.5 \leq K_S \leq 0.7$,

or $0.5 \leq k_{sfs} \leq 0.7$, i.e., $k_{sfs}(0.5, 0.7)$.

7. The coefficient of short-term debt shows the share of short-term sources of borrowed funds that generate risks to the financial stability of a legal entity. The coefficient is a quotient of short-term and total borrowed funds:

$$K_{STD} = \frac{CLA}{TBR}, \qquad (27)$$

there:

K_{STD} is the coefficient of short-term debt,

CLA is the indicator of the amount of current liabilities,

TBR is the indicator of total borrowed funds.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{dfs} = \frac{i_{cla}}{i_{tbr}}, \qquad (28)$$

there:

k_{dfs} is the coefficient of short-term debt,

i_{cla} is the indicator of the amount of current liabilities,

i_{tbr} is the indicator of total borrowed funds.

Based on the regulatory limits, this formula can be represented as $0 \leq K_{STD} \leq 0.2$, or $0 \leq k_{dfs} \leq 0.2$, i.e., $k_{dfs}(0, 0.2)$.

8. The coefficient of current liquidity shows the ability of an enterprise to direct current assets to repay its own short-term liabilities. The coefficient is the ratio of current assets and borrowed funds:

$$K_{CL} = \frac{CA}{CLA}, \qquad (29)$$

there:

K_{CL} is the coefficient of current liquidity,

CA is the indicator of current assets,

CLA is the indicator of the amount of current liabilities.

Therefore, the calculation of the coefficient can be represented mathematically:

$$k_{lfs} = \frac{i_{ca}}{i_{cla}}, \qquad (30)$$

there:

k_{lfs} is the coefficient of current liquidity,

i_{ca} is the indicator of current assets,

i_{cla} is the indicator of the amount of current liabilities.

Based on the regulatory limits, this formula can be represented as $K_{CL} = 1$, or $k_{lfs} = 1$.

Thus, according to the financial limits of the coefficients, the mathematical limits of the sets of indicators are also established (*Table 4*).

Since all eight coefficients of a single process are used in the mathematical modelling of this system, their interpretation can be presented in the form of indicators of related k_{fs} coefficients (*Table 2*).

Several patterns are observed in the comparative analysis of the limits.

1. Similarity of coefficient indicators:

$k_{afs} \sim k_{rfs} \sim k_{sfs}$, or $k_{afs}(0.5, 0.7)$, $k_{rfs}(0.5, 0.7)$ and $k_{sfs}(0.5, 0.7)$.

Therefore, the sum of these coefficients in the model can be represented by the arithmetic mean of the set:

$$k_{fs}^{1} = \frac{k_{afs} + k_{rfs} + k_{sfs}}{3}. \qquad (31)$$

It follows from the calculations that

$$k_{fs}^{1} \in (0.5, 0.7).$$

2. The reversibility of the coefficients is $k_{jfs} + k_{dfs} = 1$, because $k_{jfs}(0.8, 1)$ and $k_{dfs}(0, 0.2)$ despite the fact that these coefficients have oppositely directed vectors of values at the enterprise.

Therefore, the sum of these coefficients in the model can be represented by a separate coefficient:

$$k'_{fs} = k_{jfs} + k_{dfs} = 1. \qquad (32)$$

$$k'_{fs} = 1.$$

3. The similarity of the indicators of the initial and synthesised coefficients: $k'_{fs} \sim k_{lfs}$ because $k_{fs}^{2} = 1$ and $k_{lfs} = 1$.

Therefore, the sum of these coefficients in the model can be represented by an arithmetic mean equal to 1:

$$k_{fs}^{2} = \frac{k'_{fs}}{k_{lfs}} = 1. \quad (33)$$

$$k_{fs}^{2} = 1.$$

In expanded form, this formula can be represented as:

$$k_{fs}^{2} = \frac{k_{jfs} + k_{dfs}}{k_{lfs}} = 1. \qquad (34)$$

$$k_{fs}^{2} = 1.$$

4. Compositeness of coefficient indicators: $k_{pfs}(0.2, 0.4)$ and $k_{mfs}(0.3, 0.6)$.

Therefore, the sum of the numerical indicators of these coefficients in the model will represent clearly defined limits from 0.5 to 1:

$$k_{fs}^{3} = k_{pfs} + k_{mfs} = (0.5, 1). \qquad (35)$$

$$k_{fs}^{3} \in (0.5, 1).$$

Thus, to calculate the financial stability area as a system of indicators, the mathematical model will be presented as follows:

$$k_{fs} = k_{fs}^{1} + k_{fs}^{2} + k_{fs}^{3} = \frac{k_{afs} + k_{rfs} + k_{sfs}}{3} + \frac{k_{jfs} + k_{dfs}}{k_{lfs}} + k_{sfs} + k_{mfs}, \qquad (36)$$

i.e., $k_{fs} \in (2, 2.7)$.

When rounding k_{fs} to tenths, a set of indicators of the financial stability area equal to eight is determined. The whole set will determine the options for the stability of the system.

To verify k_{fs} in the system of the financial stability area, another mathematical interpretation is applicable.

Since $k_{fs}^{3} \geq k_{fs}^{1}$ not less than 2, but not more than 4, then:

$$2 \leq \frac{k_{fs}^{3}}{k_{fs}^{1}} \leq 4. \qquad (37)$$

Therefore, $k_{fs}^{3/1}(2, 4)$.

At the same time, the mathematical model of the financial stability area can be represented in the following expression:

$$k_{fs} = \frac{k_{fs}^{3/1}}{k_{fs}^{2}} = \frac{k_{fs}^{3}}{k_{fs}^{1} * k_{fs}^{2}}, \qquad (38)$$

i.e., $k_{fs}(2,4)$.

When rounding k_{fs} to tenths, a set of indicators of the financial stability area equal to 11 is determined. The whole set will determine the options for the stability of the system.

Thus, the full mathematical model of the system for calculating the financial stability area can be represented as follows:

$$\begin{cases} k_{fs} = k_{fs}^{1} + k_{fs}^{2} + k_{fs}^{3} \\ 2 \le \frac{k_{fs}^{3}}{k_{fs}^{1}} \le 4 \end{cases}. \qquad (39)$$

Based on the Viaduct LLC enterprise, a natural experiment was performed on the calculations of the financial stability area. The indicators of the enterprise's financial stability coefficients for the 4th quarter of 2021 were applied (*Table 5*).

1. The calculation of similar indicators was made:

$$k_{fs^{q1}}^{1} = \frac{0.59 + 0.62 + 0.55}{3} = 0.59 \in (0.5, 0.7).$$

$$k_{fs^{q2}}^{1} = \frac{0.51 + 0.66 + 0.58}{3} = 0.58 \in (0.5, 0.7).$$

$$k_{fs^{q3}}^{1} = \frac{0.61 + 0.69 + 0.63}{3} = 0.64 \in (0.5, 0.7).$$

$$k_{fs^{q4}}^{1} = \frac{0.55 + 0.58 + 0.60}{3} = 0.58 \in (0.5, 0.7).$$

2. The calculation and verification of the reversibility of the coefficients was performed:

$$k'_{fs^{q1}} = 0.80 + 0.20 = 1.$$

$$k'_{fs^{q2}} = 0.91 + 0.09 = 1.$$

$$k'_{fs^{q3}} = 0.92 + 0.08 = 1.$$

$$k'_{fs^{q4}} = 0.86 + 0.14 = 1.$$

All quarterly reversible coefficients corresponded to 1.

3. The similarity of the indicators of the initial and synthesised coefficients of reversible quarterly indicators and the current liquidity coefficient was confirmed:

$$k_{fs^{q1}}^{2} = \frac{1}{1} = 1.$$

$$k_{fs^{q2}}^{2} = \frac{1}{1.01} = 1.$$

$$k_{fs^{q3}}^{2} = \frac{1}{1.01} = 1.$$

$$k_{fs^{q4}}^{2} = \frac{1}{0.99} = 1.$$

4. The compositeness of the coefficients k_{pfs} and k_{mfs} is calculated:

$$k_{fs^{q1}}^{3} = 0.21 + 0.35 = 0.56 \in (0.5, 1),$$

$$k_{fs^{q2}}^{3} = 0.28 + 0.37 = 0.65 \in (0.5, 1),$$

$k_{fs}^{3q3} = 0.33 + 0.39 = 0.72 \in (0.5, 1)$,

$k_{fs}^{3q4} = 0.31 + 0.36 = 0.67 \in (0.5, 1)$.

By the next stage of the algorithm for calculating the financial stability area as a system of the indicators of mathematical model, calculations were performed:

$k_{fs}^{q1} = k_{fs}^{1q1} + k_{fs}^{2q1} + k_{fs}^{3q1} = 0.59 + 1 + 0.56 = 2.15 \in (2, 2.7)$,

$k_{fs}^{q2} = k_{fs}^{1q2} + k_{fs}^{2q2} + k_{fs}^{3q2} = 0.58 + 1 + 0.65 = 2.23 \in (2, 2.7)$,

$k_{fs}^{q3} = k_{fs}^{1q3} + k_{fs}^{2q3} + k_{fs}^{3q3} = 0.64 + 1 + 0.72 = 2.36 \in (2, 2.7)$,

$k_{fs}^{q4} = k_{fs}^{1q4} + k_{fs}^{2q4} + k_{fs}^{3q4} = 0.58 + 1 + 0.67 = 2.25 \in (2, 2.7)$.

To verify quarterly k_{fs} in the financial stability area system, a mathematical interpretation was applied:

$$2 \leq \frac{k_{fs}^{3q}}{k_{fs}^{1q}} \leq 4.$$

1st quarter – 2.15 : 0.59 = 3.644,
2nd quarter – 2.23 : 0.58 = 3.845,
3rd quarter – 2.36 : 0.64 = 3.688,
4th quarter – 2.25 : 0.58 = 3.880.

Consequently, the quarterly parameters of the financial stability coefficients fully comply with the conditions of the model of the second variant:

$$\begin{cases} k_{fs} = k_{fs}^1 + k_{fs}^2 + k_{fs}^3 \\ 2 \leq \frac{k_{fs}^3}{k_{fs}^1} \leq 4 \end{cases}.$$

Since the results of the calculations of mathematical modelling of the financial stability area fully correspond to the quarterly accounting statements on the economic stability of the Viaduct LLC, this model can be considered practically applicable and relevant for determining the financial stability area.

Thus, the developed methodology of mathematical modelling of calculating the financial stability area as a mathematical system, it includes all eight main coefficients accepted as parameters of financial stability, and includes the limits that correspond to the economic indicators of the stability of the enterprise. On the basis of the Viaduct LLC enterprise, a natural experiment was performed on the calculations of the financial stability area. The indicators of the enterprise's financial stability coefficients for the 4th quarter of 2021 were applied. The simulation results showed the limits of the complex parameters of financial stability corresponding to the desired parameters of "financial stability". In full, the mathematical model of the system for calculating the financial stability area can be presented as follows:

$$\begin{cases} k_{fs} = k_{fs}^1 + k_{fs}^2 + k_{fs}^3 \\ 2 \leq \frac{k_{fs}^3}{k_{fs}^1} \leq 4 \end{cases}.$$

Discussion

In the course of the study, modelling and algorithmisation of business processes was implemented to calculate the financial stability area for a small enterprise. In this regard, it is

necessary to develop this mathematical approach to modelling financial stability for large enterprises and holdings to digitalise this model to the global level of application.

Conclusion

Thus, within the framework of the study, the analysis of the development of numerical methods and algorithms of the processes of functioning of the enterprise was performed.

In the first part, the authors describe the development of algorithmisation models and automatisation of calculations for modelling the enterprise's financial stability and algorithms for their verification in EPC and IDEF0 notations, as well as using the ABC methodology.

In the second part, the authors provide a methodology for the development of quantitative indicators that will be used to model the financial stability area. In the course of modelling, the analysis to include calculations of a set of key indicators for determining the enterprise's financial stability in a set of criteria for choosing an alternative was performed. The criterion of indifference was excluded from the criteria, because the study was conducted including the definition of a set of indicators of financial stability, in which an alternative with the maximum average result included in financial stability by definition is calculated. When obtaining a large set of indicators, it is proposed to introduce the triplicity principle of final indicators into the algorithm at each stage of calculations. Thus, each of the eight coefficients in the final form is represented as three indicators, forming a more specific and optimal set of 24 final indicators of financial stability, forming financial stability areas. The approbation of this methodology on the materials of the economic indicators of Viaduct LLC for the 2021 financial year confirmed its effectiveness and compliance with the financial analysis of the enterprise according to the accounting documentation.

In the third part, the authors present the developed methodology of mathematical modelling of calculating the financial stability area as a mathematical system that includes all eight main coefficients accepted as parameters of financial stability, and includes the limits that correspond to the economic indicators of the stability of the enterprise. Based on the Viaduct LLC, a natural experiment was performed on the calculations of the financial stability area. The indicators of the enterprise's financial stability coefficients for the 4th quarter of 2021 were applied. The simulation results showed the limits of the complex parameters of financial stability corresponding to the desired parameters of "financial stability". Variants of the mathematical model for calculating the financial stability area have been successfully tested on the basis of the Viaduct LLC.

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Appendix

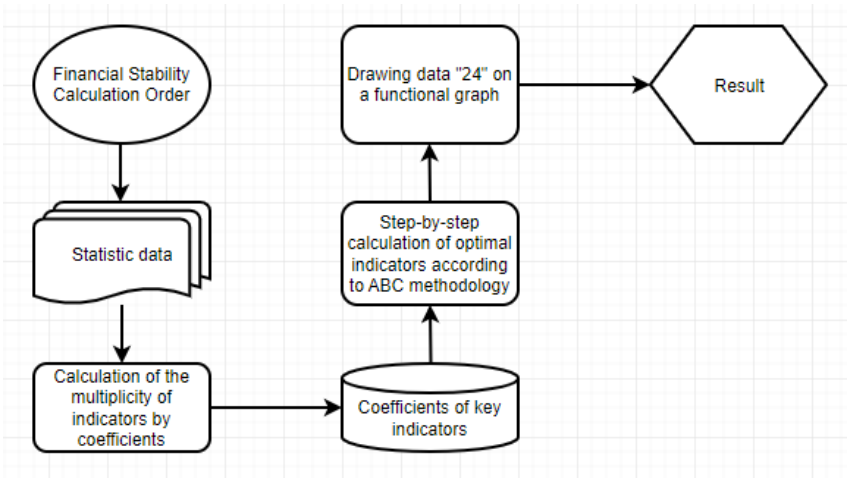

Figure 1. Example of creating a business process algorithm for generating the financial stability area of an enterprise in EPC notation

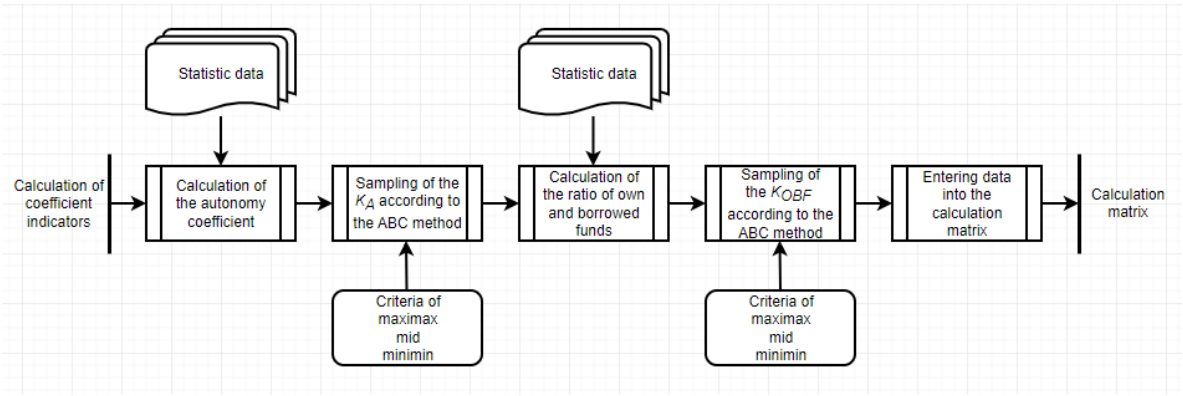

Figure 2. An example of creating a business process of algorithm for generating a calculated matrix of data coefficients of enterprise's key indicators in IDEF notation

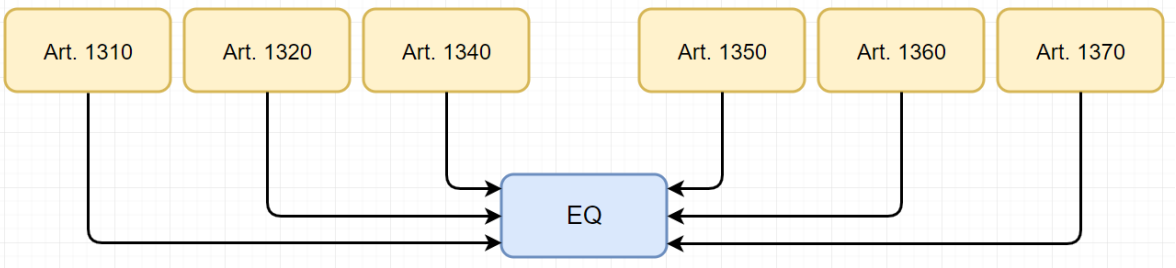

Figure 3. Algorithm for calculating equity

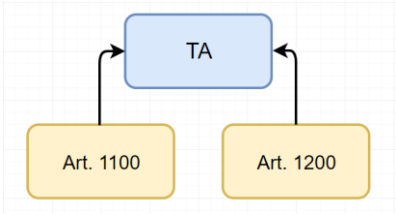

Figure 4. Algorithm for calculating total assets

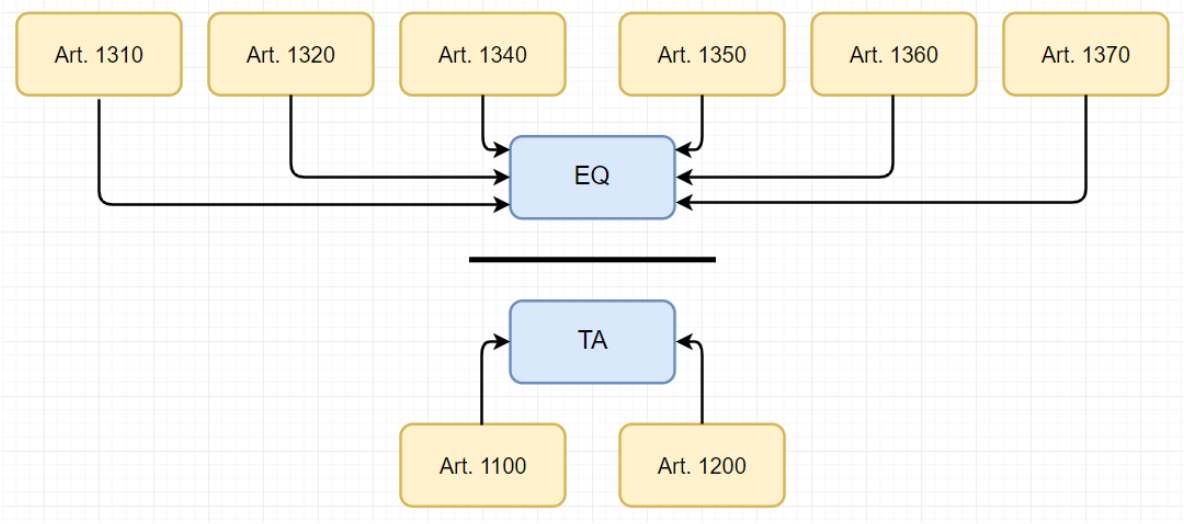

Figure 5. Algorithmisation and automatisation model for calculating the financial autonomy coefficient

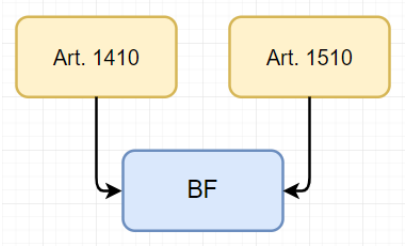

Figure 6. Algorithm for calculating borrowed funds

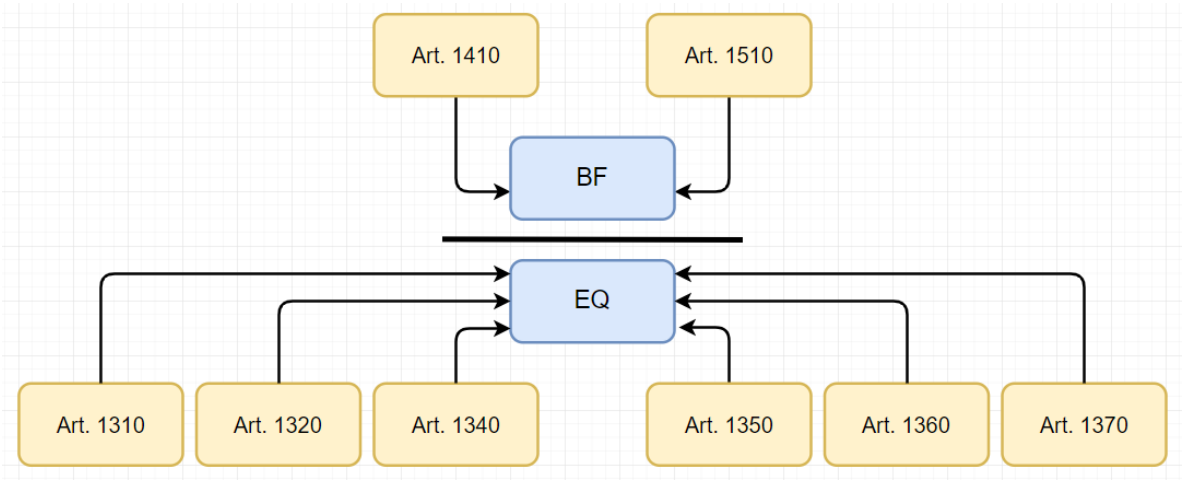

Figure 7. Algorithmisation and automatisation model for calculating the coefficient of own and borrowed funds

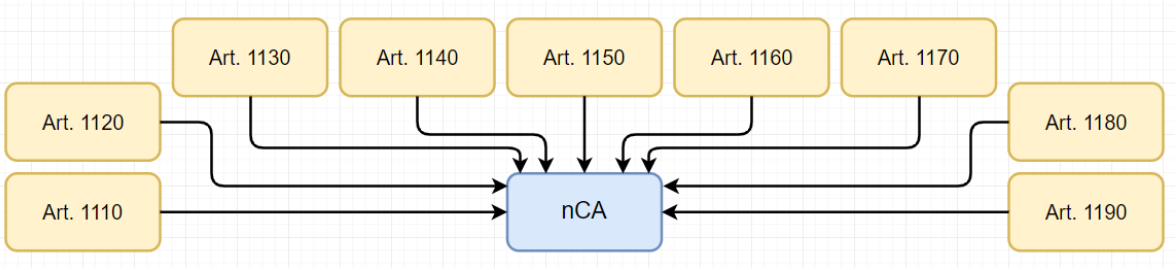

Figure 8. Algorithm for calculating non-current assets

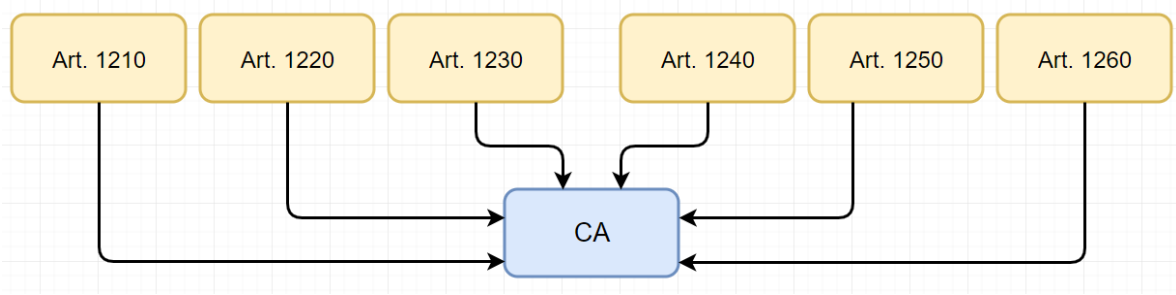

Figure 9. Algorithm for calculating current assets

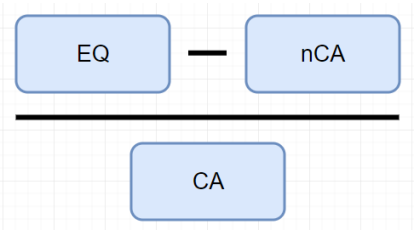

Figure 10. Algorithmisation and automation model for calculating the coefficient of provision with own working capital

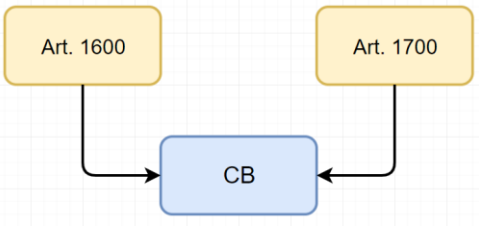

Figure 11. Algorithm for calculating the currency balance

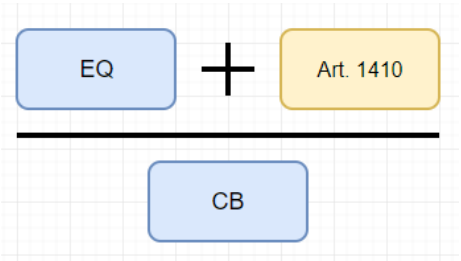

Figure 12. Algorithmisation and automatisation model for calculating the financial stability coefficient

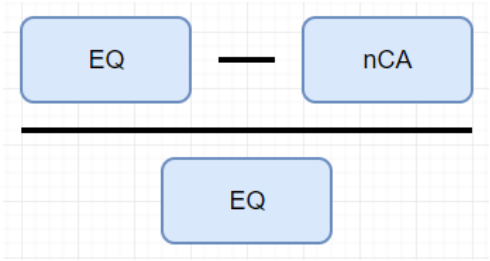

Figure 13. Algorithmisation and automation model for calculating the coefficient of equity maneuverability

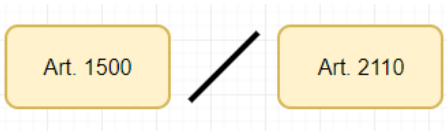

Figure 14. Algorithmisation and automation model for calculating the coefficient of solvency

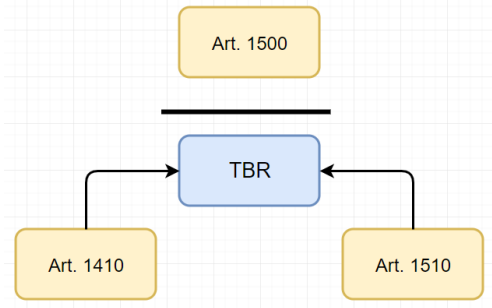

Figure 15. Algorithmisation and automation model for calculating the coefficient of short-term debt

Figure 16. Algorithmisation and automatisation model of calculation of the coefficient of current liquidity

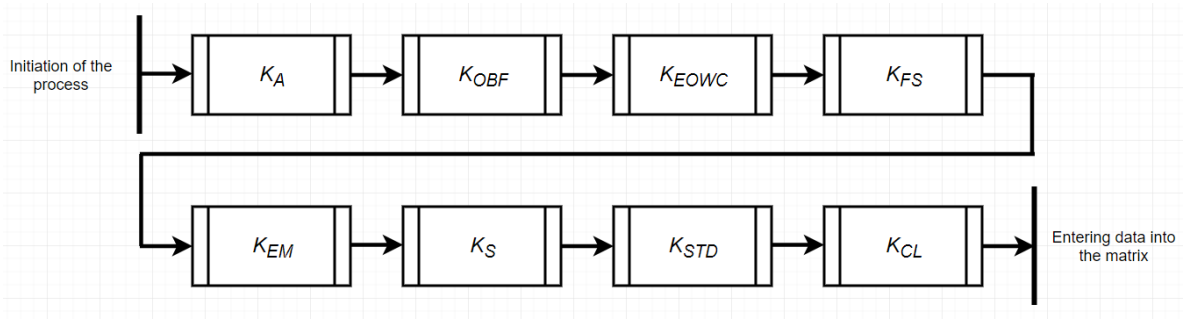

Figure 17. Business process diagram of the algorithmisation model for all eight financial stability calculation coefficients

Table 1. Indicators of economic coefficients of the Viaduct LLC enterprise by the end of 2021

Coefficient		Mini	Mid	Maxi
The coefficient of autonomy	K_A	0.5	0.6	0.7
The coefficient of own and borrowed funds	K_{OBF}	0.5	0.6	0.7
The coefficient of the enterprise's own working capital	K_{EOWC}	0.2	0.3	0.4
The coefficient of financial stability	K_{FS}	0.8	0.9	1
The coefficient of equity's maneuverability	K_{EM}	0.3	0.45	0.6
The coefficient of solvency	K_S	0.5	0.6	0.7
The coefficient of short-term debt	K_{STD}	0	0.1	0.2
The coefficient of current liquidity	K_{CL}	1	1	1

Table 2. Definition of mathematical notation for the financial stability area system (FSA)

Coefficient	Economic notation	Mathematical notation
The coefficient of autonomy	K_A	k_{afs}
The coefficient of own and borrowed funds	K_{OBF}	k_{xfs}
The coefficient of the enterprise's own working capital	K_{EOWC}	k_{pfs}
The coefficient of financial stability	K_{FS}	k_{jfs}
The coefficient of equity's maneuverability	K_{EM}	k_{mfs}
The coefficient of solvency	K_S	k_{sfs}
The coefficient of short-term debt	K_{STD}	k_{dfs}
The coefficient of current liquidity	K_{CL}	k_{lfs}

Table 3. Definition of mathematical designations of economic indicators for calculating financial stability coefficients

Indicator	Economic notation	Mathematical notation
Indicator of equity	EQ	i_{eq}
Indicator of total assets	TA	i_{ta}
Indicator of borrowed funds	BF	i_{bf}
Indicator of the source of funding	FS	i_{fs}
Indicator of non-current assets	nCA	i_{nca}
Indicator of current assets	CA	i_{ca}
Indicator of long-term borrowed funds	LBF	i_{lbf}
Indicator of currency balance	CB	i_{cb}
Indicator of the amount of current liabilities	CLA	i_{cla}
Indicator of average monthly revenue	AMR	i_{amr}
Indicator of total borrowed funds	TBR	i_{tbr}

Table 4. Limits of efficiency indicators of coefficients

Coefficient	Economic notation	Mathematical notation	Mini	Maxi	Limits
The coefficient of autonomy	K_A	k_{afs}	0.5	0.7	(0.5, 0.7)
The coefficient of own and borrowed funds	K_{OBF}	k_{rfs}	0.5	0.7	(0.5, 0.7)
The coefficient of the enterprise's own working capital	K_{EOWC}	k_{pfs}	0.2	0.4	(0.2, 0.4)
The coefficient of financial stability	K_{FS}	k_{jfs}	0.8	1	(0.8, 1)
The coefficient of equity's maneuverability	K_{EM}	k_{mfs}	0.3	0.6	(0.3, 0.6)
The coefficient of solvency	K_S	k_{sfs}	0.5	0.7	(0.5, 0.7)
The coefficient of short-term debt	K_{STD}	k_{dfs}	0	0.2	(0, 0.2)
The coefficient of current liquidity	K_{CL}	k_{lfs}	1	1	(1)

Table 5. Quarterly indicators of financial stability coefficients of Viaduct LLC for the fiscal year 2021

Economic notation	Mathematical notation	Quarter 1	Quarter 2	Quarter 3	Quarter 4
K_A	k_{afs}	0.59	0.51	0.61	0.55
K_{OBF}	k_{rfs}	0.62	0.66	0.69	0.58
K_{EOWC}	k_{pfs}	0.21	0.28	0.33	0.31
K_{FS}	k_{jfs}	0.80	0.91	0.92	0.86
K_{EM}	k_{mfs}	0.35	0.37	0.39	0.36
K_S	k_{sfs}	0.55	0.58	0.63	0.60
K_{STD}	k_{dfs}	0.20	0.09	0.08	0.14
K_{CL}	k_{lfs}	1	1.01	1.01	0.99

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Tetyana V. Garapko, Doctor of Medical Sciences, Docent, Department of Human Anatomy and Histology, Faculty of Medicine, Uzhhorod National University. Uzhhorod, Ukraine. ORCID 0000-0003-0596-9622.
Lesia R. Mateshuk-Vatseba, Doctor of Medical Sciences, Professor, Department of Normal Anatomy, Danylo Halytskyi Lviv National Medical University. Lviv, Ukraine. ORCID 0000-0002-3466-5276.
Andrii S. Holovatskyi, Doctor of Medical Sciences, Professor, Department of Human Anatomy and Histology, Faculty of Medicine, Uzhhorod National University. Uzhhorod, Ukraine.
Anatolii I. Foros, Doctor of Philosophy, Department of Fundamental Medical Disciplines and Orthopedic Dentistry, Faculty of Dentistry, Uzhhorod National University. Uzhhorod, Ukraine. ORCID 0000-0003-0824-6702.

Changes in the structural organization of spleen during short-term exposure of monosodium glutamate

Abstract: Monosodium glutamate is one of the most common food additives in the world. Its effect on the organs of the immune system is not sufficiently studied. The article presents and analyzes the data of an experimental study conducted on 40 white male and female rats of reproductive age (2.5-3.5 months old) weighing 125-195 g. The purpose of the study was to study the histological, morphometric and ultrastructural changes of the spleen under conditions of exposure to monosodium glutamate for four weeks. An experimental group of animals (10 male rats, 10 female rats), which was on a standard vivarium diet, was given monosodium glutamate at a dose of 0.07 g/kg of rat body weight every day for four weeks. In animals of the intact group, the structure of the spleen corresponded to the species norm. In the experimental group of animals, after four weeks of exposure to monosodium glutamate, an immunoinducing effect was observed with increased proliferation of activated lymphocytes and their further differentiation into plasma cells. There is a significant increase in the relative area of the germinal centers of splenic lymphoid nodules and the outer diameter of the central artery of the spleen. Arteries with a thickened wall, their lumen is full of blood. Degeneratively changed erythrocytes are located around the vessels. The veins have a deformed shape, are dilated, the lumen is also full of blood. The share of active macrophages, apoptically changed cells increases. The red pulp is full-blooded, filled with hemosiderin. Therefore, even a short-term daily exposure to monosodium glutamate, namely four weeks, causes changes in the structural organization of the spleen.

Keywords: experiment, monosodium glutamate, spleen, white pulp, red pulp, lymphocytes.

Тетяна Василівна Гарапко, доктор медичних наук, доцент, кафедра анатомії людини та гістології, медичний факультет, Ужгородський національний університет. Ужгород, Україна. ORCID 0000-0003-0596-9622.
Леся Ростиславівна Матешук-Вацеба, доктор медичних наук, професор, кафедра нормальної анатомії, Львівський національний медичний університет імені Данила Галицького. Львів, Україна. ORCID 0000-0002-3466-5276.
Андрій Степанович Головацький, доктор медичних наук, професор, кафедра анатомії людини та гістології, медичний факультет, Ужгородський національний університет. Ужгород, Україна.
Анатолій Ілліч Форос, доктор філософії, кафедра фундаментальних медичних дисциплін та ортопедичної стоматології, стоматологічний факультет, Ужгородський національний університет. Ужгород, Україна. ORCID 0000-0003-0824-6702.

Зміни в структурній організації селезінки при короткочасному впливі глутамату натрію

Анотація: Глутамат натрію є однією з найбільш поширених харчових добавок у світі. Його вплив на органи імунної системи є не достатньо вивченим. В статті наведено та проаналізовано дані експериментального дослідження, проведеного на 40 білих щурах-самцях і самках репродуктивного віку (2,5-3,5-місячних) масою 125-195 г. Мета дослідження – вивчити гістологічні, морфометричні та ультраструктурні зміни селезінки в умовах впливу глутамату натрію впродовж чотирьох тижнів. Експериментальній групі тварин (10 щурів-самців, 10 щурів-самок), яка перебувала на стандартному харчовому раціоні віварію, впродовж чотирьох тижнів щодня додавали глутамат натрію в дозі 0,07 г/кг маси тіла щура. У тварин інтактної групи будова селезінки відповідала видовій нормі. В експериментальній групі тварин через чотири тижні дії глутамату натрію спостерігається імуноіндукуючий ефект з посиленою проліферацією активованих лімфоцитів та їх подальшим диференціюванням у плазматичні клітини. Відбувається достовірне збільшення відносної площі зародкових центрів селезінкових лімфоїдних вузликів та зовнішнього діаметру центральної артерії селезінки. Артерії з потовщеною стінкою, їх просвіт повнокровний. Навколо судин розташовані дегенеративно змінені еритроцити. Вени мають деформовану форму, розширені, просвіт також повнокровний. Зростає частка активних макрофагів, апоптично змінених клітин. Червона пульпа повнокровна, заповнена гемосидерином. Отже, навіть короткотривалий щоденний вплив на організм глутамату натрію, а саме чотири тижні, викликає зміни структурної організації селезінки.

Ключові слова: експеримент, глутамат натрію, селезінка, біла пульпа, червона пульпа, лімфоцити.

Introduction

Monosodium glutamate is one of the most common food additives in the world. It is the monosodium salt of glutamic acid (*Bautista et al., 2019*). Belongs to taste enhancers, due to which it increases appetite. This leads to increased food intake, causing a high-calorie diet (*Bhandari, 2018*). The result of a high-calorie diet is excess body weight and obesity. Obesity contributes to the occurrence of numerous organ diseases, but the mechanisms of these processes remain unclear (*Camacho & Ruppel, 2017*).

In the professional literature, obesity is considered a state of chronic inflammation, which is often associated with complications such as type two diabetes, cardiovascular disease, hypertension, stroke, gallbladder disease, osteoarthritis, and psychosocial problems (*Bibik, 2018*; *Escobedo & Oliver, 2017*; *Coppey, 2018*). Numerous studies describe that a high-calorie diet leads to metabolic syndrome, insulin resistance, diabetes, splenomegaly, arterial hypertension, heart attacks, etc. (*Finlayson, 2017*; *Buchan et al., 2018*).

In obesity, the functions of both T cells and B cells are impaired. Obesity-induced reduction of IL-10 synthesis in the spleen leads to inflammatory reactions in the kidneys and metabolic disturbances (*Gotoh et al., 2017*).

Scientists conclude that monosodium glutamate causes metabolic disorders and contributes to the development of obesity. A number of separate studies on glutamate-induced obesity have been described in foreign publications (*Bautista et al., 2019*). The results of the study, which was conducted on eight-week-old rats that were on a high-calorie diet, showed an increase in blood

levels of triglycerides, total cholesterol, low-density lipoproteins, and an increase in body weight (*Farias et al., 2019*). These are all signs of the development of obesity, which also negatively affects the organs of the immune system.

The effect of monosodium glutamate on the organs of the immune system is not sufficiently studied. Therefore, this study is relevant, because it is these organs that react to the penetration of foreign antigens into the body (*Escobedo & Oliver, 2017*; *Begay et al., 2022*; *Habashy et al., 2021*).

The purpose of the study was to study the histological, morphometric and electron microscopic changes in the spleen of monosodium glutamate rats for four weeks.

The study was conducted on 40 white male and female rats of reproductive age (2.5-3.5 months old) weighing 125-195 g.

The normal structure of the spleen was studied in 10 intact animals, of which there were 5 male rats and 5 female rats. The experimental group of animals included 10 male rats and 10 female rats. They received a standard vivarium diet, to which monosodium glutamate was added daily for four weeks at a dose of 0.07 g/kg of rat body weight. The animals had free access to water and food. The control group of animals consisted of 5 male rats and 5 female rats, which received a physiological solution (0.9% NaCl solution) with a standard vivarium diet.

All experimental animals were kept in the vivarium of Lviv National Medical University named Danylo Halytsky. The research was conducted in accordance with the provisions of the European Convention on the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes (Strasbourg, 1986), Council of Europe Directives 86/609/EEC (1986), Law of Ukraine No. 3447-IV On the Protection of Animals from Cruelty Handling, general ethical principles of experiments on animals, adopted by the First National Congress of Ukraine on Bioethics (2001).

Morphometric studies were performed during the required period of the experiment on histological preparations stained with hematoxylin and eosin. VideoTest-5.0, KAARA Image Base, Stepanizer and Microsoft Excel programs were used. Statistical processing of digital data was performed with the help of the "Excel" software using the parametric method.

Preparation of spleen preparations for microscopic and ultrastructural examination was carried out according to well-known methods. Spleen pieces were fixed with a 1.5% solution of osmium tetroxide in a 0.2 M solution of sodium cacodylate at pH 7.2 for 2-2.5 hours in the cold. Sections were made on an ultramicrotome UMTP-6M with a diamond knife (DIATOM), double contrast was performed according to Reynolds and uranyl acetate. The submicroscopic study was carried out using a TEM-100 transmission electron microscope. Photo documentation using a SONY-H9 digital camera. Semi-thin sections with a thickness of 1-2 μm were made on an ultramicrotome LKB-3 (Sweden). They were stained with methylene blue.

The results of the study

As the results of our study showed, the structure of the spleen in animals of the intact and control groups corresponded to the species norm. The organ is surrounded by a capsule. The parenchyma is made of white and red pulp (*Figure 1*). The white pulp contains splenic lymphoid nodules and lymphoid periarterial sheaths. The red pulp is a place of blood deposition, contains

venous sinuses and splenic cords. This is where the destruction of spent erythrocytes and other blood cells takes place. Morphometric indicators are presented in Tables 1, 2 (*Table 1*; *Table 2*).

Splenic lymphoid nodules consist of a periarterial, mantle, marginal zone and a germinal center. In the splenic cords, B-lymphocytes are transformed into plasma cells, and monocytes into macrophages. The lymphoid component of the spleen includes small, middle, and large T- and B-lymphocytes, macrophages, and plasma cells. All cells have a typical structure (*Figure 2*).

After four weeks of the experiment, both male and female rats showed signs of antigenic stimulation on histological preparations of the spleen, as evidenced by hyperplasia of the lymphoid component of the spleen, in particular. the intensity of the formation of germinal centers increased, the processes of proliferation and differentiation of lymphoid cells increased (*Figure 3*).

A large number of active macrophages and apoptically changed cells are observed on histological sections of spleen preparations. The number of cells with signs of mitosis decreased. The venous sinuses of the spleen are enlarged and full of blood, accumulating hemosiderin. The cytoplasm of active macrophages is filled with drops of hemosiderin (*Figure 4*).

The vessels of the hemomicrocirculatory channel also undergo changes. Arteries with a thickened wall, probably due to edema, their lumen is full of blood. Degeneratively changed erythrocytes are located around the vessels. The veins have a deformed shape, are dilated, the lumen is also full of blood. The venous sinuses in the red pulp are enlarged and contain accumulations of hemosiderin.

It was established by the morphometric method that the relative area of the white pulp of the spleen after four weeks of the experiment increases in comparison with the intact group of animals by only 1.4% in male rats and by 0.91% in female rats. The relative area of lymphoid nodules of the spleen decreases by 1.95% and 1.25%, respectively. The relative area of lymphoid periarterial sheaths decreased by 4.65% and 2.6%. The relative area of the red pulp of the spleen is only 0.49% and 0.33% less than the parameters of the intact group of animals (*Table 1*; *Table 2*).

The relative area of the mantle and marginal zones on the histological preparation of the spleen section is 0.98% in male rats and 1.36% in female rats less than the indicator of the intact group of animals, the germinal center increases compared to the intact group of animals by 15.21% and 14.91% ($p<0.001$), the periarterial zone is only 0.88% more in male rats and 2.93% less in female rats than the indicator of the intact group of animals. The outer diameter of the central arteries after four weeks of the experiment increases and is 44.94% and 40.25%, respectively, significantly ($p<0.001$) more than the parameters of the intact group of animals. The inner diameter of the central arteries decreases and is 3.11% and 2.58% less than the indicator in animals of the intact group (*Tables 1*; *Table 2*).

After four weeks of the experiment, during the electron microscopic study of the spleen of white male and female rats of reproductive age, many active macrophages were found, their cytoplasm is loaded with fragments of the nucleus of other cells, parts of "undigested" formed blood elements, and contains numerous phagosomes. The proportion of reticular cells and connective tissue fibers both in the splenic trabeculae and in the splenic cords has increased, the walls of the splenic sinuses are thickened (*Figure 5*). The reticular cells' nucleus is elongated,

the contour of the nuclear envelope is uneven, tortuous, the processes of the cell envelope are thinned.

Blood capillaries are filled with erythrocytes, arranged in a "coin column", presumably due to the narrowing of the lumen, which is associated with edema of the wall. Endotheliocyte nucleus in the wall of hemocapillaries are also enlarged, swollen, the basement membrane is thickened, signs of perivascular edema are revealed (*Figure 6*).

Discussion

After four weeks of daily exposure to monosodium glutamate, an immunoinducing effect is observed with increased proliferation of activated lymphocytes and their subsequent differentiation into plasma cells. This is the morphological prerequisite for increased synthesis of immunoglobulins. We think that all the changes mentioned by us are the primary reaction of the immune organs to the daily administration of monosodium glutamate. Signs of edema of the parenchyma of lymph nodes are that the intercellular space is expanded and contains vacuole-like structures.

It has been described in the literature that under conditions of exposure to a high-calorie diet, the main changes in visceral adipose tissue occurred due to a change in the relative population of immune cells, which resulted in a higher percentage of macrophages, dendritic cells, and CD8+ T cells. A high-calorie diet had a greater effect on visceral adipose tissue than on subcutaneous In the visceral lymph node, as a result of the development of obesity, the populations of cells that suppress immune function are reduced and the populations of those that regulate/activate the immune response are increased (*Magnuson et al., 2017*).

The authors in their research showed that a high-calorie diet, compared to a normal standard diet, reduced the expression of CD20, a surface molecule present on B cells that plays an important role in the immune response and produces IL-10 mainly in the spleen. Moreover, splenocyte proliferation stimulated by T-cell and B-cell mitogens was significantly lower in obese subjects (*Gotoh et al., 2017*).

The authors found that acute irradiation of the spleen using the inverse intensity modulated radiotherapy source axis distance irradiation technique had a protective effect on rats with traumatic brain injury. The spleen of the rats was precisely irradiated by a 6 MV X-ray with a total dose of 8 Gy. Initiation of splenic irradiation four hours after traumatic brain injury reduced splenic inflammatory response, alleviated brain edema, and improved behavioral scores (*Huang et al., 2021*).

When studying the distribution of connective tissue fibers in the spleen of diabetic rats and rats treated with vitamin C, the accumulation of collagen fibers was found in the splenic trabeculae, in the capsule and around the central artery and venous sinuses of the spleen. There was thickening of the splenic trabeculae due to fibrosis, not edema as in our case. Reticular fibers accumulated in both the white and red pulp of the spleen. A partial rupture of elastic fibers in the arterial wall was observed. A slight thickening of the reticular fibers was found in the group of animals corrected with vitamin C, and the elastic fibers maintained their integrity and were better organised than in the group of animals with diabetes (*Ozerkan, 2021*).

Similar changes were found by the authors when studying the effect of Nano-Cu, an additive to animal feed. It is a potential antibacterial and growth-promoting material that can be

used as an additional additive to animal feed. However, with the widespread use of nano-Cu, the risk of developing their unknown toxic side effects is becoming increasingly likely. The study revealed nano-Cu induced obvious spleen damage and oxidative-inflammatory and immune changes associated with activation of several pro-inflammatory responses, oxy/antioxidants and modulation of CD3+CD4+/CD3+CD8+T cell subtypes in rat spleen. Nano-Cu is more immunotoxic than conventional Cu sources, so it is not suitable as a long-term animal feed additive (*Xerong et al., 2019*).

The literature mentions that the spleen decreases in size after a stroke in rodents. Splenectomy two weeks before ischemic and hemorrhagic stroke in mice and rats shows a reduction in infarct volumes. Proinflammatory mediators are also increased in the spleen and subsequently in the brain after stroke (*Seifert & Offner, 2018*).

Prospects for further development are related to the study of histological, morphometric and ultrastructural changes in the spleen of rats under conditions of long-term exposure to monosodium glutamate and correction.

Conclusion

As a result of a study conducted on male and female rats of reproductive age, it was found that even short-term daily exposure to monosodium glutamate, namely four weeks, causes changes in the structural organization of the spleen. An immunoinducing effect is observed with increased proliferation of activated lymphocytes and their subsequent differentiation into plasma cells. There is a significant increase in the relative area of the germinal centers of splenic lymphoid nodules and the outer diameter of the central artery of the spleen. The share of active macrophages, apoptically changed cells increases. The red pulp is full-blooded, filled with hemosiderin.

Conflict of interest

The authors declare no conflict of interest.

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Appendix

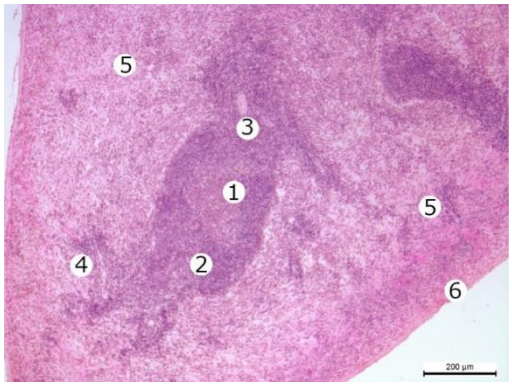

Figure 1. A fragment of the spleen of a white male rat from the intact group of animals. Staining with hematoxylin and eosin. Approx. ×100. Designation: 1 – germinal center of the lymphoid nodule; 2 – mantle and marginal zones of the lymphoid nodule; 3 – the central artery of the spleen; 4 – lymphoid periarterial sheath; 5 – red pulp; 6 – capsule of the spleen

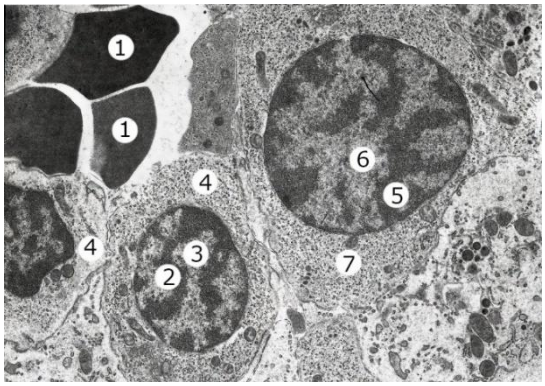

Figure 2. Electron-microscopic organization of a fragment of the red pulp of the spleen of a white male rat of the intact group of animals. Electron micrograph. Approx. ×8000. Designation: 1 – erythrocytes; 2 – heterochromatin and euchromatin (3) in the nucleus of a small lymphocyte; 4 – cytoplasm of a small lymphocyte; 5 – heterochromatin and euchromatin (6) in the nucleus of a middle lymphocyte; 7 – cytoplasm of a middle lymphocyte

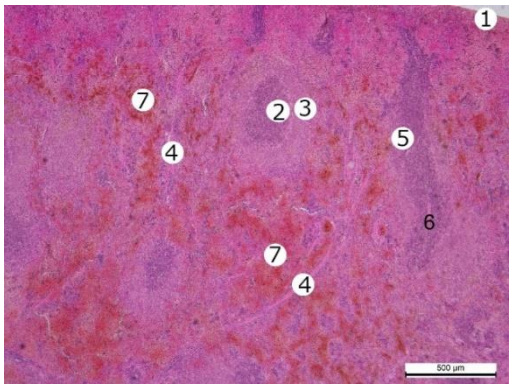

Figure 3. A fragment of the spleen of a white male rat after four weeks of monosodium glutamate exposure. Staining with hematoxylin and eosin. Approx. ×50. Designation: 1 – capsule of the spleen; 2 – germinal center of the lymphoid nodule; 3 – mantle and marginal zones of the lymphoid nodule; 4 – splenic trabeculae; 5 – lymphoid periarterial sheath; 6 – pulpal artery; 7 – full blood red pulp

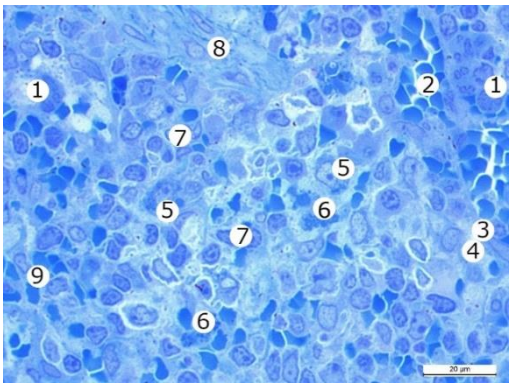

Figure 4. A fragment of the red pulp of the spleen of a white male rat after four weeks of monosodium glutamate exposure. Semi-thin cut. Staining with methylene blue. Approx. ×1000. Designation: 1 – polysegmened neutrophil; 2 – accumulation of erythrocytes in the splenic sinus; 3 – reticular cell; 4 – perivascular edema; 5 – active" macrophage; 6 – apoptically changed macrophage, overloaded with hemosiderin residues; 7 – accumulation of lymphocytes; 8 – splenic trabeculae; 9 – erythrocytes in the thickness of the red pulp

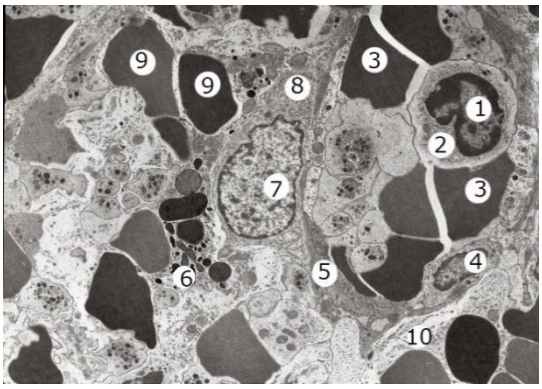

Figure 5. Electron-microscopic organization of a red pulp fragment of the spleen of a white female rat after four weeks of monosodium glutamate exposure. Electron micrograph. Approx. ×4000. Designation: 1 – nucleus and cytoplasm (2) of a small lymphocyte in the lumen of the splenic sinus; 2 – erythrocytes in the lumen of the splenic sinus; 4 – the nucleus of the interdigitating cell in the wall of the splenic sinus; 5 – thickened wall of the splenic sinus; 6 – osmiophilic inclusions; 7 – nucleus and cytoplasm (8) of a reticular cell; 9 – erythrocytes outside the sinus; 10 – perivascular edema

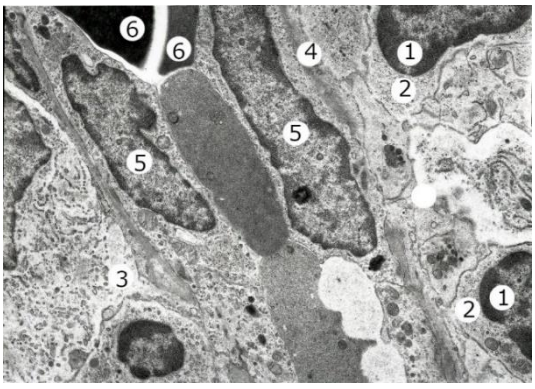

Figure 6. Electron-microscopic organization of a fragment of the white pulp of the spleen of a white male rat after four weeks of monosodium glutamate exposure. Electron micrograph. Approx. ×6000. Designation: 1 – lymphocyte nucleus and cytoplasm; 3 – perivascular edema; 4 – thickened basal membrane of the hemocapillary; 5 – swollen endotheliocyte nucleus in the blood capillary wall; 6 – erythrocytes in the lumen of a blood capillary

Table 1. Morphometric parameters of the structural components of the spleen of the studied male rats (M ± m)

Parameter, units of measurement	A group of animals		
	Intact	Experimental	
		M ± m	p
The relative area of the white pulp of the spleen, %:	25.78 ± 1.18	26.14 ± 0.9	p>0.05
– lymphoid periarterial sheaths	2.15 ± 0.04	2.05 ± 0.05	p>0.05
– lymphoid nodules:	23.63 ± 1.09	24.09 ± 0.64	p>0.05
mantle and marginal zones	17.34 ± 1.06	17.17 ± 0.52	p>0.05
germinal center	4.01 ± 0.31	4.62 ± 0.19	p<0.001
periarterial zone	2.28 ± 0.09	2.3 ± 0.1	p>0.05
The relative area of the red pulp of the spleen, %	74.22 ± 1.33	73.86 ± 1.2	p>0.05
The outer diameter of the central artery of the spleen, d_1, μm	14.02 ± 0.51	20.32 ± 0.45	p<0.001
Internal diameter of the central artery of the spleen, d_2, μm	6.11 ± 0.31	5.92 ± 0.22	p>0.05

Table 2. Morphometric parameters of the structural components of the spleen of the studied female rats (M ± m)

Parameter, units of measurement	A group of animals		
	Intact	Experimental	
		M ± m	p
The relative area of the white pulp of the spleen, %:	26.38 ± 1.02	26.62 ± 0.98	p>0.05
– lymphoid periarterial sheaths	2.31 ± 0.06	2.25 ± 0.04	p>0.05
– lymphoid nodules:	24.07 ± 1.11	24.37 ± 0.72	p>0.05
mantle and marginal zones	17.59 ± 1.15	17.35 ± 0.61	p>0.05
germinal center	4.09 ± 0.39	4.7 ± 0.18	p<0.001
periarterial zone	2.39 ± 0.12	2.32 ± 0.12	p>0.05
The relative area of the red pulp of the spleen, %	73.62 ± 1.4	73.38 ± 1.2	p>0.05
The outer diameter of the central artery of the spleen, d_1, μm	14.21 ± 0.62	19.93 ± 0.39	p<0.001
Internal diameter of the central artery of the spleen, d_2, μm	6.21 ± 0.29	6.05 ± 0.27	p>0.05

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Sergey V. Lebedev, Full Professor, Doctor in Science of Philosophy, Head of the Department, Department of Philosophy, Higher School of Folk Arts. St. Petersburg, Russia. ORCID 0000-0002-7994-2660.
Galina N. Lebedeva, Associate Professor, PhD of Philosophy, Department of Philosophy, A.S. Pushkin Leningrad State University. St. Petersburg, Russia. ORCID 0000-0002-6217-9929.

Religionisation of politics, culture and economy of the modern world

Abstract: The end of the last 20th and the first two decades of the present 21st centuries were marked by an amasing social and cultural phenomenon – a sharp increase in the role of religion in all spheres of human life. In politics, economics, culture, the religious factor plays a significant, and in many regions of the Earth, and a determining role everywhere. This phenomenon became to be unexpected for most scientists, and even for many traditional religious figures. Such influential philosophical systems of the 19th and 20th centuries as Positivism or Marxism also proceeded from the fact that religion is just opium for the people. Liberals regarded religion only as a private matter of the individual, but not a matter of society. Even conservatives viewed religion as part of the great historical tradition of their country, but not as something giving the world a transcendent idea. The secularisation of culture and politics, which began in Europe around the 17th century, seemed gradually to lead to a natural result – the complete disappearance of religion – under the influence of European culture and Western colonialism on all other continents. Since the 1970s, philosophers and political scientists have been talking about a religious renaissance in many regions of the world. The subject of the study was the religious sphere of the modern world with the rise of the Islamic movement and the Islamic revolution in Iran. The object of the study was the processes for religionising politics, culture, and economics of the modern world. The purpose of the study was to present the main patterns of the religionisation of politics, culture, and economics of the modern world. Historical, logical, analytical, and comparative methods were applied to achieve the purpose and solve the tasks set in the study. The authors used the works of prominent scientists and researchers, including A.J. Toynbee, U. Beck, P. Nolan, G.E. Lenski, C. Hackett, and E. Smith. Based on the study, the authors conclude that the resistance to globalisation under Western conditions has many directions, among which the inconspicuous protection of national culture and its spiritual basis – traditional religion – stands out. It is not by chance that not only philosophers, but also sociologists and cultural scientists started talking about the "return of ethnicity". It is the real threat of dissolving into mass Americanised culture that motivates many citizens to turn to the sources of their national culture in principle.

Keywords: secular ideologies, inter-confessionalism, politicisation of religion, religionisation of politics, post-Christianity, liberation theology.

Сергей Викторович Лебедев, профессор, доктор философских наук, заведующий кафедрой, кафедра философии, Высшая школа народных искусств. Санкт-Петербург, Россия. ORCID 0000-0002-7994-2660.
Галина Николаевна Лебедева, кандидат философских наук, доцент кафедры, кафедра философии, Ленинградский государственный университет им. А.С. Пушкина. Санкт-Петербург, Россия. ORCID 0000-0002-6217-9929.

Религиозация политики, культуры и экономики современного мира

Аннотация: Конец прошедшего XX и первых двух десятилетий нынешнего XXI веков ознаменовались поразительным социокультурным феноменом – резким усилением роли религии во всех сферах жизни человека. В политике, экономике, культуре – всюду религиозный фактор играет значительную, а во многих регионах Земли, и определяющую роль. Этот феномен оказался неожиданным для большинства ученых, и даже для многих традиционных религиозных деятелей. Такие влиятельные философские системы XIX-XX веков, как позитивизм или марксизм, также исходили из того обстоятельства, что религия есть всего – лишь опиум для народа. Либералы рассматривали религию лишь как частное дело индивида, но не дело общества. Даже консерваторы рассматривали религию как часть великой исторической традиции своей страны, но не как нечто, дающее миру трансцендентную идею. Секуляризация («обмирщение») культуры и политики, начавшееся в Европе еще примерно с XVII века, постепенно, под влиянием европейской культуры и западного колониализма на все другие материки, казалось, приведет к закономерному результату – полному исчезновению религии. Начиная с 1970-х гг., по мере подъема исламского движения и исламской революции в Иране, философы и политологи заговорили о религиозном ренессансе во многих регионах мира. Предметом исследования была религиозная сфера современного мира. Объектом исследования были процессы религиозации политики, культуры и экономики современного мира. Целью исследования было представить основные закономерности религиозации политики, культуры и экономики современного мира. Для достижения цели и решения поставленных в исследовании задач были применены исторический, логический, аналитический и сравнительный методы. В ходе исследования были использованы труды видных учёных и исследователей, в том числе А. Тойнби, К. Хэккетта, У. Бека, П. Нолана, Г. Ленски и Э. Смита. На основе исследования, авторы приходят к заключению что сопротивление глобализации по западным условиям имеет множество направлений, среди которых выделяется незаметная защита национальной культуры и ее духовной основы – традиционной религии. Не случайно не только философы, но также социологи и культурологи заговорили о «возврате этничности». Именно реальная угроза раствориться в массовой американизированной культуре подвигает многих граждан на принципиальное обращение к истокам своей национальной культуры.

Ключевые слова: светские идеологии, интерконфессиональность, политизация религии, религиозация политики, постхристианство, теология освобождения.

Introduction

The end of the last 20th and the first two decades of the present 21st centuries were marked by an amasing social and cultural phenomenon – a sharp increase in the role of religion in all spheres of human life. The religious factor plays a significant, and in many regions of the Earth, and a determining role everywhere – in politics, economics, and culture. This phenomenon became to be unexpected for most scientists, and even, paradoxically, for many traditional religious figures. Until recently, many intellectuals, and ordinary citizens, shared the conclusions of the French enlighteners of the 18th century that religion is an invention of the ruling classes to suppress the masses, and religion will disappear with the progress and development of education. Such influential philosophical systems of the 19th and 20th centuries as Positivism or Marxism also proceeded from the fact that religion is just opium for the people. Liberals regarded religion only as a private matter of the individual, but not a matter of society. Even conservatives viewed religion as part of the great historical tradition of their country, but not as something giving the world a transcendent idea. It is no coincidence that the Christian

democratic parties ruling in many countries of Western Europe emphasised their inter-confessional character, and personal confession of the Christian faith was absolutely not required for party members. The culture and politics secularisation, which began in Europe around the 17th century seemed gradually to lead to a natural result – the complete disappearance of religion – under the influence of European culture and Western colonialism on all other continents. Since the 1970s, philosophers and political scientists have been talking about a religious renaissance in many regions of the world with the rise of the Islamic movement and the Islamic revolution in Iran.

The subject of the study was the religious sphere of the modern world.

The object of the study was the processes for religionising politics, culture, and economics of the modern world.

The purpose of the study was to present the main patterns of the religionisation of politics, culture and economics of the modern world.

Based on the purpose of the study, the following tasks were developed:

- analyse the process for reviving religion in various regions of the world;
- analyse the essence and causes of the de-secularisation of world society at the present stage of its development;
- clarify the concept of religion with regard to the 21st-century realities;
- formulate the concept of a traditional religion for the country at the present stage of development of the world community.

Historical, logical, analytical, and comparative methods were applied to achieve the purpose and solve the tasks set in the study.

The authors used the works of prominent scientists and researchers, including U. Beck (*2000*), A.J. Toynbee (*1947*), P. Nolan and G.E. Lenski (*2010*), C. Hackett (*2017*), and E. Smith (*2004*).

Analysis of the process for reviving religion in various regions of the world

Since the 1970s, philosophers and political scientists have been talking about a religious renaissance in many regions of the world with the rise of the Islamic movement and the Islamic revolution in Iran. Terms such as "politicisation of religion" and "religionisation of politics" have appeared. At the turn of the century, it became clear that the "religionisation" of politics is a fairly constant factor that has covered almost all countries of the world to one degree or another. Two decades of the new century have fully confirmed this assumption.

At the turn of the century, it became clear that the "religionisation" of politics is a fairly constant factor that has covered almost all countries of the world to one degree or another. Two decades of the new century have fully confirmed this assumption.

The conflict in Ulster, which has been going on for many decades since about 1968, as well as mass Christian anti-communist movements in eastern Europe, especially in Poland, the wars that led to the collapse of Yugoslavia – all this testifies to the increasing religion role in the society's life, even in European countries that have long experienced the process of secularisation. At the same time, it should note that religious teachings have been offering society a concrete alternative to the existing order of things at the end of the last and the

beginning of this century. All the powerful secular ideologies of the last century were unable to explain the existing social problems of the country and the world and give them a rational alternative. Currently, it should repeat that religion has become one of the most important factors of politics. Without considering the religious factor, it is difficult to define the current state of development of the post-Soviet countries at all.

The revival of the religious factor in political development was already talked about four decades ago, when the revolution erupted in Iran on February 11, 1979. It should note that this was indeed a truly popular revolution, in which the bulk of the nation participated. And after all, no one could have expected that millions of people would be ready to speak under the slogans of restoring true Islamic rule of the 7th century at the end of the 20th century. However, Iran was one of the most Westernised countries in the Middle East. At the same time, it is impossible not to notice that the rise of fundamentalism is precisely taking place in the most Westernised countries. French-speaking Algeria plunged into civil war in the early 1990s, when Islamists began an armed struggle against the secular regime of the country. It may seem strange that the Islamists mostly spoke French. And it was in this language that they printed their propaganda materials.

The Islamism rise in the Middle East has long been perceived as something permanently peculiar to the region. Meanwhile, the repeated rise to power of the Hindu religious party Bharatiya Janata Party (BJP), which largely abolished the secular nature of the republic, in billion secular India did not arouse the attention of experts as separate extremist attacks by Islamists in other countries. Currently, more than half of Latin American countries are governed by moderate or radical leftists, but inspired not so much by the teachings of Marx as by the "theology of liberation".

Finally, communism in eastern Europe was largely crushed by the position of the Catholic Church of the time of John Paul II. Indeed, of course, some Gdansk shipyards' strikers primarily fought for sausage, but they were hardly inspired by the free choice between Coca-Cola and Pepsi-Cola. However, Catholicism, which had a character that united all Poles due to historical conditions in Poland, really managed to rally a significant part of the nation against the Communist Party power. Currently, there are hundreds of monuments to Pope John Paul II in Poland. He is seriously considered the winner of communism in this country.

In Western countries, especially in the European Union, there is also a religious revival, although it is almost unrelated to traditional churches. Regarding the traditional religious structures of Europe, it can be stated that they continue to experience a crisis lasted for more than a century. Therefore, Europe has repeatedly been tried to declare a "post-Christian Continent". It is significant that the draft constitution of the European Union, tried to enter into force back in 2005, did not mention the Christian roots of European civilisation at all. However, a lot was said about "rights", and first of all it was about the "rights" of various sexual "minorities". By the way, National referendums in France and the Netherlands rejected this constitution. However, the role of Christian organisations in these referendums was insignificant. Basically, the French and Dutch voted against the transformation of their countries into something "pan-European" based on nationalist or left-wing sentiments, and only to a lesser extent from religious motives.

In recent decades, a surge in religious sectarianism has been characteristic mainly for Western countries. Reports of sectarian group suicides or crimes committed by them constantly occupy the lines in mass media. In a number of Western countries, representatives of various non-traditional sects are up to 10% of the population. The surge of these religions is directly related to the fact that many traditional confessions are unable to offer acceptable answers to emerging personal and social problems.

In addition to homegrown sects, most young Europeans and Americans accept religions that are unusual for the West. The fact that at least 150 thousand native Frenchmen have become Muslims in France, and several million white Americans belong to various Eastern cults in the United States, is no longer surprising. According to various surveys, about 20 thousand Americans, 50 thousand Britons, and four thousand Germans accept Islam every year. However, the religious upsurge has more embraced the huge, and increasingly growing masses of coloured immigrants in Western countries.

Thus, the process of reviving religion in many regions of the world has been called "de-secularisation". Since "secularisation" is called a return to the secular style of politics and culture, accordingly, the prefix "de-" means the opposite process, i.e., the expansion for influencing religion on all spheres of human society.

The essence and causes of the de-secularisation of world society at the present stage of its development

The reasons for this phenomenon, regardless of its name, are diverse, but understandable. Dominating almost the entire 20th century, secular ideologies were unable to solve the problems facing society. No matter how one treats the ideologies of anarchism, communism, fascism, and Western democracy, it is obvious that none of these ideologies has achieved victory. The social consequences of the Russian Revolution, from which the proletarians of the West benefited, were eventually defeated as a result of the betrayal of their own leaders. The military organisation of German fascism did not lead to victory. Finally, Western democracy did not win at all as a result of the collapse of its opponent in the USSR. Western-style democracies were unable to respond to the problems facing humanity at the turn of the 20th and 21st centuries. In such cases, as always, the good old ideas of national identity, national culture, based on traditional religion, inspired by centuries of experience, are once again gaining popularity and mass support.

There is another circumstance in the de-secularisation of the modern world. Since the last decade of the 20th century, the world has been experiencing the globalisation era. It should be understood as the gradual weakening, and in the future, the complete disappearance of the sovereignty of once independent states. Indeed, for five millennia, it was the state that was the main form of human social and political existence. However, globalisation has led to the economy, finance, and social policy of each individual country managed by unelected supranational bodies, such as the International Monetary Fund (IMF), the World Trade Organisation (WTO), and others, in other words, into the hands of an unselected financial oligarchy.

In a globalised world, no democracy is envisaged although democratic procedures remain in the form of periodic elections and multiparty system. The world ruling elite pursues a policy of eliminating the social gains achieved by the masses in Western countries. As a result, the

process of disappearing the "middle class" began in the West due to the transfer of entire industries from Western countries to regions with cheap labour. National cultures and traditional religions of many countries are deliberately undermined, because the followers may oppose unification. Part of the undermining of national identity was the policy of encouraging mass immigration if mass unemployment in their country is.

As a result, the nation-state lost real control over economic, cultural, and political life, following. However, when the same American-like English language, Hollywood blockbusters, Coca-Cola and other "brands" prevail everywhere, it is not surprising that the resistance to globalisation lies in the struggle for national identity. At the same time, national identity often lies in traditional culture based on traditional religion. Thus, globalisation has only spurred the process of de-secularisation of many regions of the world.

A. Toynbee, the famous British historian of the 20th century, directly linked the emergence, development and decay of civilisations with the same processes in the religious sphere. Moreover, he believed that the processes taking place in religion are at the heart of civilisational development, and "civilizations are the handmaidens of religion" in some cases. Toynbee argued that civilisations generally "are governed by the spiritual progress of mankind" (*Toynbee, 1947*). However, long before A. Toynbee, Russian Slavophiles came to this conclusion, emphasising that the peculiarities of each cultural and historical type are primarily determined by religion. The desire to protect traditional culture is increasing in the globalisation era.

Thus, the revenge of religion is due to many quite prosaic reasons for modern development. It is quite possible that a new atheistic wave will follow in the world in the near future. However, today the ongoing de-secularisation of the world is observed. It is undoubtedly, it is one of the most important phenomena of world development.

Political movements based on religious teachings are closer to fundamentalism. This is due to the fact that believers, who are active in politics, are more critical of the traditional ruling church, believing that it is not able to defend their rights, since it usually supports the existing system. Fundamentalists condemning the official church and strongly opposed to the authorities are more able to attract the masses of active believers. On the contrary, the ruling regimes more often seek to modernise the creed to justify their power. Therefore, the world de-secularisation is largely characterised by the religious fundamentalism rise.

The concept of religion with regard to the 21st-century realities

This part of the article clarifies the concept of "religion" in regard to the realities of the 21st century. The concept is used so often and so widely that its very meaning has been lost. Religion is a factor that has existed for an incomparably longer time than politics, ideology, and the state. No society can exist without religion. The state, public organisations, and political parties use many religious symbols in their activities and campaigning, and many religious holidays are state holidays in many countries of the world, e.g., in Russia, Christmas and Easter are celebrated at the state level as state holidays, and not as "purely" religious holidays. Church leaders in many countries are part of the political elite, the opinions of religious leaders largely determine the electoral behaviour of citizens, and senior state officials most often use religious ceremonies when taking office.

Nowadays, when there is a global transformation of the whole society, changes affecting the foundations of culture and civilisation make the problem of human identity in the sphere of religion relevant, which is also connected with the problems of modern religious society.

As the well-known Western publicist Ulrich Beck notes, "We are witnessing a metamorphosis of society, during which people are freed from the social forms of industrial society – from the division into classes and strata, from traditional family relations between husbands and wives, just as during the Reformation they were freed from the domination of the Church and moved to the forms of secular life societies" (*Beck, 2000, p. 78*). Society leaders, political technologists, ordinary citizens are increasingly turning to the most stable criteria that have proven their importance and role in preservation and survival over time. Religion is the most important factor determining the specifics and purpose of civilisation. It determines social relations.

There are objective factors, as modern Russian authors note, according to which the term "traditional religion" can be distinguished as the degree of influence of this religion on the mentality and way of life of a people or a group of peoples, on the formation and development of the state and national identity, on standards of behaviour and perception of the world. Of course, a religious organisation acquires and implements these functions with a very long existence among a significant part of the population" (*Kafanov & Mchedlova, 2009, p. 287*).

In different countries, politics, migration, the crisis of family values, the decline of social solidarity, intolerance and tolerance manifest themselves in different ways because of religious traditions. It is necessary to look at how the attitude towards religion is manifested in Europe and Russia.

It is difficult to perceive Europe as something averaged: in different states there are different proportions of people who consider themselves followers of religion. The majority of the population of countries such as Cyprus (98%), Romania (92%), and Poland (93%) declare their adherence to a certain religious trend, slightly fewer followers of certain faiths in Ireland (87%) and Portugal (80%). The smallest proportions of those who consider themselves followers of religion are in the Netherlands (41%), Sweden (32%), Estonia (28%). Russia (49%) is closer to France (50%) in this indicator. The largest share of believers who pray every day is recorded in Poland (48%), Romania (49%), Ireland (44%), Cyprus (39%), Portugal (32%), Ukraine (30%), and Slovakia (30%). Worship in these countries is important for maintaining stability and the search for national identity. Attending religious services is not so popular even in those European countries where the entire population is followers of a certain religion. The proportion of those who attend church daily does not exceed 4%.

In Russia, among the respondents, those who consider themselves to be of any religious denomination, which in the language of science is called "self-identification", the overwhelming majority – 87% – consider themselves Orthodox, i.e., 43% of the total number of Russians. Islam is in second place, 11% of believers, or 6% of the respondents, identify themselves as Muslims. When determining the degree of religiosity of Russians, it turned out that Russian society is rather secular. According to the European Social Survey (ESS), about half of the respondents in Russia are not religious in general, including 14% of them say that they are not religious at all, 32% probably not, 22% hesitate when determining the degree of their religiosity.

The religiosity nature can be judged not only by the subjective self-identification of respondents, but also by the level of religious activity.

About a third of Russians attend religious services more or less regularly; among them, only 4% of respondents go there once a week and more often, 8% do once a month, even more the number of those who participate in public services only on religious holidays is 19%, a fourth of Russians (27%) do it only occasionally, over a third of respondents (41%) indicate that they never attend religious services.

It is more typical for Russians to have common with God through prayer. 15% of respondents pray daily; 6% do it a little less often, but at least once a week, 14% do it monthly or at least on religious holidays, 16% do it even less often. About half (46%) never perform prayer (*Kafanov & Mchedlova, 2009, p. 296*).

According to the European social research, the absolute majority in Europe are representatives of Christian denominations, which is determined by the entire history of Europe. At the same time, there are certain regions of the spread of Christianity. 85% of the followers of the religion consider themselves Catholicism in France, 97% in Portugal, 94% in Spain, 99% in Poland, 90% in Belgium. A high percentage is observed in countries such as Slovakia (83%), Slovenia (93%), and Hungary (68%).

Protestant movements are most common in Denmark (94%), Norway (97%), Sweden (89%), and Finland (84%). In Russia, Romania, Ukraine, and Estonia, the majority of believers are followers of the Orthodox Church (87%, 88%, 82%, and 64%, respectively).

The concept of a traditional religion for the country at the present stage of development of the world community

The very concept of "traditional religion for the country" is rapidly devalued nowadays. Migration processes have led to the emergence of new religions, primarily Islam: 8% in France, 6% in Belgium, 5% Sweden, 5% in Switzerland, 4% in the UK, 4% in Germany in 2006 (*Kafanov & Mchedlova, 2009, p. 291*). These data, however, are rapidly becoming obsolete due to the large-scale migration to Europe of immigrants from Muslim countries, as well as the very high natural growth of these new Europeans. In 2016, Islam is being preached by 11.1% of population in Bulgaria, 8.8% in France, 8.1% in Sweden, 7.1% in Netherlands, 6.3% in Great Britain, 6.1% in Germany and Switzerland (*Hackett, 2017*; *Figure 1*).

As the modern Russian researcher F.O. Pleshchunov notes, "over the past few decades, Muslims have not just become an integral part of European society. They have changed the culture of this society. Most Europeans today just have to walk through the streets of their hometown to find out what a mosque looks like, to understand the difference between traditional clothes that Pakistanis or people from the Arab world prefer to wear ..." (*Pleshchunov, 2011*).

Indians have long emigrated outside their country, resulting in large Hindu diasporas, e.g., there are over one and a half million people from India living in the UK who profess Hinduism (about the same number of British Indians by religion – Sikhs, Parsis, Christians). In London, the capital of the former British Empire, immigrants from the historical lands of India (the Republic of India, Pakistan, Bangladesh, Sri Lanka) make up over 15% of the population, and it is not by chance that the city received the ironic name "Londonabad". In 1995, the world's

largest Hindu temple Shri Swaminarayan Mandir was opened in London. According to surveys of Londoners, this very beautiful temple was included in the list of the Seven Wonders of Great Britain. In the same London, with the financial support of a member of the Beatles musical group George Harrison, a temple of one of the directions of Hinduism – Krishnaism – was opened a little earlier, in 1969. Large Hindu temples exist in the Canadian city of Toronto, in the American cities of Chicago, Houston and a number of others. Given the ongoing mass emigration of Indians to Western countries, the high birth rate in the families of Indian emigrants, as well as a large number of mixed marriages of Hindus with non-Believers, whose children are counted as Hindus, Hinduism is turning from a national religion into a world religion. It is very indicative of the fact that in a number of Western countries the number of "white Hindus" is growing, i.e., indigenous local residents who have adopted any direction of Hinduism. So, in the UK, 1.5% of people who called themselves Hindus are pure-blooded Englishmen by origin. About the same number of Englishmen and Englishwomen are married to Hindus.

There are over one and a half million Hindus in the USA. According to the conducted research, the divorce rate is lower, the level of education and income is higher among American Hindus. 48% of American Hindus have master's or doctoral degrees. 43% of American Hindu families have an annual income of more than 100,000 dollars US. Hindus in the USA are the most law-abiding denomination. Interestingly, the Indians are the only one of the large diasporas in the United States that has not created its own ethnic mafia.

At the same time, Western political correctness prevents from calling things by their proper names. German politician Tilo Sarrazin, who wrote a book about the "self-destruction of Germany", instead of a substantive discussion of the arguments and figures he gave, was booed as a "racist and xenophobe". Similarly, European politicians, who publicly proclaim the need to protect the primordial, i.e., Christian European values, find themselves in a political ghetto when even the abundance of votes cast does not even lead to consideration of the alternatives they offer, e.g., the French National Front Party of Marine Le Pen. However, sometimes, politically incorrect European politicians simply die in car accidents like the leader of the Austrian nationalists Joerg Haider or at the hands of lone killers like the Dutch politician Pim Fortuyn.

However, the failure of the multiculturalism policy, i.e., the hope that representatives of different religions and cultures will live together, obeying the rules of Western-type civil society, was recognised by German Chancellor A. Merkel, French President E. Macron, British Prime Minister B. Johnson. However, the recognising this fact is not able to rid Europe of tens of millions of Muslims and followers of non-Christian creeds. In general, in full accordance with the concepts of A. Toynbee, the failure of multiculturalism is an indicator that Western civilisation is no longer able to offer any ideals to representatives of the non-Western world.

Arabs in France, Pakistanis and Hindus in England, Turks in Germany are all actually new ethnic groups that have lost many features of the indigenous ethnic groups of their historical homeland, in particular, the language, but have not joined the nation that accepted immigrants. It is no coincidence that the self-identification of epy Europeans, who immigrated from outside, has the character of a "return" to their ancestral religion, for the majority – Islam. It should note that the "Islamic Renaissance" is more typical for immigrated natives of Western countries, while their own parents usually do not show religious zeal. The mothers of the majority of

Muslim women, who went to street demonstrations in Paris in defense of the hijab, never wore the hijab themselves.

This is not surprising. In the form of protection of the mythologised tradition, the nationalism of new ethnic groups is manifested. As E. Smith notes, "nationalism is not at all what it seems to itself. The cultures he demands to protect and revive are often his own invention or changed beyond recognition" (*Smith, 2004, p. 74*). At the same time, Western civilisation itself can no longer attract many of its own citizens of overseas origin. After all, earlier Western civilisation carried Christianity, railways, newspapers, schools, hospitals, democratic principles. Now, mostly Western culture is associated with mass culture, same-sex marriages and Big Macs only.

According to K.W. Deutsch, nationalism plays a compensatory function, creating a sense of unity and protection of marginals in the hostile environment of a foreign society (*Deutsch, 1969*). Now new Europeans, very numerous and rooted in European countries, who continue to feel marginalized, are united by new myths, e.g., an exalted perception of the colonial past of the historical Homeland, and traditional religion in a fundamentalist wrapper, sharply contrasting "high morality" to the West that has decomposed as a result of the "sexual revolution".

However, this is Europe's problem. There is a significant difference in the settlement of Muslims, e.g., they live in their ancestral territories in Russia, and in Europe, Muslim enclaves represent a completely new trend that came from outside, perceived by Europeans as alien.

In Russia, Muslims, who are "newcomers" from among guest workers from the republics of the former Soviet Central Asia, have not yet demonstrated high religiosity. In Central Asia, they usually tend to exaggerate the influence of the Islamic factor, which is insignificant in fact because of 70 years of Soviet power. To compare, the results of a study of migrant women in Moscow can be cited. According to them, only 10.3% of respondents from Central Asia described themselves as very religious, including 8% of Kyrgyz women, 9% of Tajik women, and 14.1% of Uzbek women in contrast to the general religiosity in the same Arab countries (*Social vulnerability..., 2011*). At the same time, in the 1960s, when the mass immigration of Muslims to Western European countries began, guest workers were also not characterised by a high level of religiosity. However, the second and third generation of non-indigenous Europeans begin to demonstrate their belonging to the Islamic world. Therefore, in principle, Russia may also face the problem of non-integrated Muslims into society.

Discussion

In the course of the study, deep issues of the essence of the process of world community religiosity and de-religiosity in the late 20th and early 21st centuries were raised. Consequently, in the future, a more detailed analysis of these processes is required to answer the question of influencing religious processes on the social, political, and economic life of society, its transformation and development in various social systems.

Conclusion

The factor that ensures the stability of Russian civilisation is the coexistence of different faiths. According to registration authorities, as of June 1, 2005, there were 30,325 registered

religious organisations in the country belonging to 66 religious' movements (*Information on religious organisations..., 2018*). In 2013, Rosstat named 47 confessions, and combining 90 organisations into one line "other faiths". And at the beginning of 2020, more than 31 thousand religious organisations and more than 60 different denominations were registered in Russia. Such a discrepancy in figures is explained by changes in counting methods and the very delicacy of the topic of determining religiosity in a secular society.

Russian civilisation can be defined as Orthodox, and of course, no religion can compete with Orthodoxy in terms of strength and degree of influence on the history and culture of Russia, but at the same time it is impossible not to recognize the contribution, mutual influence, mutual enrichment of other religious traditions (Islam, Protestantism, Judaism, Buddhism) in the creation and protection of a common state. The coexistence in the Russian civilisation of religions that have become the basis for other civilisations is its peculiarity, an amazing feature and, moreover, a deep essence.

The resistance to globalisation under Western conditions has many directions, among which the inconspicuous protection of national culture and its spiritual basis – traditional religion – stands out. It is not by chance that not only philosophers, but also sociologists and cultural scientists started talking about the "return of ethnicity". It is the real threat of dissolving into mass Americanised culture that motivates many citizens to turn to the sources of their national culture in principle.

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Appendix

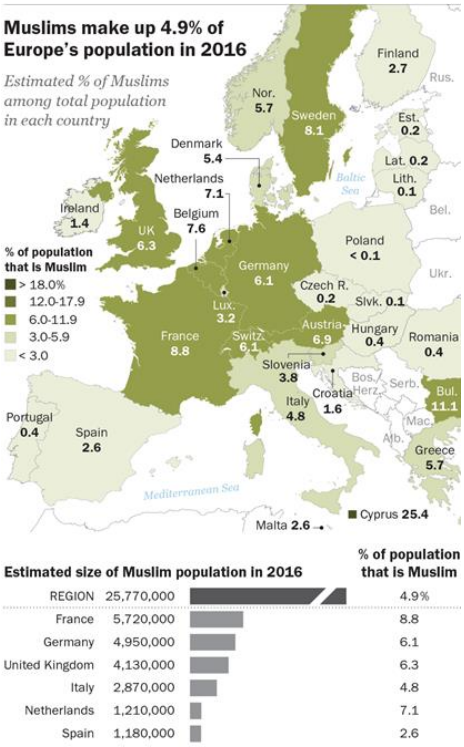

Figure 2. Estimate size of Muslim population and percent of population in 2016

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