IMAGE: A MAP OF THE STARS OF THE ORION CONSTELLATION

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SUMMARY

The full-scale war unleashed by the Russian Federation in February 2022 in Ukraine significantly affected the state of the country's economy as a whole, as well as business opportunities. From this perspective, it became necessary to analyze which financial sources could enable businesses in Ukraine to maintain their business activities and effectively stabilize the recession under present conditions. This became the purpose of this article. It turned out that the banking system could potentially be the main source of stabilization for anti-crisis business management on this path, which it has actually become. A number of conclusions were drawn based on systematic and complex research approaches, in the course of a two-stage analysis of surveys on business sector entities, the structure and dynamics of commercial banks' performance indicators in Ukraine as of 2022, their ability to provide business with the necessary banking services. The scope of business lending is gradually decreasing. This is caused by the unwillingness of banks to cooperate with problematic businesses with low creditworthiness. And this problem still remains unsolved. As for the deposit policy, banks have increased deposit rates, which is a positive trend. At the same time, the requirements for carrying out cash operations have become more complicated, and the scope of additional information to be provided by businesses has increased, which may further increase business operational risks. The stock market saw a suspension of activities during the period of shock, and then trading and securities transactions resumed. In general, the stabilizing role of the banking system for business in Ukraine during this period had a positive effect on the general economic situation.

Keywords: war economy, economic crisis, financial stability, analysis, financial condition, banking system, business activity.

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I. INTRODUCTION

One of the most important functions of the banking system of any country is to provide the business sector with financial resources for proper functioning. The importance of a satisfactory financial position of enterprises lies in the fact that they need to carry out their production activities, supply consumers with products, provide jobs for a large part of the population, and replenish the state budget. Therefore, financial support of entrepreneurs of various levels is crucial for the stable functioning of the entire economic system of the country. This issue has become especially acute for Ukraine since the outbreak of a full-scale war by the Russian Federation against Ukraine, which resulted in the undermining of its national economy, international trade relations, and the occupation of a large part of Ukrainian territories.

Under conditions of the deterioration in the Ukrainian enterprises' performance, there is a need to assess their financial status, identify the main problems of their management, and search for the possibility of attracting additional resources from commercial banks by using the entire range of their financial services. First, we are talking about lending, depository activities,

keeping business accounts with banks, securities transactions, and cash servicing. Almost the only possible way to preserve economic activity, especially in the conditions of a war economy, is for entrepreneurs to refer to banks as external sources of financing. Attracting additional funds from banks will enable providing troubled enterprises with working capital, to compensate for the negative consequences of the increase in raw and production materials prices, the decrease in demand for products and services, and the lack of labor due to the conscription of employees.

There is another side to the banking system in an economic situation like this, i.e. as a financial regulator it is able to manage financial flows and stabilize the decline in the country's economy. At the same time, in the conditions of war, it remains relevant for commercial banks to continue to stably service their customers, as well as to attract more financial resources as the Ukrainian business sector needs are growing.

II. LITERATURE REVIEW

A large number of scientists from all over the world devoted their research to the topic of providing services to business entities by commercial banks.

Among Ukrainian researchers, scientists Larionova K., & Tanasiienko V. (2021) focused on examining the situation with lending to small and medium-sized businesses by banking institutions in Ukraine in the context of the COVID-19 pandemic. The authors examined the dynamics of business lending, as well as the change in average crediting interest rates. That research was based on an analysis of the best lending programs by banking institutions, optimal interest rates, and loan repayment terms.

Artemenko D. (2021) devoted his research to lending to agricultural enterprises since enterprises in this sector are one of the most numerous in Ukraine. His work presents information on the scope of loans granted to agricultural businesses, the share of overdue loans, and information asymmetry in the credit market for borrowers.

Among European scientists, there are those who studied the role of the banking system in providing enterprises with financial services. Kristle R.Cortés, et al. (2020) studied the impact of stress tests on the structure of the credit services market in the United States. Rebel A. Cole, et al. (2020) devoted his research to the correlation between the long-term financing of private firms and their subsequent financial results. Özde, Öztekin, & Gönül, Çolak (2021) conducted a study of the impact of the pandemic on global bank lending and the ease of access to loan capital by corporate firms.

In recent years, there has been a large number of scientific studies of different depth and subject matter. But it can be stated that the scientists listed above did not consider the question of how important the modern banking system is as a stabilizing factor in supporting the private sector amidst such an extraordinary and destructive event for the country's economy as war. Although some modern countries' banking and private sectors found themselves in wartime working conditions, full-fledged studies of their interconnection with each other were rarely conducted.

III. RESEARCH APPROACH

In the current wartime, the problems of running a business are becoming more acute, that is: determining and maintaining its current financial condition, assessing the degree of financial dependence on the banking system, and assessing the possibility of improving one's financial performance by using the services of commercial banks. In this situation, the connection and interdependence between businesses and banks increases.

Businesses, on the one hand, are the clients of banks. Banks are interested in their clients being solvent, economically viable, and stable.

On the other hand, businesses must be sure that the banking system will be able to become a reliable financial source and partner in a crisis period, able and willing to ensure the strength of such economic relationships. Therefore, bilateral

interest and willingness to closely interact and build mutually beneficial financial relations should be demonstrated and ensured. This interaction is natural in stable economic conditions, but it is very fragile, sometimes dubious, and unpredictable at various stages of the war on the territory of Ukraine. Therefore, the goal of this study is to determine how the main stabilization function of the banking system for business activities was ensured in Ukraine in 2022 under the conditions of a war economy.

The research was conducted in 2 stages:

- *Stage 1:* collection and summarization of data from reports on the financial condition of different businesses; circumstances, and terms of financial services provided by commercial banks of Ukraine.
- *Stage 2:* analysis of the interaction between businesses and the banking system, the ability of the banking system to provide stable financial support for businesses under the crisis conditions of martial law in the country.

At the first stage, methods of statistical processing and data grouping of financial results and statistics, methods of summarizing surveys of the business entities on changes in production activities, and financial performance were used. For that purpose, we used information from open sources. It is clear that in the conditions of war, the number of such financial content sources is very limited and is of high secrecy to ensure a high level of economic security.

At the second stage, an analysis of the structure and dynamics of Ukrainian commercial banks' performance indicators as of 2022 was carried out. The results of the analysis are presented graphically. Analytical generalizations of financial information and the results of the statistical calculations are implemented with the help of systematic and complex approaches.

IV. FINANCIAL AND ECONOMIC DATA ANALYSIS

4.1 Research field

To assess the stabilization financial support of Ukraine's business sector during the war period as of 2022, an assessment of the main indicators of its activities is needed. Such an analysis will make it possible to draw conclusions about the main problems of economic entities and possible methods for solving them. Table 1 presents basic information about the performance indicators of enterprises and the business environment during this period.

Table 1: Summary of the business owners survey on the performance indicators and business environment in Ukraine as of 2022*

Subject of the survey	Index of changes, um. unit		
	04.2022	06.2022	11.2022
Production	-0.55	-0.12	-0.13
Sales	-0.48	-0.16	-0.14
Export	-0.42	-0.31	-0.18
Assessment of the financial and economic situation	-0.36	-0.20	-0.33
Assessment of the business environment	-0.54	-0.37	-0.34

The generalization is based on the analysis of the results of the 2022 survey conducted by the Institute of economic research and political consultations (Monthly survey of enterprises. Issue 1, 3, 7). They conducted a monthly survey, used the methodology of business surveys, and

harmonized it in accordance with the requirements of the Joint Harmonized EU Program of Business and Consumer Surveys. From 327 to 521 respondents were interviewed within different months. Among them, there are mainly industrial enterprises located in 21 out of 27 regions of Ukraine. Information was collected using a combination of several data collection methods: online form filling and conducting telephone interviews with business representatives, with the interviewers filling in the online form.

From Table 1, it can be seen that the performance indicators of enterprises during the year significantly deteriorated. The volume of production and indicators of sales volumes decreased in businesses of all types. Due to border crossing restrictions, the volume of export plummeted. This, accordingly, destabilized the financial status of export-oriented enterprises and negatively affected their revenues. These conclusions are underpinned by the assessment indicators of the financial and economic situation and the business environment in general.

Among the internal factors of influence, the problem of rising prices for raw materials and other goods was particularly acute (as noted by 68% of enterprises surveyed). 30% of respondents pointed to the problem of a decreased demand for products and services, 22% complained about a lack of working capital (Monthly surveys of Ukrainian enterprises, 2022).

The results of this survey make it clear that the business sector of Ukraine needs an urgent improvement in terms of its financial position, which can theoretically be achieved through using the services of commercial banking institutions in Ukraine.

To confirm whether this is possible amidst the war in Ukraine and to assess the stabilizing role of the banking system in the context of business activities during this period, it is necessary to consider all the services that banking institutions can provide. In the course of the conducted research, a review of financial and economic data on the following main services of banks was carried out (Figure 1).

Figure 1: List of those selected for analysis of the main banking services in order to support Ukrainian business in 2022

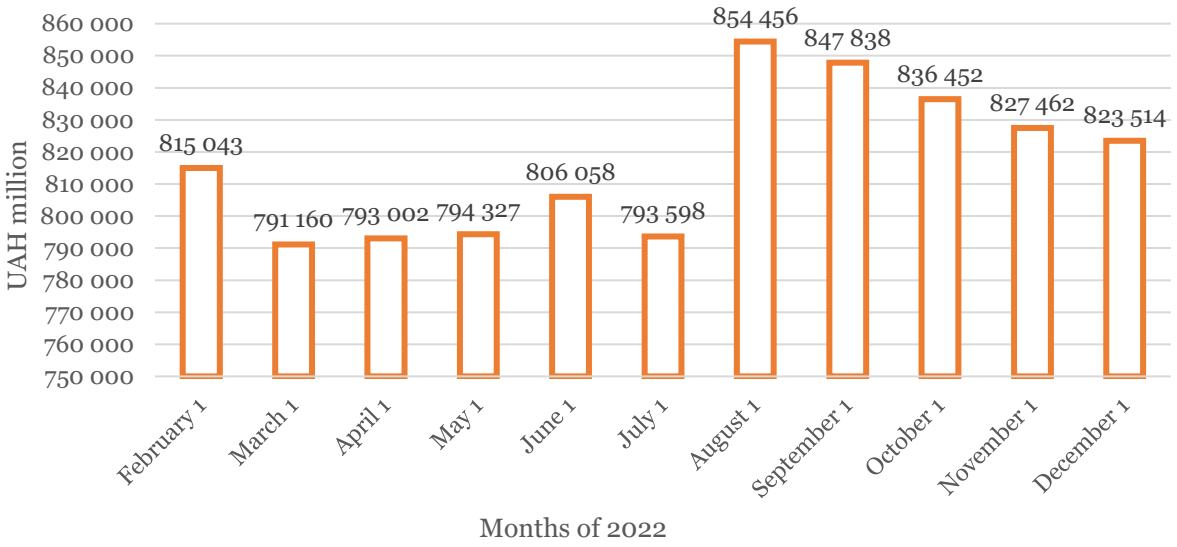
Next, we are going to analyze how banking services (Figure 1) were able to ensure financial capacity and stability for business in such a difficult and crisis period.

4.2 Analysis of the business's ability to obtain bank loans

As for banks' granting loans to enterprises, since February 24, 2022, the main vector of the banking system has been to take measures to simplify the work conditions of banks and to

provide the borrowers with different benefits. The main condition under which these decisions were made was the complication in foreign currency transactions, as a result of which there were difficulties in granting foreign currency loans.

For a comprehensive assessment of the credit market work, we consider it expedient to consider changes in the scope of business entities' crediting. Figure 2 showcases information on the actual scope of loans issued to business entities in 2022.



Source: Main indicators of Ukrainian banks, (2022)

Figure 2: Dynamics of the actual scope of loans issued to business entities in 2022

From Figure 2, it can be seen that during February 2022, the scope of lending decreased by approximately 24 million hryvnias. In the conditions of a stressful situation, foreign banks almost completely stopped crediting, while state banks continued to fully function. Since February 24, 2022, as part of systemic measures, the National Bank of Ukraine has made a number of resolutions to simplify the banks operating conditions amidst full-scale war and to further support their ability to grant loans to enterprises. Among them, we can point out the following:

- Expansion of state support programs, in particular, "Affordable credits 5-7-9" and portfolio guarantees through the "Export Credit Agency" (How the NBU et al, 2022). Thus, any Ukrainian enterprise received the opportunity to take advantage of preferential lending at 0% per annum for the period of martial law.
- On February 24, 2022, in order to ease the financial burden on credit borrowers, most banks of Ukraine introduced credit holidays that were valid until June 1, 2022 (Report on financial stability, 2022).

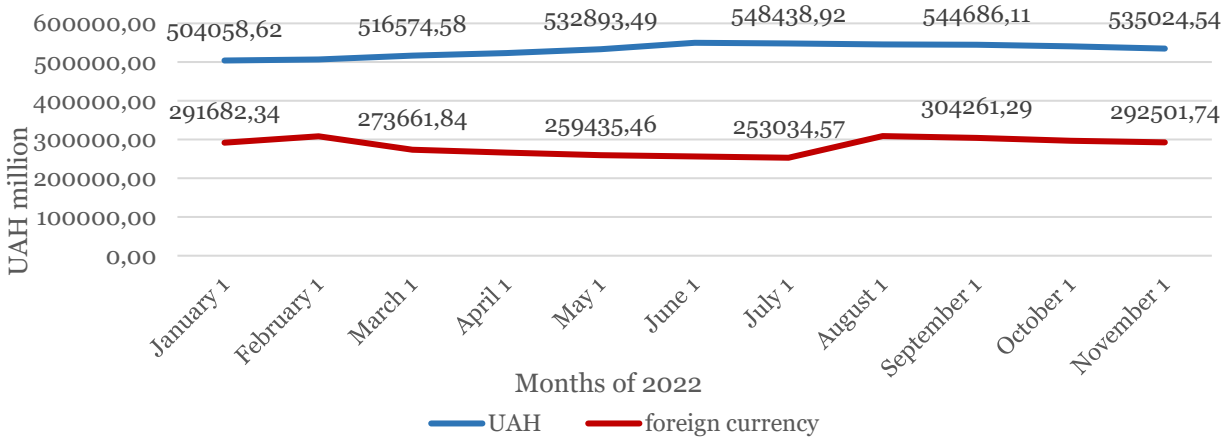
These measures enabled stabilizing the decline in the scope of issued loan capital, and during the period of March-June 2022, there was a gradual recovery in the scope of loans, up until the point when they reached and exceeded the pre-war level in July. From August to December, the trend of a gradual decrease in the number of loans granted continued. The reason for this is that lending by commercial banks to existing customers is currently restricted. It should be noted that the scope of credits discussed in this work takes into account the loans that were issued in recent years, including from the period before the start of a full-scale war. According to the data of the National Bank of Ukraine (the central bank), the number of net loans to economic entities in UAH equivalent was increasing from the beginning of February till May 2022. At the same time lending to enterprises in foreign currency saw

a downward trend and in November 2022 it was only 77% of the November 2021 level. The difference in the lending scope assessment based on residual funds and net loans can also be explained by the payment deferment provided by commercial banks to enterprises.

Thus, the number of loans issued in previous years remain present in the total lending scope for a longer time. The reduction in the net portfolio is caused by two aspects: suppressed demand and provisioning for incurred and expected credit risks.

Due to the lack of more detailed information from official sources on the scope of the loans granted specifically in 2022, it is only possible to consider the scope of all currently active loans in terms of the currencies in which they were issued. Figure 3 shows information on the change in the currency structure of loans granted to business entities.

We can see from Figure 3 that commercial banks preferred loans in the national currency – UAH (the hryvnia). Despite the decrease in the scope of loans granted in foreign currency during the war, previously issued loans continued to work despite the restrictions on foreign currency circulation.



Source: Distribution of loans granted to individuals et al, (2022)

Figure 3: Dynamics of the scope of loans granted to enterprises in terms of currencies To assess the ability of Ukrainian enterprises to pay their obligations, it is necessary to analyze the volume and share of non-performing loans in their total scope.

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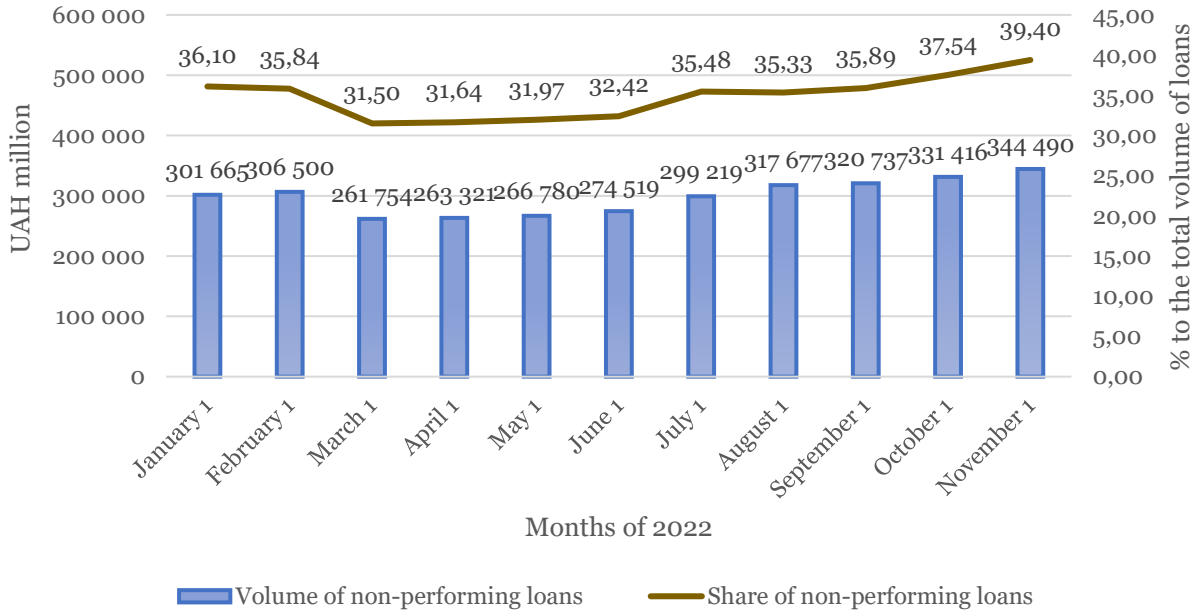
Figure 4 presents information on the volume of non-performing loans and their share in the loan portfolio of commercial banks in Ukraine.



Source: Distribution of loans granted to business entities et al, (2022)

Figure 4: Dynamics of the scope of enterprises' non-performing loans and their percentage share in the total scope of loans

It can be seen from Figure 4 that the percentage of non-performing loans changed in accordance with the change in the actual volume of these same loans. At the very beginning of the war in February 2022, there was a decrease in the scope of non-performing loans by almost 45 million hryvnias. But, since April 2022, there has been a trend toward a monthly increase in the scope of non-performing loans. This can be explained by the loss in revenues, the destruction of assets and collateral, and, as a result, the deterioration of the borrowers' solvency.

Since banks are allowed to conduct flexible restructuring procedures to support debtors, the NPL level does not rise as fast as it might otherwise. Such restructuring procedures allow a number of debtors to survive difficult times and return to timely loan servicing (Basic principles et al, 2022). Given the obtained results, the reason for the reduction in the granting of new loans by banking institutions can lie in the fact that they are not interested in increasing their credit risks by issuing loans to problematic business entities and, thus, increasing the scope of problematic loans during the recession period.

Statements from the board of the central bank claim that banks continue lending to sectors and enterprises that are critical in the conditions of martial law (How the NBU supports et al, 2022): the agro-industrial complex, the food industry, the essential goods and medical goods production industries, etc.

There is a need to assess the compliance of the set goals with the actual indicators in order to draw conclusions about the degree to which the banking system supports the critical sectors and to assess the degree of needs and dependence of enterprises of various production sectors on bank loans.

Table 2 provides information on the distribution of loans granted to business entities by types of their economic activities in 2022.

It can be seen from the given statistical information that banking institutions lend the most to wholesale trade enterprises, agricultural sector and retail trade crediting is very common. It can be seen that the agrarian industry and food industries began to borrow even more than before the war period.

Table 2: The number of loans granted to business entities by types of economic activity in 2022

Indicators:	01.02.2022		01.11.2022		Deviations for the analyzed period	
	Loan amount, thousand UAH.	Share, %	Loan amount, thousand UAH.	Share, %	Absolute deviation, thousand UAH.	Relative deviation, %
Agriculture	82736781.96	10,15	123630962.6	14.94	40894180.64	4.79
Crude oil and gas extraction	8785010,161	1.08	13491198.34	1.63	4706188,179	0.55
Food production	61007906.45	7.48	65937367.52	7.97	4929461.07	0.49
Electricity supply, etc.	64596672.54	7.92	64886773.53	7.84	290100.99	-0.08
Wholesale	172097826.5	21,11	168251207.6	20,33	-3846618.9	-0.78
Retail	118560075.4	14.54	120572986.9	14.57	2012911.5	0.03
Warehousing	19557567.25	2.40	17537632.67	2.12	-2019934.58	-0.28
Real estate transactions	57147595.44	7.01	60367355.21	7.30	3219759.77	0.29
Head offices' activities	6048013,917	0.74	10491907.22	1.27	4443893,303	0.53
Other	224659242.4	27.56	182358891.3	22.04	-42300351.1	-5.52
Total loans granted	815196692.1	100.00	827462282.8	100.00	12265590.7	-

Source: Basic principles et al, (2022)

It can be stated that the banking system has concentrated on lending to the most important industries to support the Ukrainian economy and its population. Almost half of the loans for the entire period analyzed were granted to subjects of large and medium-sized enterprises, the other half was issued to small enterprises and micro-entrepreneurs. It is important to mention that a high share of lending to wholesale trade and agriculture enterprises is characteristic of enterprises of all sizes and scales.

In summary, we can say that enterprises' crediting is currently in a state of a gradual decline, although due to the inclusion of loans granted in different periods to the statistics, this situation is difficult to detect at once. The Central Bank managed to reduce certain negative consequences of the shocking situation since the beginning of hostilities. It should be noted that in the current situation, the problem of the decline in the debtors' solvency cannot be solved, therefore the regulator's policy cannot be considered a complete failure.

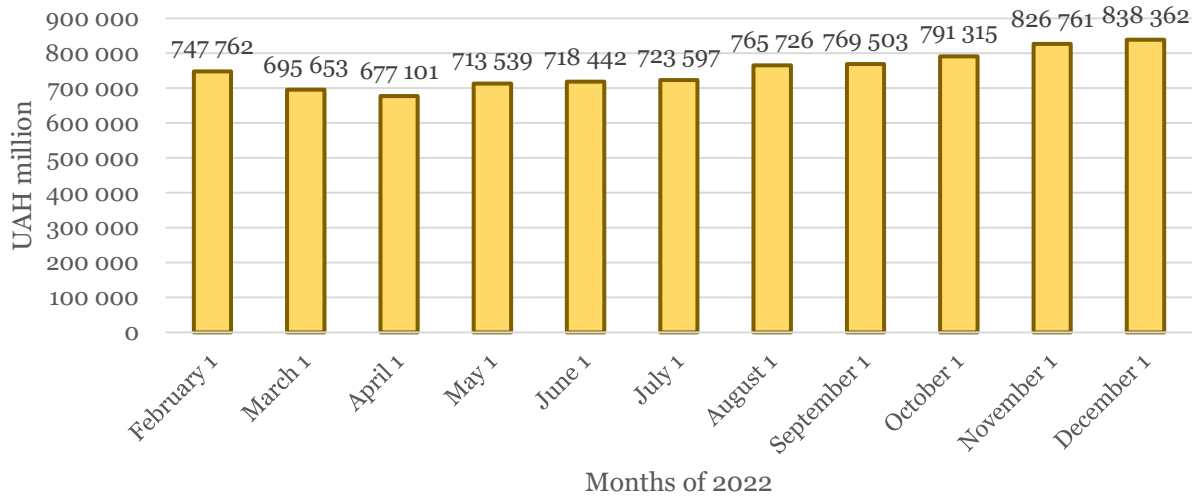
A negative effect by commercial banking institutions is restrictions on lending to enterprises starting from the second half of 2022. The Ukrainian banks are currently in a much better financial position than enterprises, which require much more financial resources. We can say that in the field of lending, the banking system does not fully exercises its function of supporting the enterprises' activities.

4.3 Analysis of the ability to mobilize funds of enterprises with banks

The state of the deposit services market in Ukraine should be considered separately. The analysis of the amount of enterprises' funds deposited in the banks will allow us to draw conclusions about the use of funds by banks to receive interest incomes in the future, as well as about the degree of prevalence of banking services among subjects of the business sector.

Figure 5 shows basic information about the change in the amount of enterprises' funds deposited as of 2022.

From the given statistical information, it can be concluded that during the stressful period of February-April 2022, the amount of funds deposited did not decrease significantly. And from May 2022, a gradual increase in the amount of invested funds began, which is a very positive sign. This is partly explained by the fact that when the inflow of new funds from business entities decreased from the beginning of summer, the competition between banks intensified, and they were forced to raise deposit rates. In autumn, with the revival of business activity, account balances began to grow in all bank groups. The increase in business funds provides banks with more even access to funding, while inflows of retail funds are concentrated in a few financial institutions, mainly state-owned banks.



Source: How the war affected deposits et al, (2022)

Figure 5: Dynamics of the actual scope of deposits raised from the enterprises' funds in 2022

For enterprises, investing money in deposits is a real opportunity to partially compensate for the losses caused by currency devaluation at the expense of interest incomes. In general, it should be noted that the service of providing deposits creates an opportunity for commercial banks to improve their financial condition in the short term, and for enterprises in the long term. Besides, it is worth mentioning that with the beginning of the war, the popularity of fixed-term deposits plummeted, which is explained by the lack of quick access to funds

in uncertain times. That is why customers currently prefer demand deposits. In addition, the reliability of the deposit market was strengthened by the state government with the help of the introduction of a 100% deposit guarantee. This measure enabled increasing the depositors' confidence in the mandatory return of their money during wartime. The decision was implemented both for individuals and for legal entities.

Analysis of the deposit market condition is further complicated by the insufficient array of available data for analysis. Data on the scope of net deposits that were attracted specifically during 2022 are available only in an illustrative form, with no specific figures and indicators. As the central bank itself notes, most of the funds received by banks remain in current accounts, so the term structure of funding is deteriorating. In particular, the share of time deposits of the population in all currencies dropped from 43% before the war to 35% as of the end of October. In addition, some medium and small banks faced funds outflows on the side of the population and businesses (How the war affected deposits et al, 2022).

4.4 Analysis of the ability of businesses to carry out cash desk and other financial transactions

Regarding the regulation of cash operations, the National Bank of Ukraine introduced certain alterations to their work. Since June 27, 2022, the provider of payment services has been obliged to provide the user with such information as the terms and conditions for carrying out a payment transaction or provide the access to such information before the payer initiates a payment transaction using issued payment instruments, indicating the payment services provider, the type of payment transaction, commission fees, method of communication and security measures, the validity period of the payment services agreement, the procedure for making changes to the agreement and conditions for its termination (Updated the Instructions et al, 2022). For businesses, such a decision made it much more difficult to work with cash transactions, as it required them to collect a larger array of information. In turn, it became easier for banking institutions to keep records of cash settlements. Such simplification of the working process provided banks with an opportunity to cooperate with businesses in the money transfer sphere more efficiently.

Providing additional business information is not a significant complication of business activities, while greater awareness of banking institutions about customers and transactions is an important measure to increase cash transactions' security and reliability, and to introduce more order to these transactions.

On February 24, 2022, the National Securities and Stock Market Commission (hereinafter referred to as the NSSMC) introduced restrictions on securities transactions of all types (except government bonds) that were valid until August 2022. The ban also applied to banking transactions. The organized securities market and securities transactions were completely stopped. This was done in order to prevent panic actions that could collapse the markets and deprive them of the possibility to fully operate in the future, to preserve data and property rights. Subsequently, the "freezing" of the securities market made it possible to find assets related to the aggressors - the Russian Federation and the Republic of Belarus and to limit the opportunities for such companies to conduct business in Ukraine.

With the eliminated possibility for Belarusian and Russian companies to operate in Ukraine and a certain stabilization after the state of shock amidst the war, there was a need to abolish the accepted restrictions. On August 8, the NSSMC decided to eliminate restrictive measures (The long-awaited decision et al, 2022). After the bans were lifted, the government focused on facilitating the activities of professional participants and supporting them. In particular, the procedure for identification of persons when purchasing securities was simplified, accordingly, this applies to securities transactions execution, and the purchasing procedure by non-residents.

Also, the central bank unified the approaches to accounting securities on aggregated accounts both for residents and non-residents (The long-awaited decision et al, 2022).

The economic system of any country is not able to fully function when an operation of a significant part of the financial markets is restricted. In the long term, even during the war, there is a need to renew them. Therefore, we consider the complex actions to "unfreeze" the market and simplify procedures for the purchase of securities to be an expedient solution, which made it possible to restore the effective operation of the entire stock market of Ukraine.

V. CONCLUSION

To sum up, it can be noted that the banking system continues to provide the corporate sector with credits in large volumes. There was a tendency towards a gradual decline in granting of loans in 2022, which is connected with the reluctance of banks to provide credits to enterprises in a period of financial instability. This negatively affects the position of businesses in Ukraine. The incentive for such a decision was the increase in the number of enterprises that are unable to pay their obligations. In order to improve the situation with attracting funds and improving the financial condition of enterprises, it is advisable that the banking institutions should revise their policy on granting loans, because at present the banking system's financial condition is significantly better than that of the business sector. The dilemma of such a choice is mainly based on the fact that additional lending to troubled enterprises will negatively affect the financial condition of the banking institutions.

It turned out that the number of funds raised from the deposits increased, which is associated with the increase in interest rates. This decision is entirely positive and logical in terms of improving the financial condition of the business sector, as it will allow enterprises to receive more funds from their monetary resources being used. To support business entities, it is desirable that such a policy on setting interest rates should continue.

In order to carry out cash transactions, a decision was made to increase the array of necessary data about the payment transaction to be provided, as well as the information on the subjects of these transactions and much more. Such a measure is quite appropriate in wartime, because it helps increase the reliability and safety of transfers, and makes it easier for banks to keep track of cash transactions. Introducing more requirements for information provision and complicating the execution of transactions of this type is currently impractical because there is a risk that it will slow down transactions' execution and overcomplicate the preparation procedure both for customers and for commercial banks.

A temporary suspension of the stock market activities and securities transactions was expedient at the beginning of the war. It enabled avoiding a market collapse and saving data and property rights, which can be attributed to positive consequences. With the end of the period of shock, it became necessary to resume full-fledged work on conducting securities transactions, because, within the framework of supporting the financial system of Ukraine, it is expedient to bring back business entities the opportunity to receive revenues from securities transactions. That's why the National Securities and Stock Market Commission allowed resuming of these transactions. In this aspect, considering the present economic situation it is advisable that stock market restrictions should not be introduced and the possibility of conducting trades and securities transactions should be maintained.

Summarizing everything described above in this study, it can be stated that the banking system has implemented a wide range of measures to provide businesses with its services and monetary resources. The financial condition of business institutions naturally deteriorated due to military operations, and a decline in general business activity was observed, however, thanks to the commercial banking institutions' activities, the state government managed to reduce the negative consequences of this deterioration.

Among the measures that had the greatest positive impact, it is possible to emphasize the

increase in deposit rates and the resumption of securities transactions.

The main drawback of banking institutions' policies, which negatively affected the state of business, is the restriction on obtaining loans. Taking into account the current financial capabilities of commercial banks, it would be expedient to revise such policies, simplify the procedure of obtaining a loan, and, optionally, reduce the credit interest rates.

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Getting a grasp of the psycho-affective processes and social anomie leading to counterproductive work behaviour (Fox & Spector, 2006) represents a major challenge for researchers and organisations. The Cameroonian context is characterised by widespread impoverishment, which incites some officials to divert the objectives of the prescribed work to their personal interest, with no regard to the damage caused to either the organisation or its members (Nyock Ilouga et al., 2018). This study examines the mediating role of emotions in the relationship between empowering leadership and counterproductive work behaviour. 156 civil servants of both sexes were selected to complete a questionnaire which includes both the Empowering Leadership Questionnaire (Arnold et al., 2000) and the Job Affective-relative Work questionnaire (Van Katwyk et al., 2000). Our results suggest that the emotions felt by employees mediate the effect of perceived empowering leadership on the counterproductive behaviour that employees engage in at work

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I. INTRODUCTION

Counterproductive work behaviour is a complex and dynamic phenomenon. The study of such behaviour requires the consideration of various factors: emergence factors, vulnerability factors and moderating factors (Jauvin & al., 1999). In recent decades, the prevention of deviant behaviour and the promotion of well-being have become the major concerns of public and private companies (Bernaud & al., 2016). This concern becomes alarming in Cameroon where workers evolve in a context characterised by the collapse of the value placed on work, boredom, dissipation, vacuity, apathy and disloyal behaviour (Nyock Ilouga & al., 2018). An investigation by the Cameroonian Ministry of Finance reveals that the country lost nearly 6,000 billion CFA francs between 2012 and 2017 as a result of embezzlement of public funds, desertion at work and unreported deaths (Biaga, 2019). In a bid to identify the causes and eventually find solutions to this phenomenon, researchers pay particular attention to the organisational disinvestment caused by long breaks, repeated absences, presenteeism (El Akremi, 2006), theft, aggression or sabotage (Le Roy, 2010) or any other form of disloyal practice aimed at harming a client, a colleague or the organisation itself (Buss, 1961). The psychodynamic perspective suggest that, these various types of behaviour often reflect a sort of revenge displayed by employees in response to a perceived frustration or injustice (Dejours, 2001). This situation is usually the root of interpersonal conflicts at work (Bies & TRipp, 1996; Kim et al., 1998; Aquino et al., 1999; Le Roy, 2010).

The interest in the psycho-affective mechanisms that precede counterproductive work behaviour stems from an attempt to overcome the obvious limitations of behaviourism, which overlooks the interiority of individuals. However, as El Akremi (2006) points out, the first reaction to frustration is emotional and attitudinal. It is therefore appropriate to admit that the external stimuli for this behaviour is transmitted by psychological

mechanisms. In the same vein, this study examines the mediating role of emotions, expressed as resentment, in the relationship between perceived empowerment leadership and counterproductive work behaviour. Resentment refers to a memory of injustice (or frustration) experienced repeatedly, causing negative emotions which, combined with a feeling of powerlessness, drives the victim into taking revenge (Fleury, 2020). The Cameroonian work environment is dominated by an erratic mode of operation enforced by line managers. Workers must comply with operating rules from hierarchical structures that are rigid and poorly adapted to operational objectives and constraints (Tamekou, 2008). This increases formalism and submission to the detriment of autonomy and creativity. Such a situation is the antithesis of so-called empowering managerial practices and can be a source of frustration for employees.

As a matter of fact, the steps taken by the Cameroonian authorities are barely able to considerably reduce counterproductive behaviour at work. Most of these legal and administrative measures - derived from the situational prevention model in criminology (Clarke, 1980) - focus on prevention, control and repression. It is accepted from a behaviourist point of view that negative reinforcement contributes to the gradual reduction of unwanted behaviour (Skinner, 1938). However, the persistence of counterproductive behaviour in the Cameroonian context leads to a closer look at some of the deeper psychological processes involving emotions and resentment, which motivate the willingness to violate organisational norms and harm stakeholders.

Based on an analysis of leadership practice in some Francophone African countries, Shu (2013) suggested that non-formal socio-cultural criteria such as: dowry, solidarity and the strong involvement of traditional power should be considered when designing and implementing management practices in African organisations. This reality hinders the ambitions of many employees in need of autonomy and a large degree of decision-making latitude in the practice of their professions. This frustration also affects many workers who, due to this managerial difficulty associated with the lack of resources, are bored at work.

1.1 Frustration and negative emotions at work

Based on current knowledge in the field, we know that the increase in counterproductive work behaviour is a structural and systemic problem, rooted in social, economic, organisational and cultural factors (Chappell & Di Martino, 2000; Mayhew & Quinlan, 1999). Several individual, organisational and social factors are associated to it. Some are not work related (personality, family tensions) while others are directly related to work (incomprehension of tasks, impoverishment of workers, boredom and vacuity, perceived leadership). The emergence of counterproductive work behaviour may result from a combination of multiple, interrelated and accumulating factors. According to the explanatory models formulated, emotions play an important role. We can regard emotion as a mental state that triggers one to react in an impulsive and irresponsible manner. As such, emotion remains an intrinsic component of our action insofar as it is integrated in our beliefs and desires. Emotion is a particular state of a being mobilised under well-defined conditions (a so-called emotional state) accompanied by a subjective experience and somatic and visceral manifestations (Doron & Parot, 2004). Whether pleasant or unpleasant, emotions have the common characteristic of not being purely cerebral but rather being accompanied by somatic and physiological modifications. Some theories consider the cognition of emotional sequence as the perception and evaluation of the significance of an event for a person's well-being (Christophe, 1998). These cognitive approaches to appraisal also assume that the nature of emotion is determined by a cognitive evaluation ("appraisal") in which the criteria of usefulness or harmfulness to the organism of a transaction with the environment occupy a central position. Emotion is a temporal process that includes various psychological mechanisms through which an event, a situation will become an emotional stimulus and give rise to an evaluation. In other words, counterproductive work behaviour results

from the negative evaluation of an event that is emotionally perceived as harmful to the person's well-being. The frustrating event gives rise to emotions such as rage, anger, revenge and betrayal although reactions can vary over time and are intimately related to the subjective meaning given by the individual to the event (Fineman, 2008).

In the view of Berkowitz (1998), strong emotions can lead to impulsive reactions. In this light, Fox and Spector's (1999) study clearly links frustration to the increase in counterproductive work behaviour. These authors consider frustration as the main trigger for revenge. What role do stable emotional tendencies play in the expression of the response to a frustrating event? Based on the frustration-aggression model (Dollard et al., 1939), Berkowitz (1989) highlights the role of negative emotions in the relationship between frustration and aggression. From this author's view, aggressive behaviour is a function of the individual's evaluation of a situation and the intensity of negative emotions. Emotion is an adaptive response to environmental stimuli (Plutchik, 1989) that gives way to the formulation of intentions to either engage or not in certain behaviour (Bies & al., 1997).

Following the *Stressor-Emotion Model* (Spector & Fox, 2005), negative emotions do not only result from an unforeseen blockage in the quest for a goal; but also emerge in response to any stressful organisational situation. As such, based on the *Stressor-Emotion Model*, when an employee experiences a frustrating or stressful situation at work, he or she develops negative emotions and feelings and eventually adopts anti-social behaviour. Empirical studies indicate that high work demands, organisational injustice, conflicting relationships with superiors and interpersonal injustice are important sources of frustration that lead to negative emotions in the employee, such as depression, sadness and anger (Bruk-Lee & Spector, 2006; Fox & Spector, 1999; Fox et al., 2001; Miles et al., 2002; Spector & Fox, 2002, 2005. Similarly, a study by Fox et al. (2001) points out that negative emotions are linked to certain stressful variables in organisational settings such as conflict (r= .45), organisational constraints (r= .47), distributive justice (r= .38), procedural justice (r= .44).

The frustration-aggression dynamic model (Dollard et al., 1939) emphasises that counterproductive behaviour is generally used to reduce the tension created by frustration. In this perspective, the individual will only resort to revenge if he or she does not have the right and legitimate means to repair a frustration (or injustice) incurred. The feeling of powerlessness then appears as an indispensable mediator in the relationship between frustration and revenge. As a matter of fact, Bies (2001) point out that negative emotions felt repeatedly form hostile scripts. As such, once the stressful and frustrating situation is felt, negative emotions settle in the individual and a primary and secondary evaluation follows according to the cognitive aspect (arousal of hostile thoughts, memory and affective scripts); the affective aspect (recurrence of hostile and angry feelings) and the conative aspect (transfer of arousal, willingness to engage in hostile behaviour). From the elaborated hostile schemas, the interpretation of ambiguous events feed the feeling of powerlessness resulting to resentment (Fleury, 2020).

1.2 Understanding the dynamics of resentment

Resentment is defined as a memory of injustice that arouses negative emotions accompanied by a desire for revenge. It is a form of resentment fostered by repeated instances of injustice experienced by man in his environment (Fleury, 2020). Resentment in individuals always results from an injury, violence suffered, frustration or trauma to which the victim cannot react directly, due to powerlessness. He therefore ponders his revenge, which he cannot carry out and which torments him incessantly to the point of "explosion".

Schematically, an employee experiences frustration or injustice as a result of a belief in a right that he or she is denied (Greenberg, 1996). This situation can expose the employee to the ordeal of resentment if he or she lacks the possibility of obtaining redress. As Fleury (2020)

points out, the mechanism of resentment is based on "mental rumination", which is a characteristic of bitterness related to the uncomfortable situation experienced and maintained on a daily basis in the psyche with the desire to take revenge; this revenge is not only aimed at repairing the harm incurred, but also to get rid of the negative emotions associated with it.

According to Leventhal (1979), Lang (1985) and Bower (1980), the schematic process of emotions starts from the different components (circumstances, perceptual conditions, expressive, psychological, subjective, behavioural responses) of each particular emotional experience which are represented together in the episodic memory. The recurrence of these emotional experiences with similar elements then leads to the formation of a prototype (generalized pattern) of this class of emotion. Whether manifest or dormant, if this class of emotion is associated to feelings of powerlessness, the individual will be exposed to resentment. Once resentment sets in, the undefined address of the response broadens the target of revenge. This situation helps to deal with a reality that could not be tolerated because it is deemed unfair, unequal, humiliating, unworthy of the merit that one attributes to oneself. (Scheller, 1970).

1.3 The test of empowering leadership in an entropic context

In their analysis, Pinder and Harlos (2001) note that maintaining a culture of perceived unfairness and frustration in a company (with strong control, ambiguous rules, weak evaluations) often makes employees silent, so that they choose to not express their views. Yet leadership needs are constantly evolving to accommodate the fact that workers are the main resources for organisations to thrive in the knowledge economy (Davenport, 2010). Adopting an approach that helps to maximise organisational performance and human capital well-being has become an imperative that forces many organisations and managers to review their leadership practices. Considered as a process of power sharing by line managers, empowering leadership enhances the autonomy, potential, meaning and impact of employees and work teams (Kirkman & Rosen, 1999). Empowerment is a process of enhancing feelings of self-efficiency among organisational members by identifying, eliminating disempowering conditions, increasing resources, expanding room for manoeuvre and empowering people through formal and informal organisational practices of sharing useful information (Conger & Kanungo, 1988). Empowering leadership generally gives rise to prosocial behaviour since it requires formal leaders to encourage subordinates to express their opinions, promote collaborative decision making and support information sharing and teamwork (Arnold, Arad, Rhoades, & Drasgow, 2000; Chen, Bih, Zih, & Tsung, 2011; Pearce, Sims, Cox, Ball, & Smith, 2003). However, Cameroonian workplaces go through a leadership crisis which seems to have abandoned to the workers the responsibility for inventing their functioning mode. This leadership crisis is rooted in the difficulty, already chronic, of moving from bureaucratic and authoritarian style to manage by objectives and control (Nyock Ilouga & Moussa Mouloungui, 2019). In reality, the networks of solidarity in charge of the organisation of professional circles in Cameroon disable the control mechanisms, which are indispensable in management by objectives. Nevertheless, some of the empowering leadership behaviour identified by Arnold and al. (2000) seem to have taken root in this context. These are : 1) *management by example*, which reflects the leader's commitment not only to his work, but also to that of his team members ; 2) *coaching (autonomy)* which is a set of behaviour aimed at empowering team members; 3) *participatory decision-making*, which comprises the inclusion of ideas and opinions of team members into the decision-making process; 4) *consideration (interaction with collaborators)* which is a set of behaviour that promotes the well-being of team members; and 5) *information sharing* which is the dissemination of important information such as information concerning the mission and philosophy of the organisation. These observations suggest the hypothesis that perceived empowering leadership reduces the expression of resentment in employees. This

reduction is amplified by the control of negative emotions (H_1).

II. THEORETICAL RESEARCH MODEL AND DATA ANALYSIS STRATEGY

Baron and Kenny (1986) clarified the roles of the variables involved in a triangular relationship in which one variable (the mediator variable) plays an intermediary role between two other variables (the independent variable and the dependent variable) all involved in an explanatory model. The figure of their mediation model is similar to the following figure:

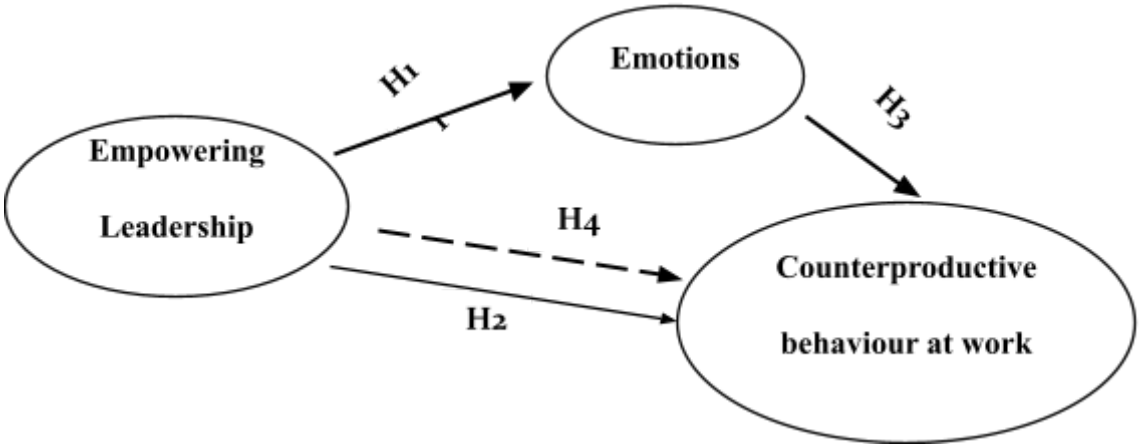

Figure 1: The conceptual framework of the research

This model has three variables, of which it is assumed that the interaction between two (empowerment leadership and emotions), rather than the underlying components, causes the third (counterproductive work behaviour). This structure involves a system of three linear regression equations that enables the materialization of the direct impact of the independent variable (X) on the mediator (M) and on the dependent variable (Y), but also the residual effects of the independent variable (X) and the mediator variable (M) on the dependent variable (Y) when (M) and (X) are introduced simultaneously in the same linear least squares regression equation.

$$Y = \beta_{1.0} + cX + e_1 (E_1)$$
$$M = \beta_{2.0} + aX + e_2 (E_2)$$
$$Y = \beta_{3.0} + c'X + bM + e_3 (E_3)$$

If E_1; E_2; E_3 represent the three linear least squares equations, $\beta_{1.0}$; $\beta_{2.0}$; $\beta_{3.0}$ denote the intercept of each of the three equations; with c' the total effect of X on Y ; the direct effect of X on M ; c' the residual effect of X on Y and b the residual effect of M on Y.

Yzerbyt and al. (2018) recently showed that: when all three conditions are met, mediation is effective if and only if the total effect (c) of the independent variable X on the dependent variable Y (E_1) is greater in absolute value than the residual effect (c') of the independent variable X on the dependent variable Y (E_3). In other words, assuming that all three equations are correctly estimated, the mediation model has an underlying equality that can be formulated through the following fundamental equation: $c = c' + a \times b$. It appears that the difference between the direct effect (c) and the residual effect (c') of X on Y is equal to the product of the direct effect (a) of X on M and the residual effect (b) of M on Y.

In this conception, rather than focusing on the direct benefits of empowering leadership and the role of emotions, Baron and Kenny (1986) mainly focus on the effect of their interaction. There is therefore a high risk of inflation in

multicollinearity when the effects of the independent variable and the mediator on the dependent variable are jointly estimated (E_3). As a result, the independent variable could have a smaller coefficient when it predicts the dependent variable (c) on its own and a larger coefficient when it acts simultaneously in the same equation with the mediator (c'), but the larger coefficient will not be significant while the smaller coefficient would be. In the case where the value of c' is reduced to zero, we have strong evidence of a single dominant mediating variable, whereas, if this same residual effect of *X* on *Y* is non-zero, then several mediating factors are involved. In order to reduce the risk of multicollinearity inflation and to ensure the significance of the mediator effect, the use of the factorial approach suggested by Yzerbyt et al. (2018) is recommended. This approach proceeds to the demonstration that the two coefficients that form the product between the direct effect of *X* on *M* (a) and the residual effect of *M* on *Y* (b) are simultaneously significant.

2.1 Hypotheses

Emotions arise from the stimuli perceived by the individual in his or her environment. This evaluation is further intensified when combined with issues of perceived organisational justice. In a given organisational context indeed, emotions are not always entirely similar in nature, although Rein et al. (1995) concede that negative affect tends to be retained in memory longer than positive affect. Thus, whether positive or negative, the two categories of emotions do not specifically appear in isolation, though agreed that one may dominate the other. Beaud and Pialoux (1999) have noted that even in the most constrained organisations, the most hostile to any form of emergence of worker subjectivity, laughter, humour, joy, anger, hostility or affection are present everywhere. In this vein,

H1: Empowering leadership determines the emotions of employees at work.

The studies of de Arnold et al. (2000) reveal that empowering leadership practices tend to increase pro-organisational behaviour. It is however important to study the effect of this variable on counterproductive work behaviour.

H2: The practice of empowering leadership reduces the occurrence of counterproductive work behaviour.

Following the logic of the *stressor-emotion model* (Spector & Fox, 2005), *the employee's emotional state is expected to determine his behaviour at work (H3).*

In other words, an employee with negative emotional experiences shows more CWB while the expression of positive emotions will likely show less.

H4: The employee's emotions mediate the relationship between perceived empowering leadership and CWB.

Based on the studies of Van Katwik and al. (2000) who distinguish negatives emotions from positives emotions at work, the following sub-hypotheses are formulated:

H4a) Positive emotions mediate the relationship between empowering leadership practices and CWB. This hypothesis

H4b) Negative emotions mediate the relationship between empowering leadership and CWB.

III. METHODOLOGY

3. 1 Participants

This study was carried out with a snowball sample of 156 civil servants from the central administration (78 men and 78 women), serving in different government ministries in Yaoundé, Cameroon. Following the code of ethics and professional conduct for university research, we presented the objectives of the study to the participants and assured them that their anonymity as well as the confidentiality of their answers would be maintained. According to the implied consent method (Fortin et al., 2006), participants who expressed their consent to participate in the study should complete and return the questionnaire freely. In order to better

describe the nature of the sample, the socio-demographic data of the 156 participants are presented in Table 1. It appears majority of the sample is made up of teachers, 33.3%; engineers represent 23.7%; work inspectors represent 14.7%; 11.5% of senior technicians; 15.4% health personnel and 1.3% civil administrators. The average age is 36.1 years and the average professional experience is 7.73 years. Here is a characteristic of the population dominated by youths under 40, where the youngest is 20 years old and the oldest is 59. This age distribution reflects the population of the country, and perhaps of the African continent, which is made up of a large cohort of youths with a low life expectancy and which presents major challenges in terms of employability, health, nutrition etc. (Nyock Ilouga & al. (2018).

Table 1: Sample description

		Frequency	Percentage
SEX	Men	78	50.0
	Women	78	50.0
AGE M= 36.10 years	20-40	109	69.9
	40-60	47	30.1
PROFESSIONAL CATEGORIES	teachers	54	34.4
	Health personnel	24	15.4
	engineers	55	35.2
	Inspectors (postal, work, treasury)	23	14.7

3.2 Material

This research took place within the month of January 2022. Participants were asked to complete a paper-and-pencil questionnaire structured in four main parts.

The first part deals with personal information (age, gender, occupation, work experience).

The second part deals with *the Empowering Leadership Questionnaire (ELQ)* developed by Arnold et al. (2000). This scale provides 38 items distributed into five dimensions. Example: "to what extent does your superior stimulate high performance through his/her behaviour"? Respondents were asked to give their opinion on a five-point Likert-type scale ranging from 1. Never to 5. Always. Items 1-5 measure management by example (α= .89); 6-11 measure participatory decision-making (α= .86); 12-22 measure autonomy (α= .94); 23-28 measure information sharing (α= .89); 29-38 measure interaction with collaborators (α= .93). The overall value of Cronbach's α (0.97) confirms a good internal consistency of this scale.

In the third part, the evaluation of emotions was based on the scale of Van Katwyk et al. (2000). This scale (*Job Affective-relative Work Scale-JAWS*) provides 20 items (Ex: My job irritates me) and measures 10 negative (α= .90) and 10 positive (α= .88) emotions encountered at work. Respondents were asked to express their opinions on a five-point Likert scale ranging from 1) never to 5) very often.

The fourth section measuring counter-productive work behaviour comprises the *Counter-productive Work Behaviour Check list* (CWB-C) by (Spector et al., 2006). This scale was designed using the compilation of certain items from previous scales (Fox & Spector, 1999; Hollinger, 1986; Neuman & Baron, 1998; Robinson & Bennett, 1995; Spector, 1975). Since this study measures the probability of occurrence of CWBs as a result of the employee's feelings, we opted for the actor's (aggressor's) perspective and respondents were asked to rate their frequency of CWBs observation using a five-point Likert scale ranging from 1) never to 5) every day. Example: Verbally abusing a colleague or client.

3. 3 Process of data analysis

Internal consistency tests (Cronbach's alpha) were used to assess the internal consistency between the items of the tools used. Descriptive analyses (means and standard deviations) were also used to summarise the information collected on each variable. To test our different hypotheses, the linear least squares technique was used to solve linear regression equations (Baron & Kenny, 1986).

IV. RESULTS

4.1. Descriptive analysis

The descriptive statistics on the variables show that the average level of positive emotions expressed (M= 3.54) by the Cameroonian civil servant is relatively higher than the level of negative emotions (M= 2.29). The values of the standard deviations are low, which reflect a high concentration of respondents' opinions around the means of the different variables of the study. As regards the dimensions of empowerment leadership, the mean scores obtained are very close to each other and slightly above the theoretical mean on the Likert scale. There are equally very low standard deviations. Nevertheless, it appears that the average score of counter-productive behaviour against individuals (M= 1.73) remains relatively lower than the average score for counterproductive behaviour against the organisation (M= 2.47). It therefore shows that the context of the Cameroonian public service is strongly dominated by counter-productive behaviour targeted against the organisation such as theft and misappropriation of state property as mentioned in the National Anti-Corruption Commission report published in 2020. The analysis of the correlation matrix reveals, on the one hand, very significant links between the different dimensions of empowerment leadership (IV) and, on the other hand, very significant links between these dimensions of the IV and counterproductive work behaviour. It appears that positive emotions are negatively related to CWB while negative emotions are positively related. All these significant correlations show that all our three variables (IV, MV and DV) are jointly related when combined in pairs.

Table 2: Correlation between variables of the research.

Variables	M	SD	1	2	3	4	5	6	7	8
ME	3.791	1.00	1	,						
DECISION T	3.29	1.00	,659**	1						
AUTO	3.35	1.08	,622**	,802**	1					
INFO S	3.30	1.08	,504**	,665**	,821**	1				
INTERAC	3.18	1.06	,510**	,729**	,806**	,668**	1			
NEG EMOT	2.49	0.88	-,338**	-,498**	-,531**	-,558**	-,462**	1		
PO EMOT	3.54	0.80	,331**	,323**	,378**	,406**	,333**	-,547**	1	
CWB O	2.47	1.05	-,366**	-,455**	-,487**	-,509**	-,393**	,551**	-,434**	1
CWB P	1.73	0.96	-,317**	-,409**	-,464**	-,474**	-,359**	,566**	-,357**	,671**

4.2. Hypothesis tests

The results of the relationship hypothesis test from the linear regression analysis indicate that all dimensions of perceived empowerment leadership have a statistically significant effect on employees' emotions. Multiple regression analysis was carried out on SPSS to estimate the direct effects of empowerment leadership dimensions on counterproductive behaviour. These results equally reveal the respective contributions of each empowerment leadership crisis dimensions in the explanation of the variance of the scores obtained during the evaluation of counterproductive behaviour.

Overall, it appears that empowering leadership is a predictor of counterproductive behaviour against the organisation ($R^2_{aj} = 0,222 ; F = 9,861\, p = 0,000$) and the effect of information sharing remains significant ($\beta = -,254 ; t = -2,289 ; p = 0,023$)). However, the effects of other dimensions are insignificant, i.e., management by example ($\beta = -,021 ; p = 0,819$),), interaction with the supervisor ($\beta = 0,068 ; p = 0,551$),), autonomy ($\beta = -0,173; p = 0,275$) and participation in decision making ($\beta = 0,102; p = 0,420$) . Concerning counter- productive behaviour against individuals, the analyses carried out show that empowering leadership practices represent an explanatory factor with a significant effect ($R^2_{aj} = 0,321 ; F = 12,115; p = 0,000$). Among the empowerment leadership dimensions, only the effect of information sharing remains significant ($\beta = -,325; t = -2,763; p = 0,006$)). The effects of other dimensions are insignificant. Namely, management by example ($\beta = -,071; p = 0,476$), interaction with the supervisor ($\beta = 0,42; p = 0,725$),), autonomy ($\beta = -,079; p = 0,637$) and participation in decision making ($\beta = -0,164; p = 0,222$)). The result of this analysis indicates that empowering leadership contributes to a significant reduction in counterproductive work behaviour; this observation confirms our first hypothesis (H_1). Similarly, the effect of empowering leadership practices on employees' emotions turned out to be significant. Empowering leadership specifically helps increase positive emotions ($R^2_{aj} = 0,321 ; F = 6,985; p = 0,000$) in emplo- yees. The effect of the information sharing dimension is significant ($\beta = ,217; t = 2,286; p = 0,02$). The effects of management by example ($\beta = -0,79; p = 0,02$) as well as other dimensions remained insignificant. No signifi- cant indirect effects were observed with manage- ment by example ($\beta = 0,136; p = 0,90$); participatory decision making ($\beta = -0,037; p = 0,734$); interaction with the supervisor ($\beta = 0,061; p = 0,528$)) information sharing ($\beta = -0,217; p = 0,024$) and autonomy ($\beta = 0,001; p = 0,993$).

In terms of negative emotions, it appears that empowering leadership contributes to a significant decrease in negative emotions in employee ($R^2_{aj} = 0,162 ; F12,115; p = 0,000$). With a significant effect for information sharing (.$\beta = 0,217; p = 0,06$)).Regarding management by example ($\beta = 0,071; p = 0,476$)); participative decision making ($\beta = -0,164; p = 0,222$)); interaction with the superior ($\beta = -0,042; p = 0,725$)); autonomy ($\beta = 0,079; p = 0,637$)). These results reveal that potential effects produced by the different dimensions of the leadership crisis may favour the multiplication of counterproductive behaviour against individuals. However, not all the potential effects observed here are statistically significant. In other words, all dimensions of the empowering leadership crisis are involved in explaining this type of behaviour. This result goes in line with Hypothesis 2. The analysis of the effect of emotions on counterproductive work behaviour carried out revealed that emotions felt by employees explain their adoption of counterproductive work behaviour against organisations ($R^2_{aj} = 0,320 ; F = 37,45; p = 0,000$), while the negative emotions expressed tend to favour their multiplication ($\beta = 0,539; t = 5,655; p = 0,000$), the positive emotions felt

rather contribute to their reduction ($\beta = -0,250; t = -2,390; p = 0,018$)). This result indicates a need for leaders to multiply actions that generate positive emotions while avoiding those that may cause negative emotions in employees. This would significantly reduce aggressive behaviour towards their organisations. Furthermore, our analyses revealed that employees' emotions account for their engagement in aggressive acts against people ($R^2_{aj} = 0,315 ; F = 36,575; p = 0,000$). In fact, it appears that the expression of negative emotions significantly increases CWBP ($\beta = 0,585; t = 6,654; p = 0,000$) while positive emotions slightly contribute to their reduction ($\beta = -0,085;; p = 0,392$). This result confirms the third hypothesis of this study.

4.3. The mediation Analysis

To establish the relationship between the three main variables of this study, a mediation analysis was applied. Structural equation modelling was used to ensure the validity of the proposed models. The objective of the structural model test is to evaluate the fit level of the study's model to the data, in order to assess the relationship between each latent variable and the overall model. The goodness of fit of the structural model is verified via the evaluation of the absolute, incremental and parsimony indices.

As such, the results of this analysis, implemented using JASP software under Windows, show satisfactory incremental indices (CFI, TLI, NFI) and parsimony indices (RMSEA and SRMR) for the first model (Table 3).

Table 3: Psychometric parameters of model 1

Fit index of the causal model	Normed chi-square	Chi-square	SRMR	RMSEA	NFI	CFI	TLI
Value	1.939	34.910, ddl=18	0.032	0.078	0.96	0.98	0.97

Statistics in Table 3 indicate a very good fit of the data to the structural model (Shermelleh-Engel & al., 2003). This suggests that the structural model is valid and can be applied to the study population for an explanation of the CWBs.

Since the saturation coefficients of the manifestations of each construct are high and significant, it thus appears that each construct is well informed by its dimensions which represent the different manifestations at the same time. This allows us to test the postulated mediating effect.

4.4 The mediating role of negative emotion

The objective of this analysis is to examine the mediating role of the negative emotions (M) in the relationship between empowering leadership (X) and counterproductive work behaviour (Y). A causal path analysis was used following the structural equation modelling technique (Alger & De Boeck, 2017). The guidelines of Baron and Kenny (1986) were followed in order to verify the respect of the basic postulates of a mediation effect.

Table 4: Multiple regression for model 1

Negative emotions as Mediator	Direct Effect (β)	Indirect Effect (βi*βj)	Total Effect	Effect	Conclusions
EL → NE → CWB	-.44**	-.37 ** (-.76*.49)	-.81**	Full Mediation	Hypothesis accepted

Firstly, these authors mention that, in order to conclude a mediation effect, the independent variable must be related to the mediating variable. This first condition was met, as the regression equation [$M = \beta_{2.0} + aX + e_2 (E_2)$] shows that:

- *Empowering leadership significantly contributes to explaining the variance in negative emotion scores, adjusted R^2 = .32 a =-0.761, z = -6.566, p < .001.*
- Secondly, it is necessary for the independent variable to be significantly related to the dependent variable. This second condition was equally met. The regression equation ($[Y = \beta_{1.0} + cX + e_1 (E_1)]$ reveals that:
- *Empowering leadership contributes significantly to explaining the variance in scores obtained from the assessment of counterproductive work behaviour, adjusted R^2 = .54;$c' = -0.444$;; z = -3.635, p < .001.* Thirdly, the mediating variable must be related to the dependent variable. This third condition was met, as the regression equation reveals that:
- *Negative emotions significantly contribute to explaining the variance in scores obtained from the assessment of counterproductive work behaviour, adjusted R^2 = .54; b= 0.486, z = 5.648, p < .001.*

Finally, according to Baron and Kenny (1986), perfect mediation is observed if the independent variable no longer has an effect on the dependent variable when the mediating variable is controlled. Conversely, if the relationship between the independent and dependent variable decreases but remains significant when the mediating variable is controlled, then a partial mediating effect can be concluded. However, Yzerbyt and al. (2018) have shown that: when the three conditions are met, mediation is effective if and only if the total effect (c) of the independent variable X on the dependent variable Y [$Y = \beta_{1.0} + cX + e_1 (E_1)$] is greater in absolute value than the residual effect (c') of the independent variable X on the dependent variable Y [$Y = \beta_{3.0} + c'X + bM + e_3 (E_3)$]. In other words, assuming that all three equations are correctly estimated, the mediation model has an underlying equality that can be formulated through the following fundamental equation: $c = c' + a \times b$. It appears that the difference between the direct effect (c) and the residual effect (c') of X on Y is equal to the product of the direct effect (a) of X on M and the residual effect of M on Y.

- Since the final condition was also met, *the fundamental equity can be evaluated as follows :By simultaneously including the independent variable (empowering leadership) and the mediator (negative emotions) in the same regression equation, the regression coefficient estimating the residual effects of empowering leadership ($c'_1 = -0,367; p < .001$) remains significant as predictors of counterproductive work behaviour and $|c| > |c'|$.*

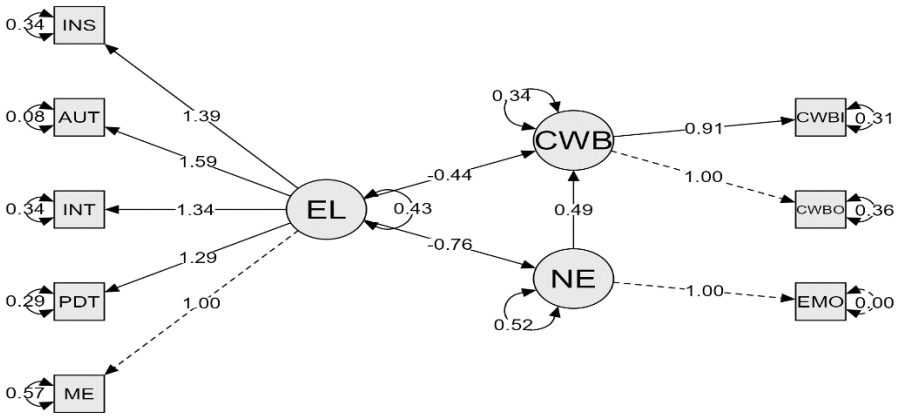

Figure 2: Model 1. *Note:* EL= Empowering leadership, CWB = Counterproductive work behaviour, AUT = Autonomy, INS=Information Sharing, INT = Interaction with the supervisor, PDT = Participative decision-taking, ME = Management by example, NE (EMO) = Negative Emotion, CWBI= Counterproductive work behaviour towards individuals, CWBO = Counterproductive work behaviour towards organisations.

It appears that 45.09% of the effect of empowering leadership on counterproductive work behaviour occurs through negative emotions. This result validates our hypothesis HR_{4a}.

Concerning the second model, the incremental and parsimony indices presented in Table 4 below are quite satisfactory.

Table 5: Model 2 parameters

Fit index of the causal model	Normed chi-square	Chi-square	SRMR	RMSEA	NFI	CFI	TLI
Value	1.896	34.143, ddl=18	0.031	0.076	0.96	0.98	0.97

Statistics in Table 5 indicate a very good fit of the data to the structural model (Shermelleh-Engel & al., 2003). This makes it possible to apply it to the study population for an explanation of the CWBs. Since the saturation coefficients of the manifestations of each construct are high and significant, it thus appears that each of the three constructs (empowering leadership, positive emotion and CWB) is well informed by its dimensions which represent the different manifestations at the same time. The test of the postulated mediator of the positive emotion effect is carried out through a multiple regression analysis and the results are presented in the table below.

4.5 The mediating role of positive emotions

The objective of this analysis is to examine the mediating role of the positive emotions (M) in the relationship between empowering leadership (X) and counterproductive work behaviour (Y). Following the approach outlined above, the first step is assured and reveals that:

Table 6: Multiple regression for model 2

Positive emotions as Mediator	Direct Effect (β)	Indirect Effect (βi*βj)	Total Effect	Effect	Conclusions
EL → PE → CWB	-.68**	-.16 ** (.49*-.33)	-.84**	Partial Mediation	Hypothesis accepted

Empowering leadership significantly contributes to explaining the variance in negative emotion scores, adjusted R^2 = .165; a =493, z = 4.823, p < .001.

Secondly, it is required that both the independent and dependent variables are significantly related. This second condition was equally met and reveals that:

Empowering leadership significantly contributes to explaining the variance in scores obtained from the assessment of counterproductive work behaviour, adjusted R^2 = .44; $c' =. - 0,684$ *; z = -5.194, p < .001.*

Thirdly, the mediating variable must be related to the dependent variable. *This third* condition was met, *as the regression equation reveals that:*

Positive emotions significantly contribute to explaining the variance in scores obtained from the assessment of counterproductive work behaviour, adjusted R^2 = .44; b= 33; z = -3.629, p < .001.

Finally, as prescribed by Yzerbyt et al. (2018), the last condition was also met thus evaluating the following fundamental relation : $c' =- 0,684; a = 0.493; b =- 0.33; c =- 0.845$. *By simultaneously including the independent variable (empowering leadership) and the mediator (positive emotions) in the same regression equation, the regression coefficient evaluating the residual effects of empowering leadership* ($c'_2 =- 0.163; p <.001$) *remains significant as predictors of counterproductive work behaviour and* $|c| > |c'_2|$

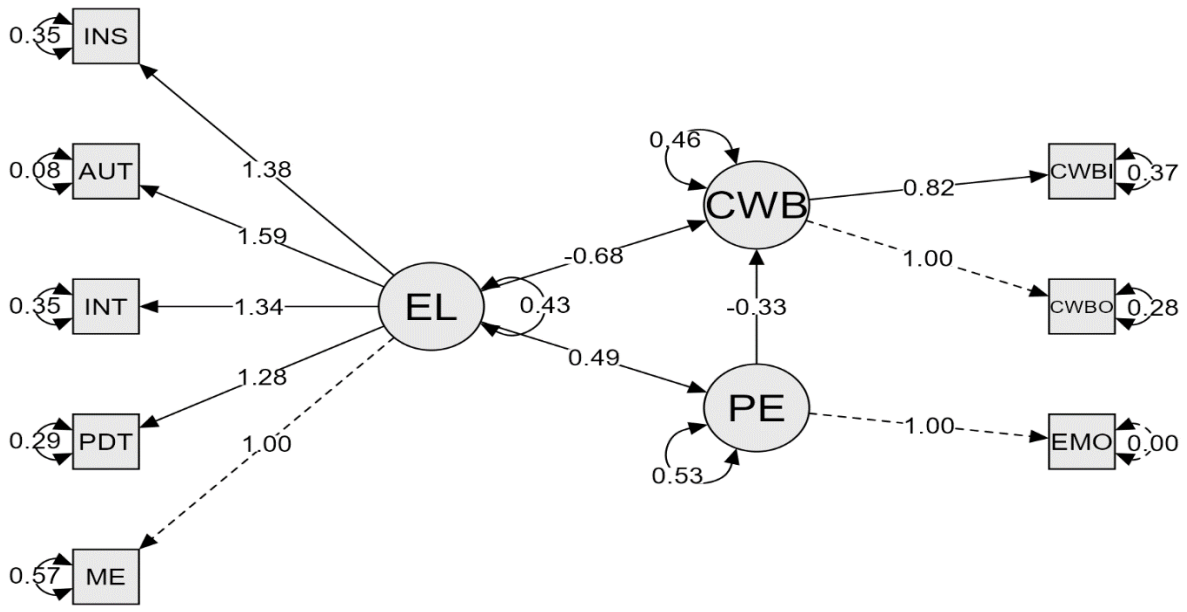

Figure 3: Model 2. *Note:* EL= Empowering leadership, CWB = Counterproductive work behaviour, AUT = Autonomy, INS=Information Sharing, INT = Interaction with the supervisor, PDT = Participative decision-taking, ME = Management by example, PE (EMO) = Negative Emotion, CWBI= Counterproductive work behaviour towards individuals, CWBO = Counterproductive work behaviour towards organisations.

It appears that 19.29% of the effect of empowering leadership on counterproductive work behaviour occurs through positive emotions. This result validates our hypothesis HR_{5b}.

From the analyses carried out, it appears that the emotions felt by employees mediate the effect of perceived empowering leadership on the counterproductive behaviour that employees engage in at work. Furthermore, the mediation of positive emotions significantly reduces CWBs, while the mediation of negative emotions contributes to increasing them. Hence, the severity of transgressions may increase as the discomfort of negative emotional sanctions is intensified. However, empowering leadership practices contribute to increasing positive emotional feelings in employees while reducing negative emotions and CWB.

V. DISCUSSION

The result of this study highlights that in a context where employees experience more positive than negative emotions, they are tempted to engage in very few counterproductive behaviour, although the studies of Rein et al. (1995) acknowledge that negative effect tends to be retained longer in memory longer rather than positive effect. Following this logic, positive emotions can significantly counteract aggressive tendencies. However, if positive emotional sequences occur in a context where employees are dominated by negative emotions, there will be an increase in CWBs against the organisation and individuals. This result is in line with Berkowitz's (1969) model which notes that any unpleasant event (provocation, frustration, unpleasant stimulus...) causes a negative effect, which induces a temporary activation of various thoughts, memories, reactions and physiological responses, making the individual more likely to later act aggressively. It is therefore clear that, out of frustration, civil servants will react directly to the crisis of empowering leadership by adopting counterproductive behaviour against the organisation or individuals, probably when the intensity of the frustration is high. This observation goes in line with the *Stressor Emotion Model* (Spector & Fox, 2005).

The *Stressor-Emotion Model* establishes a linear causal relationship between lack of autonomy, negative emotions and CWBs. This reflects the need to emphasise employees' autonomy and access to information in order to reduce their tendency to engage in theft, embezzlement, corruption, etc., which are rife in the public service today. In his study model, Kelley (1992) points out that in leadership practice, the best followers are committed subordinates who are able to courageously state their views. However, in order to achieve this, managers need to create a framework that enables them to become "exemplary employees". This can only be possible if the manager sets an example and is a role model for the employees.

Bies and his collaborators have found that employees generally also expect managers to treat them with respect, honesty, courtesy and politeness, to care about their rights and well-being and to observe certain moral standards of interpersonal behaviour (Bies & Moag, 1986; Bies, 2001). In this case, the superior appears as a relational partner whose level of respect for the principles of interpersonal behaviour constitutes a criterion for employees to judge his or her fairness (Bies, 2001) and loyalty (Tyler & Degoey, 1996). Moreover, Erhart and Klein (2001) observed in a study that employees would prefer to work with a relationship-oriented leader, as opposed to a charismatic or task-oriented leader.

Previous studies have shown that empowering leadership leads to the development of positive effect and prosocial behaviour at work. This form of leadership is based on a process of power sharing by formal leaders that improves the autonomy, potential, purpose and impact of employees and work teams (Kirkman & Rosen, 1999). This study follows this trend by noting that the crisis of empowering leadership activates negative emotions in employees and leads them to adopt counterproductive work behaviour in response, which may be targeted either against the organisation that employs them, or against individuals working there (authorities and colleagues) or who attend for a service needed (customers).

This study encourages managers to focus more on empowering employees in order to stimulate positive emotions, which are one of the key factors of commitment and prosocial work behaviour. More importantly, these leadership practices help to avoid tensions and resentments within the organisation which can lead to revenge (Fleury, 2020) or counterproductive behaviour (Spector & Fox, 2005).

Similar to previous studies on the model, the emotions felt by the employee are addressed in this study as processes through which certain identified variables contribute to the development of counterproductive work behaviour. Nonetheless, Fida and al. (2015) noted the importance of moral disengagement in the process of an employee violating an organisational norm. Bandura (2016) defines moral disengagement as a set of ways in which individuals rationalise their wrong (unethical) actions. It is the propensity of an individual to use cognitions that allow them to restructure their unethical actions so that they appear less cruel, while mitigating the distress that would result from the harm they cause others. Future research could further explore this relationship by including this mediating variable to better explain anti-organizational behaviour.

Author's contribution and conflict of interest

1. Nyock Ilouga Samuel was responsible for the Conceptuals apects, data analysis and Discussion of the results ;
2. Djigou Jacques was responsible for redaction, littérature review and data collection ;
3. Moussa Mouloungui Aude Carine was responsible for the forms issue, ethical considerations and references.

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Public Policy Issues, Ethics, and Roles of Marketing Research – Concerns and Initiatives

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ABSTRACT

Companies analyze customer information to understand customers better and to generate customer insights. The objective of the study is to analyze various public policy and ethical issues associated with the process. These include intrusions on consumer privacy; misuse, misinterpretation, and misrepresentation of research findings; ethical and social dilemma in the collection and analysis of customer information; and ethical dilemma in the generation of customer insights with the application of neuromarketing. The methodology adopted is a conceptual analysis of these approaches. Companies and researchers find it easier to invade consumer privacy in the digital age. Companies strive to behave responsibly by abiding by the laws and regulations enforced to protect customers. Addressing the issues promptly and effectively will allow companies to convince customers, to build effective customer relationships, and to achieve business excellence. Policymakers may be able to appreciate customer requirements and preferences better and formulate policies, rules, and regulations accordingly.

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I. INTRODUCTION

Companies are able to develop superior offerings and marketing programs when they have relevant information and knowledge about customers. Companies require relevant information not only about their customers but also about their competitors, resellers, and other actors and marketplace forces (Tajudeen, Jaafar, & Sulaiman, 2016). The information helps companies to gain powerful consumer and market insights. Collection and analysis of customer information and generation of customer insights are not possible without companies maintaining a proper marketing research process (Malhotra & Dash, 2016). Companies may face a number of issues in the collection and in the analysis of information in marketing research and in the generation of customer insights. There are various public policy issues and ethical concerns. Companies should be aware about these public policy issues and ethical concerns related to marketing research (Bakardjieva & Kimmel, 2017). A company which is involved in the various activities related to marketing research and its customers benefit from the activities. However, both companies and researchers may misuse research findings for their own selfish interests. Such misuse of research findings may cause harm to customers. Customers may develop negative perceptions about companies. Relationships of customers with companies may be affected (Adediran, 2012). Two of the most important concerns in public policy issues and ethics in marketing research relate to intrusions on consumer privacy and the misuse, misinterpretation, and misrepresentation of research findings (Mandal, 2018). Even when both companies and consumers themselves may be serious about protecting consumer privacy, it may be difficult to protect consumer privacy in the digital age. Individuals, knowingly or unknowingly, share a lot of information online. The information shared might be accessed by companies. Public policy issues and ethics are involved because of the manner in which customer information is used (Mandal, 2019a). Such issues are important because these issues not only affect the customers but also affect the society at large. Various public policy issues and ethics involved in the collection and analysis of customer information in marketing research are discussed in the study. Both companies and

researchers should be aware about such issues while conducting marketing research.

The importance of public policy issues and ethics regarding collection and analysis of customer information in marketing research and generation of customer insights cannot be overemphasized. So, both marketers and academicians should study and analyze the roles of public policy and ethics in marketing research and in gaining customer insights. It is necessary to conduct an in-depth analysis about the issues. However, few studies focus on this important issue. The study aims to address this research gap.

The objective of the study is to conduct a conceptual analysis of the various public policy and ethical issues related to the collection and analysis of customer information in marketing research and generation of customer insights.

The methodology adopted is a conceptual analysis of the literature related to public policy and ethical issues involved in the collection and analysis of customer information in marketing research and in generation of customer insights. The latest and the relevant literature on public policy and ethical issues related to marketing research in the digital age are searched. The literature mainly consisted of research papers published in top-tier academic journals on the topics. Research papers published recently and research papers with more citations in prominent journals are studied and analyzed. The research papers published in the last five years (2016-2022) have been given higher emphasis. The research papers are collected from SCOPUS, Web of Science, Proquest, and other prominent databases. Primary data is not collected and empirical analysis is not done in the study. Also, the study is conducted mainly in the context of the United States.

The novelty and the contributions of the study lie in the fact that a thorough conceptual analysis of the literature and the issues associated with public policy and ethical issues related to collection and analysis of customer information in marketing research and generation of customer insights is done. Academicians, researchers, and marketers will be able to appreciate what all aspects they need to keep in mind while approaching and investigating customers for collection and analysis of information. They should be ethical in all these aspects while dealing with and interacting with customers. Otherwise, the sentiments of customers might be hurt and they might be offended. Based on the discussions and the analysis done in the study, policymakers will be able to understand the actual requirements and preferences of customers. Such understanding and insights about customer requirements will help them to formulate the policies, rules, and regulations better.

The study is structured as follows:

Section 2 discusses about the intrusions on consumer privacy in the digital age. Marketing research findings may be misused, misinterpreted, and misrepresented, and these issues are discussed in section 3. Ethics related to collection and analysis of information about customers are discussed in section 4. Ethics and social dilemma related to collection and analysis of customer information are discussed in section 5. Neuromarketing is a recent development in the field of psychology. Neuromarketing is applied in the field of marketing to understand and to analyze consumer psychology. Neuromarketing, its applications, and the ethical dilemma associated with it are discussed in section 6. Responsibilities of marketers and initiatives taken by companies to protect customers are discussed in section 7. The salient points of the study are discussed in section 8 with sub-sections 8.1 and 8.2 highlighting the theoretical implications and the managerial implications of the study respectively. Section 9 concludes the study with sub-sections 9.1 and 9.2 highlighting the limitations of the study and the avenues of future research respectively.

II. INTRUSIONS ON CONSUMER PRIVACY AND SECURITY IN THE DIGITAL AGE

Consumers are positive about marketing research. They support collection and analysis of data by researchers. They feel that marketing research serves a useful purpose. They also enjoy being interviewed and providing their opinions

(Dauxert, 2019). However, some respondents strongly resent or even mistrust marketing research. They are suspicious about the objectives with which information is collected from customers. They worry that companies build customer databases based on the information collected. The databases contain personal and sensitive information about customers. Individuals fear that companies and researchers may analyze the stored information by applying sophisticated techniques to understand the deepest feelings, track internet and mobile device usage to understand the buying behavior of customers, and then may apply the knowledge to influence customers. Americans are suspicious about the collection, analysis, and usage of their personal information. In a recent survey, 90 percent of the respondents felt that they have lost control over the collection, analysis, and usage of their personal information. They feel that companies and researchers keep track of the information shared by them on social media and use them for satisfying their own selfish motives (O'Connor & Schmidt, 2018).

Customers were worried about the retail giant, Target when it used their buying histories to understand sensitive insights about them (Zhu, Song, Ni, Ren, & Li, 2016). Customers were worried about the intentions of Target because Target used the information to figure out details about those customers who were expecting babies. Target even tried to estimate the due date of delivery and the gender of the child. Such activities are unethical and illegal (Zhu et al., 2016). Customers felt that Target would get access to sensitive information related to customers.

Target provides its customers with a Guest ID number, credit cards, and e-mail addresses. Target uses such customer information along with demographic information from other sources to track customers' purchases in details (Zhu et al., 2016). Target studied the buying behaviour of women who had previously signed up for its baby registries. Target developed a "pregnancy prediction" score for each customer based on the information collected. The score was developed by analyzing the purchasing patterns of customers across 25 product categories. Based on the scores, Target started sending personalized coupons for baby-related items to expectant parents at each of their pregnancy stages (Zhu et al., 2016).

Target was able to understand expectant parents and their requirements better when it targeted them. Target could convert such customers into loyal buyers as their families developed (Zhu et al., 2016). However, the strategy had limitations and it backfired. Customers felt that Target was intruding into the privacy of customers. An angry man visited a local Target store and complained that his high-school-aged daughter was receiving offers from Target. Coupons for strollers, cribs, and maternity clothes were offered by Target. "Are you trying to encourage her to get pregnant?", the angry father demanded. The store offered an apology to the father. It was also revealed that Target knew about the young woman's pregnancy much before her father did. Many customers also disapprove the fact that Target knew about their pregnancies even before they had told their families and close friends. Customers were also suspicious and worried about what else Target might be tracking and profiling. They were suspicious about the intentions of Target (Zhu et al., 2016). One reporter concluded, "The store's bulls-eye logo may now send a shiver.... down the closely-watched spines of some Target shoppers" (Zhu et al., 2016).

Marketers are able to intrude on consumer privacy because of the recent developments in the field of information technology in the digital age. However, marketers and researchers should ensure that they do not intrude on consumer privacy when they mine customer information (Weiss, 2020). Also, marketers and researchers find it difficult to collect and to analyze customer information and customer details without intruding on consumer privacy. For example, is it a good thing or a bad thing that some retailers use mannequins with cameras hidden in one eye to record customer demographics and buying behaviour in order to serve them better? Critics also argue whether it is ethical for marketers to keep a track of the online activities of individuals on social media sites like Facebook, Twitter, YouTube, or Instagram in an effort to be more

responsive. Critics are worried when marketers track consumers' mobile phone usage and mobile phone locations to issue location-based information, advertisements, and offers to serve their customers better.

Companies keep a constant track of customer activities to collect information. For example, SAP's Consumer Insight 365 service helps mobile service providers to "extract data about subscribers (and their) mobile-centric lifestyles" (Farnsworth, Lawler Kennedy, & Kumar, 2016). It ingests as many as 300 mobile web surfing, phone call, text messaging, and other mobile events per day for each of 20 to 25 million mobile subscribers across multiple carriers. Marketers are able to know about their customers better from the data. As one analyst comments that by combining mobile data with other information, it can be ascertained "whether shoppers are checking out competitor prices on their phones or just emailing friends. It can tell them the age ranges and genders of people who visited a store location between 10 am and noon, and link location and demographic data with shoppers' web browsing histories. Retailers might use the information to arrange store displays to appeal to certain customer segments at different times of the day, or to help determine where to open new locations" (Huang, Fildes, & Soopramanien, 2019). Companies are able to target customers better with the help of such information. However, it becomes difficult for companies to maintain consumer privacy in the process (Palmatier & Martin, 2019a).

Consumers are worried and concerned about their own privacy. Consumer privacy is a major issue of concern now-a-days in the marketing research industry (Kumar & Reinartz, 2018). Companies should maintain a balance and they need to optimize between generating customer insights from the collected information and maintaining consumer privacy and consumer trust. Customers also want to create a balance between personalization and privacy. They prefer customization based on their needs and preferences. At the same time, customers dislike the fact that companies keep a close watch and track their information (Thomaz, Salge, Karahanna, & Hulland, 2020). The key question remains: When does a company cross the line in gathering and using customer data?

Marketers should consider consumer privacy seriously and should try to protect it. They should be active and prompt in addressing privacy concerns of customers. Customers may be irritated and frustrated if companies are unable to address issues related to consumer privacy. Failure to address consumer privacy may also result in increased government intervention. It affects customer trust and customer relationship in the long run. The industry adopts a number of measures and takes a number of initiatives to address the issues (Yun, Lee, & Kim, 2019). One example is the Marketing Research Associations' *Your Opinion Counts* and *Respondent Bill of Rights* initiatives. Such initiatives instil trust and belief in the minds of customers that companies are serious about the opinions and suggestions provided by customers. Such initiatives also allow customers to understand the benefits of marketing research and to distinguish it from telephone selling and database building (Mandal, 2019b).

Customers should have the perception and the assurance that companies care about them and are serious about protecting consumer privacy. Companies adopt a number of measures and initiatives to protect consumer privacy. A chief privacy officer (CPO) is employed by many companies like IBM, American Express, Apple, Facebook, Microsoft, and even the U.S. government. Safeguarding and protecting the interests of customers are the primary responsibilities of CPO (Kumar & Reinartz, 2018). Customers provide information gladly if they are convinced that companies are delivering value. For example, customers are open to providing information if they feel that such information will help companies provide future product recommendations. Time is saved and companies are able to provide value if customers are convinced about the intentions of companies (Campbell, Sands, Ferraro, Tsao, & Mavrommatis, 2020). Marketers and researchers should ask for only the information they need, use it responsibly to provide customer value, and should avoid

sharing information without the permission of customers.

III. MISUSE OF RESEARCH FINDINGS

Findings obtained through marketing research may be employed as powerful persuasion tools. Companies use research findings to substantiate their claims in advertising and promotion. At present, however, many research studies appear to be little more than vehicles for pitching the products of sponsors (Crosswell, 2020). Companies sometimes design research surveys in a way so that they obtain the intended results. For example, a Black Flag survey once asked: "A roach disk .... poisons a roach slowly. The dying roach returns to the nest and after it dies is eaten by other roaches. In turn these roaches become poisoned and die. How effective do you think this type of product would be in killing roaches?" As was expected, a majority of the respondents (79 percent) responded positively.

Research designs are tampered with and research findings are misused, misinterpreted, and misrepresented by a number of marketers, research agencies, and advertisers. Most abuses tend to be mere subtle stretches (Kang, Shin, & Ponto, 2020). The interpretation, authenticity, reliability, and validity of such research findings are questioned by critics and experts. Again, research findings are interpreted, influenced, and judged based on the perceptions, interests, and knowledge of researchers combined with their individual preferences and biases.

Critics and experts recognize and accept that marketing research can be abused, misrepresented, and misinterpreted (Mandal, 2018). Several organizations and associations are involved in the development of codes of research ethics and standards of conduct. The roles of these organizations and associations are to ensure the integrity of marketing research. These include the Council of American Survey Research Organizations (CASRO), the Marketing Research Association (MRA), and the American Marketing Association (AMA). For example, the CASRO Code of Standards and Ethics for Survey Research provides guidelines about the responsibilities of researchers towards respondents while conducting research. Regulations regarding privacy, confidentiality, and avoidance of harassment are highlighted. The manner in which results are reported to clients and to the public are of major concern. Such concerns and responsibilities are also highlighted (Smith, Pandit, Rush, Wolf, & Simon, 2016).

Major issues related to misuse of marketing research findings can be solved if researchers assume responsibility for their own actions. Companies and researchers should accept responsibility for policing the conduct and reporting of their own marketing research. The interests of customers, companies, and researchers will be protected in this manner (Vriens, Brokaw, Rademaker, & Verhulst, 2019).

IV. MARKETING ETHICS IN COLLECTION AND ANALYSIS OF CUSTOMER INFORMATION

It is imperative for organizations to remain ethical in their actions. Organizations should have a strong sense of ensuring ethics in business while conducting marketing research and more specifically while collecting and analyzing information from customers (Yallop & Mowatt, 2016). Ethics should form the basis of all operations performed by companies. An ethical orientation must be integrated in the marketing strategies and in the decision making of companies. The American Marketing Association stipulated the following specific guidelines for conducting marketing research: (1) It prohibits selling or fund-raising under the guise of conducting research, (2) it supports maintaining research integrity by avoiding misrepresentation or the omission of pertinent research data, and (3) it encourages the fair treatment of clients and suppliers (Eisend & Kuss, 2019; Ingram, LaForge, Schwepker, & Williams, 2007). Various marketing research societies specify the duties and responsibilities of marketing researchers while conducting research so that the rights of subjects are protected. All rules and regulations related to marketing research are formulated so that marketing research produces unbiased and factual

information and decisions are taken based on authentic information (Malhotra & Dash, 2016).

Technological developments allow companies and researchers to collect information easily. However, increased application of advanced technologies results in potential threats to customer information. The threats grow in number and in intensity (Mathu, 2019). The collected data can be abused and accessed without authority. Marketing researchers should act promptly to prevent these. Stored data can be abused easily and this has been proved a number of times when security breaches happened at some of the largest banks, retailers, credit-reporting services, and peer-to-peer networks of the United States (Graves, Acquisti, & Christin, 2018). Customers are concerned about preserving and ensuring their fundamental rights to privacy. Consequently, customers want to be assured that the information collected from them are kept secured.

The respondents in marketing research surveys should be informed by firms that participation is voluntary, and the information collected will not be shared with or sold to any other firm (Malhotra & Dash, 2016). Advanced marketing research tools like neuromarketing and facial recognition software are employed by firms (Stanton, Sinnott-Armstrong, & Huettel, 2017). It is ensured that companies and marketing research agencies receive consent from consumers before collecting information. For example, Coca-Cola conducts neuromarketing experiments. Facial expressions of participants are recorded when they watch advertisements or prototypes. Eye movements of the participants are tracked. Also, responses are collected only from those respondents who provide consent to having their data to be recorded (Hsu, 2017).

Facial expressions of participants are recorded and analyzed by firms with the help of facial recognition software. Demographic information of participants is predicted based on their appearances (Spivak, Krepych, Faifura, & Spivak, 2019). For example, facial recognition software identifies passers-by, analyzes their faces and then displays advertisements based on their gender, age, and attention level (Chien, Wu, & Luor, 2019). Such analysis and prediction help companies to do targeted communication which is more interesting and captivating to the consumer walking by. Companies may sometimes be embarrassed by such initiatives. For example, a teenager with skin problems may be shown a broadcast of an acne product while he walks by.

Several organizations try to ensure that consumer privacy is protected and try to keep a close watch on the information collected from customers. These include the Center for Democracy & Technology (CDT) and the Electronic Privacy Information Center (EPIC). A number of initiatives are also taken by different national and state governments in the United States to protect consumer privacy. Rules and regulations require that privacy policies and practices of companies be disclosed to customers on an annual basis (Berle, 2020). Stringent laws are formulated by the U.S. federal government to protect consumer privacy on the internet. Legislation is formulated by several states to protect privacy. However, it becomes difficult for companies to strictly adhere to different policy regulations across the country. Companies also find it difficult to conduct business on the internet (Peasley, 2019).

Facial detection software in Facebook allows users to tag a person only once. The same person gets tagged automatically in other photographs because of the software (Joshi, Damle, & Kumar, 2018). The software stores biometric data of users. Biometric data include one or more physical traits such as facial characteristics, iris scans, or fingerprints. Facebook users have the option of turning off facial detection. However, they cannot prevent Facebook from getting their biometric data collected. Because of all these issues, in countries like Germany and other countries within the European Union, strict privacy laws and regulations are enforced. Regulators have demanded that Facebook stop collecting any biometric data (Gerrish & Idi, 2019).

V. COLLECTION OF CUSTOMER INFORMATION AND ETHICAL AND SOCIAL DILEMMA

Information is collected from customers by retailers by capturing the attention of customers with the help of innovative ideas and techniques. Several retailers spend $5000 to purchase an EyeSee mannequin from a provider called Almax. Retailers receive dual benefits because of the mannequin. Retailers are able to display clothing and record details of customers like genders, ages, and ethnicities (Sarstedt & Mooi, 2019).

The usage of mannequin has resulted in controversy and debate because of the implications of the innovation. Critics accuse that permission from customers is not sought when retailers collect sensitive customer information with the help of mannequins. Although Almax claims that the technology applied does not store customer information, critics argue that shoppers are surveyed without consent being taken and the technology is used for the benefit of the retailer (Sarstedt & Mooi, 2019). Information about shoppers is collected without the shoppers realizing that something is watching them. Also, the information might be collected without their knowledge and consent. Moreover, customers do not have control over what retailers do with the collected data (Palmatier & Martin, 2019b).

Retailers try to convince critics that mannequins do not record any data. Consequently, the usage of mannequins can be considered the same as that of a closed-circuit system (Enerstvedt, 2017). Some critics argue that privacy should not be expected by individuals in public places. Any employee could have recorded the details of an individual who walks through the shop doors. The electronic system only performs the job faster and more accurately (Palmatier & Martin, 2019b).

The technology used in mannequins helped retailers to reap benefits. The predominance of Asian shoppers after about 4.00pm was recognized by one retailer. Consequently, it recruited a greater number of Chinese-speaking individuals to assist the Asian shoppers (Sarstedt & Mooi, 2019). For another retailer, it was revealed that children were visiting the stores more. So, it displayed products for children more than they displayed other products. Almax succeeded because of such initiatives based on analysis and prediction. It plans to record and to analyze conversations of shoppers to generate better customer insights and to serve their customers better (Sarstedt & Mooi, 2019).

Retailers are allowed by legislation to maintain cameras and to record customers for security purposes. However, retailers should inform customers that their activities are being recorded (Abdullaev, Al-Absi, Al-Absi, Sain, & Lee, 2020). However, it is argued by critics that retailers use mannequins for marketing and commercial gains rather than for ensuring security of customers. Also, the technology used is not revealed by retailers. For example, Almax did not disclose the names of any of its clients citing the privacy requirements of clients (Sarstedt & Mooi, 2019). Experts believe that it is difficult to believe and to convince customers that mannequin which records almost every detail of shoppers, do not intrude their privacy. In the long run, customers may start avoiding those retail stores that use this technology (Sarstedt & Mooi, 2019).

VI. APPLICATIONS OF NEUROMARKETING AND ETHICAL DILEMMA

Neuromarketing is the science of studying human minds with the help of analysis of human brains (Meyerding & Mehlhose, 2020). Now-a-days, neuromarketing is having a number of applications in marketing research. Neuro-marketing helps in understanding the minds of customers and in gaining customer insights. Neuromarketing helps to recognize and to analyze facial expressions and has the ability to read minds of consumers. Neuromarketing uses wireless electroencephalogram (EEG) scanners that measure the involuntary brain waves that occur when they view a product advertisement or a brand (Jayashree & Rao, 2020). Marketers are able to read the minds of consumers and are able to understand their imminent feelings. Marketers are able to understand customer preferences from such insights. Based on the results of a series of neuromarketing studies, Campbell's modified its

logo on soup labels. The company emphasized that soup increases customers' emotional responses to the cans (Gurgu, Gurgu, & Tonis, 2020). Marketers and researchers are able to understand their customers better because of neuromarketing. However, the potential for abuses for such tools is immense. Also, consumers may not approve marketers of reading their brain waves and marketing goods and services to them in a manner that bypasses their conscious thoughts (Bayle-Tourtoulou & Badoc, 2020). Critics question whether it is ethical to read the minds of customers. It is also questionable whether it is ethical to apply brain mapping for understanding the psychology of customers (Spence, 2020). Neurofocus is a company which applied neuromarketing to collect and to analyze customer information. Such analysis would have been difficult to obtain by using traditional research methods (Gurgu et al., 2020). However, it is questionable and debatable to apply such tools for collecting and for analyzing customer information.

VII. RESPONSIBILITIES OF MARKETERS AND INITIATIVES TAKEN

Public policy and ethical issues related to marketing research are of concern and organizations should act responsibly. Some of the major issues include intrusions of consumer privacy and misuse, misinterpretation, and misrepresentation of research findings. Permission and consent should be taken from those customers whose information is being collected (Malhotra & Dash, 2016). Marketing researchers should inform and explain to customers that the information collected will not be misused and will be used only for research purposes. Information from customers should not be collected in the guise of marketing research and with the intent of using the information for marketing gains (Kolb, 2017). Marketers and researchers should take the responsibility of protecting the information collected from customers. Companies and researchers should assure customers that they really care for customers and everything is done to ensure and to protect consumer privacy.

Many companies realize the importance of consumer privacy and security. They take initiatives which ensure the welfare of customers. Companies try to place the interests of customers first when they think of collecting customer information (Melanthiou, Evripidou, Epaminonda, & Komodromos, 2020). Several companies like Microsoft, IBM, American Express, Facebook, Citibank, and others have appointed a Chief Privacy Officer (CPO). CPO has the major responsibility of ensuring the privacy and security of customer data. CPO requires to coordinate with all other functions in the organization like technology, legal, accounting, marketing, sales, services, and communications. All the functions should work in coordination to ensure consumer privacy (Mandal, 2019b).

Various policies and measures are adopted by companies to convince customers that companies really care for the welfare of consumers. Several companies have a formal written code of ethics which is shared with all the stakeholders. Ethical guidelines are followed by companies. They strive to build and to develop a culture of ethical behaviour in the organization. Employees are held responsible for observing ethical guidelines while collecting information about customers (Mandal, 2019b). Google is a company which is known for its ethical culture. It follows ethical guidelines while dealing with customers. Google has earned this reputation in the corporate world by supporting a touch-feely work environment, strong ethics, and its basic guiding principle: "Don't be evil" (Race, Randall, Rouncefield, & Slack, 2020).

The methods adopted by companies for collection of customer information may be disliked by customers. Customers may vent out their displeasure or frustrations about a company through various communication tools and techniques available to them. Previously, customers could express their opinions to a small group of individuals. However, now-a-days, with the availability and the usage of the internet, individuals may connect with anyone on the social media to express their dissatisfaction and frustration (Dimitrova & MacKay, 2017). Positive word of mouth travels fast. Negative word of

mouth travels faster. Negative word of mouth may damage the reputation and the image of companies. For example, Microsoft has attracted a number of anti-Microsoft websites. The distrust of companies among U.S. customers is evident in research showing the percentage of customers who view corporations unfavourably has reached 26 percent (Sullivan, 2009). Codes of ethics should be formulated and ethical guidelines should be devised by companies keeping all such issues in mind. Such initiatives allow companies to safeguard their customers.

Now-a-days, marketing research activities by companies are related to performance marketing. It includes understanding returns to the business from marketing activities and programs, as well as addressing broader concerns and their legal, ethical, social, and environmental effects (Riswanto, Hurriyati, Wibowo, & Hendrayati, 2020). Performance marketing has a wide scope which includes understanding not only the financial returns but also the non-financial returns to business and society from various marketing activities and programs (Ikonen, Luoma-Aho, & Bowen, 2017). The impact of marketing research on the marketing scorecard is studied and analyzed by top companies and marketing research agencies. They also consider the legal, ethical, and environmental effects of marketing research and collection and analysis of customer information (Kreutzer, 2019).

Sometimes, companies may be able to convert an admittedly deceptive stunt into a huge PR win (Trusov, Bodapati, & Bucklin, 2010). Heineken wanted to collect relevant customer information and insights. Heineken was aware that young European adult males are extremely passionate about football. Heineken understood that it would be easier to generate customer insights if it utilized the opportunity effectively. A fake musical concert was arranged during a crucial Real Madrid versus AC Milan football match. The match was shown on a big screen during the concert. The reactions of the audience were witnessed by more than 1.5 million people on live SkySport TV. More than five million visitors visited the Heineken website devoted to the event. Sufficient customer insights were generated by Heineken from the event. The initiative resulted in a win-win situation for both Heineken and its customers. Subsequent PR and word of mouth made it a world-wide phenomenon (Barry, 2010).

VIII. DISCUSSIONS

Companies and marketing researchers collect information about customers, analyze the information, and generate customer insights. This process of collection, analysis, and generation of customer insights has pros and cons. The process of generating customer insights allows companies to understand their customers better. However, there are a number of public policy and ethical issues associated with collection and analysis of customer information in marketing research, and subsequently, with generation of customer insights. Customers worry about the privacy, safety, and security of the information shared by them with companies and marketing researchers. Companies ensure welfare of customers during the entire process. However, in many instances, companies collect and analyze information provided by customers to fulfil their selfish business motives. Companies sometimes intrude on consumer privacy in the process of collection and analysis of information from customers. In some cases, companies and research agencies modify and misuse the research findings to serve their own selfish motives. Although it is imperative for companies to collect and analyze customer information to generate customer insights, critics and experts emphasize that companies and researchers should not cause harm to customers in the process. On the contrary, they should adopt measures and initiatives which ensure welfare of customers and which build a sense of trust and belief in the minds of customers. They should adopt measures so that research findings are not abused, misinterpreted, and misrepresented. They should formulate and enforce proper rules and regulations to protect customers and to ensure their welfare. Customers prefer companies which they feel are ethical in their actions. Consequently, companies and researchers should remain ethical while collecting and analyzing customer information in marketing research. It becomes difficult to remain ethical because ethical and social dilemma are involved

in the process. Nevertheless, to ensure that they remain ethical, companies and researchers should be truthful to themselves and should abide by marketing research agencies to understand consumer psychology by analyzing their brains. Critics worry that companies and researchers may know more than they are supposed to know about customers. Companies and researchers apply new and innovative techniques to know about customers. Neuromarketing is a process which allows researchers to understand and to interpret the innermost feelings of individuals. Critics worry that companies and researchers may take undue advantage of those feelings. Companies and research agencies should act responsibly to protect the interests of customers. They should respect consumer privacy, should not misuse research findings, should abide by the rules and regulations formulated to protect customers, and should be proactive in assuring their customers that customer welfare is of prime importance.

8.1 Theoretical Implications

Academicians and researchers will have a proper understanding of the public policy and ethical issues related to the collection and analysis of customer information, and the generation of customer insights. They will be able to appreciate the importance of such issues based on the discussions done in the study. They might conduct an in-depth analysis of the issues. They might analyze the existing rules and regulations and then suggest rules and regulations which will be more effective in providing better privacy and security for customers, in reducing misuse, misrepresentation, and misinterpretation of research findings, and in creating stronger bondage between customers and companies. The discussions might also help academicians in developing theoretical models which will help in understanding the issues and in suggesting better solutions. Overall, the discussions might help policymakers to understand customer requirements and customer concerns better. This in turn will help policymakers to formulate policies, rules, and regulations which will protect the interests of customers effectively.

8.2 Managerial Implications

Managers will understand and realize the importance of consumer privacy, safety, and security. Consumer privacy should be ensured to win customer trust and to develop long-term customer relationships. Managers collect and analyze customer information to generate customer insights. In the process, research findings may be tampered with. However, managers should ensure that the research findings are not misused, misinterpreted, and misrepresented to serve the selfish motives of companies. Managers should remain ethical in the collection and analysis of customer information and in the generation of customer insights. They should respect and should abide by the rules and regulations formulated for ensuring consumer privacy and for protecting customers. Strategies should be formulated and initiatives should be taken keeping all these aspects in mind. Companies might also provide valuable inputs for policy formulations to protect customers. Policymakers may receive assistance from managers in devising the policies, rules, and regulations. Overall, companies should be aware about their roles and responsibilities towards ensuring consumer welfare and the welfare of the society at large.

IX. CONCLUSIONS

Marketers and researchers collect and analyze customer information to generate better customer insights. Various aspects related to collection and analysis of customer information and generation of customer insights are highlighted and discussed in the study. The major public policy and ethical issues in the process are related to intrusions on consumer safety, security, and privacy in the digital age; misuse, misinterpretation, and misrepresentation of marketing research findings; ethics and social dilemma involved in the collection and analysis of customer information; and ethical dilemma involved in the application of neuromarketing in understanding consumer psychology. Companies should be responsible and should ensure welfare of customers and welfare of the society at large. They should adopt strategies and undertake

initiatives to fulfil those responsibilities. All such activities will develop trust and belief in the minds of customers, will help in developing effective customer relationships, and will result in a win-win situation for both customers and companies.

9.1 Limitations

The study conducted a conceptual analysis of the literature on various public policy and ethical issues in the collection and analysis of customer information and in the generation of customer insights. Primary data is not collected and empirical analysis is not done. Empirical analysis might have provided results which are actionable. Also, the discussions done in the study focused mainly on the issues related to the United States. The public policy and ethical issues might be different in other markets and in other countries.

9.2 Avenues of Future Research

Researchers may study and analyze the various public policy and ethical issues in connection with the collection and analysis of customer information and the generation of customer insights. They might study and analyze the existing laws and regulations and suggest laws and regulations which are more effective. Researchers might collect primary data and might conduct empirical analysis. Such analysis will allow researchers to suggest measures which are actionable and implementable. The study is conducted in the context of the United States. Other than the United States, researchers may conduct research to extend the discussions in the context of countries where different rules and regulations might be applicable. Researchers might investigate how the measures and initiatives will apply or differ and the set of measures and initiatives which might be applicable in the context of different markets and countries.

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ABSTRACT

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Keywords: time series, forecasting, neural network, data preprocessing, training and control samples, pandemic, coronavirus infection, russia, moscow, deductor studio, data clearing, partial processing, spectral processing, autocorrelation, sliding window.introduction.

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I. INTRODUCTION

The task of predicting time-dependent processes (TDP) has been and remains relevant, especially in recent years, when powerful tools for collecting and processing information have appeared. Forecasting TDP is an important scientific and technical task, as it allows you to predict the behavior of various factors in environmental, economic, social, and other systems.

The development of forecasting as a science in recent decades has led to the creation of many models and methods, procedures and methods of forecasting that have different values. According to estimates of foreign and domestic experts in the field of forecasting, there are already more than a hundred forecasting methods, which raises the problem of choosing methods that would give adequate forecasts for the processes or systems under study. Strict statistical assumptions about the properties of TDP often limit the capabilities of classical forecasting methods. The use of neural networks (NN) in this task is due to the presence of complex patterns in most TDP that are not detected by known linear methods.

Neural network methods of information processing began to be used several decades ago. Over time, interest in neural network technologies faded, then revived again. This variability is directly related to practical research results. Today, the capabilities of neural network technologies are used in many branches of science, ranging from medicine and astronomy, to computer science and Economics. The ability of a neural network to process information in various ways stems from its ability to generalize and identify hidden dependencies between input and output data. The great advantage of neural networks is that they are capable of learning and generalizing the accumulated knowledge.

The goal of any forecast is to create a model that allows you to investigate the future and assess trends in a factor. The quality of the forecast in this case depends on the presence of a background variable factor, the measurement error of the value in question, and other factors. Formally, the prediction problem is formulated as follows: find a function f that allows you to estimate the value of the variable x at time (t + d) from its N previous values, so that

$$x(t + d) = f(x(t), x(t -1)..., x(t-N+1)).$$

Usually d is assumed to be equal to one, i.e. the function f predicts the next value of x.

TDP is a sequence of observed attribute values ordered at non - random time points.

It is already clear that the coronavirus pandemic has affected the economies of all countries of the world. In this situation, Russia is at the very epicenter of the crisis. On the one hand, there is an urgent need to address the problems caused by the reduction in consumption of almost all resources that form the basis of the country's export potential. On the other hand, it is necessary to solve the problems of stimulating the production and consumption of goods and services within the country. In this situation, it is important to obtain forecast values for the process of infection with the Covid-19 coronavirus in Russia in General and in Moscow by date.

From the point of view of data analysis technologies, forecasting can be considered as determining some unknown quantity from a set of associated values. Therefore, forecasting is performed using data mining tasks such as regression, classification, and clustering.

Coronavirus can be viewed as a time-distributed process. The data collected and used to develop forecasts are most often time series, i.e. they describe the development of a process over time. Therefore, forecasting in the field of coronavirus is usually associated with time series analysis.

Due to a number of advantages, the analytical neural network platform Deductor Studio, developed by BaseGroup Labs, was chosen as a tool for predicting coronavirus in the Russian Federation and Moscow in modern conditions (www.basegroup.ru, Ryazan, Russian Federation). A few words about this software product. Deductor Studio provides the development of deep data analysis systems that cover data collection, consolidation, data cleaning, modeling, forecasting, and visualization. The Deductor Studio platform is designed to solve a wide range of tasks related to processing structured data presented in the form of tables. These tables form a sample intended for training a neural network, forming an expert system for the subject area under study, and predicting processes that depend on various factors. At the same time, the scope of the system can be almost any - the mechanisms implemented in the system are successfully used in financial markets, insurance, trade, telecommunications, industry, medicine, logistics and marketing tasks, and many others. Today, the whole world is working on the problem of creating mechanisms for detecting the spread of Covid-19 to eliminate it. Forecasting would help solve this very serious problem

Objective: to propose a reasonable method for predicting the number of covid-19 coronavirus infections by date using neural technologies on the example of Moscow and the Russian Federation.

II. NEURAL NETWORKS IN COVID-19 PREDICTION: A BRIEF OVERVIEW LITERATURE REVIEW

https://www.sciencedirect.com/search?qs=covid%20prediction%20neural%20network

Predicting the spread of coronavirus is important in developing protective measures and behavioral measures for the population. The problem with modeling such a system is that every day COVID-19 and the number of new potential cases cannot be determined in a simple mathematical equation. There are many reasons for such problems. The spread of human filaments generally depends on various features, depending on both human behavior and the biological

structure of the coronavirus itself. In any case, research needs to be done to biologically describe the coronavirus in order to develop a medical treatment, as well as to model the spread that will help prevent new cases and focus on the places with the greatest potential needs. According to authors Michał Wieczorek, Jakub Siłka, and Marcin Woźniak [1], predicting the spread of coronavirus is very Important for active action planning. Unfortunately, coronaviruses are not easy to control, as the speed and reach of their spread depend on many factors, from environmental to social. The article by these authors presents the results of research on the development of a neural network model for predicting the spread of COVID-19. The prediction process itself is based on the classical approach of training a neural network with a deep architecture using the NAdam training model. For training, the authors of the article used official data from government and open repositories.

The COVID-19 pandemic has challenged global science. The international community is trying to find, apply or develop new methods for the diagnosis and treatment of patients with COVID-19 as soon as possible. The work of authors Shayan Hassantabara, MohsenA hmadib, Abbas Sharific [2] is devoted to the use of deep learning to identify and diagnose patients with COVID-19 using x-ray images of the lungs. To diagnose the disease, they presented two algorithms: deep neural network (DNN) on the fractal feature of images and neural network (SNN) methods using lung images directly. The results of the authors ' work show that the presented methods allow detecting infected areas of the lungs with high accuracy-83.84%.

Several works are devoted to the detection of COVID-19 disease using neural network technologies, among which we can distinguish [3], [4], [5]. The authors of these papers propose a method based on a convolutional neural network (CNN) developed using the EfficientNet architecture for automated COVID-19 diagnostics. The architecture of an automated medical diagnostics system is also proposed to support healthcare professionals in the decision-making process for the diagnosis of diseases.

Several important models have been introduced in recent months. In [6], machine learning was applied to evaluate how the flash of this stream will take place. However, predicting the situation in the case of COVID-19 is not easy, since there are many factors that determine rapid changes [7]. Therefore, many approaches have been used to help.

In [8], the flow prediction was performed using a mathematical model that evaluated undetected infections for the Chinese region. Sometimes even very simple techniques are used. When a solution is needed immediately, we can start predicting based on preprocessing, in which some cases are simply removed for the applied model on the Euclidean network [9]. In Japan, prognostic models also evaluated the first symptoms of the disease [10]. One of the first models presented for Italy was the use of the Gauss error function and Monte Carlo simulation on registered cases [11]. In addition, stochastic predictors provide potential help in the early days when not much data is available for machine learning approaches [12]. Such stochastic models also seem to work even for very large societies, such as India [13]. Therefore, when artificial intelligence is applied in the first days of forecast periods, the results are mostly related to a single region or country. One of the first approaches for China was presented in [14]. An interesting discussion of the principles of using mathematical modeling was presented in [15]. Some methodologies not only predict the number of new cases, but also make some assumptions about the growth dynamics [16]. There are many sources of information for predicting the situation. As reported in [17], social networks can bring valuable information not only about confirmed cases of the disease, but also about further spread. The relationship between new cases and the rate or coverage of growth can be transformed into a prediction elsewhere, as shown in [18]. this transfer of knowledge to model another region was carried out between Italy and Hunan province in China. The case of the ship "Diamond Princess" was discussed in

[19]. There are also models that assess the situation in larger regions or in more than one country. In [20] and [21], an applied forecasting model was defined for working with data from China, Italy, and France. Some models only consider the total number of cases worldwide as a whole [22].

The model proposed in [23] is a complex solution. The proposed neural network architecture was developed for flexible forecasting of new cases in various countries and regions of the world. The architecture consists of seven layers, and the output predicts the number of new cases.

Today, models for predicting inflation based on artificial neural networks in most studies are evaluated both in terms of the accuracy of the forecasts themselves, and in comparison, with regression models. Unfortunately, it is almost impossible to achieve high accuracy in predicting monthly inflation based on neural networks, but their superiority over regression models, which also did not succeed in this task, is demonstrated in the short and especially in the long term.

III. GENERAL SCHEME FOR BUILDING AN ANALYTICAL SOLUTION FOR FORECASTING COVID-19

The solution of the problem of forecasting with the help of a trained neural network assumes, first of all, the availability of statistical data on the spread of this disease by day, provided by Rospotrebnadzor of the Russian Federation (https://coronavirus-monitor.info/country/russia/moskva/) for the Russian Federation (Fig.1) and Moscow (Fig.2).

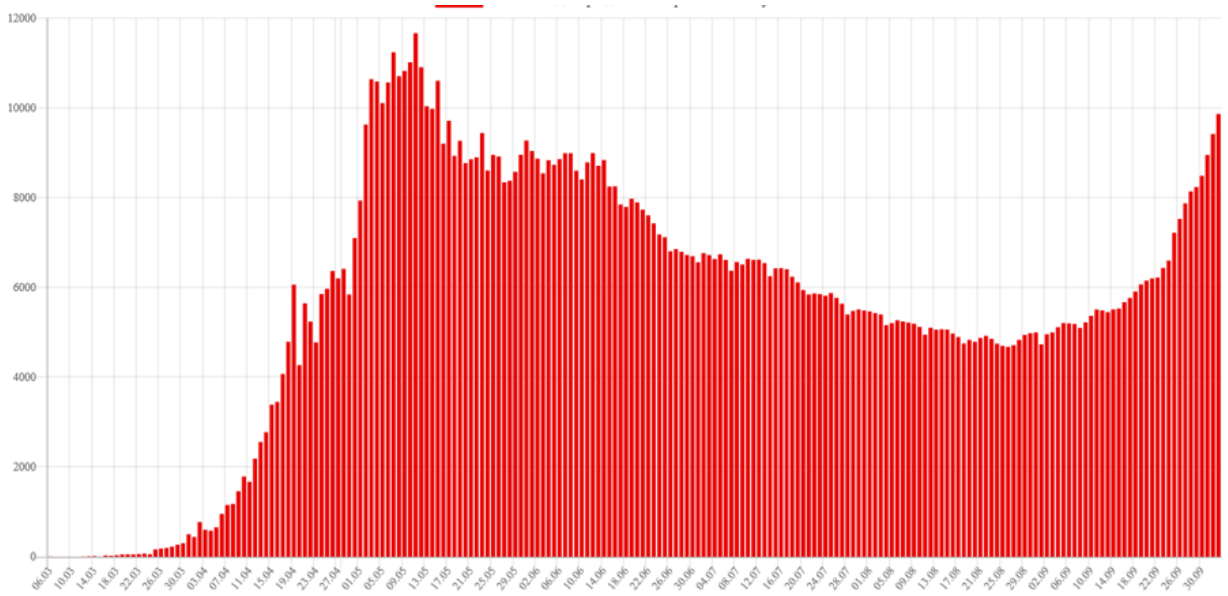

Figure 1: Graph of detected cases of Covid-19 coronavirus infection in the Russian Federation by dates as of October 03, 2020

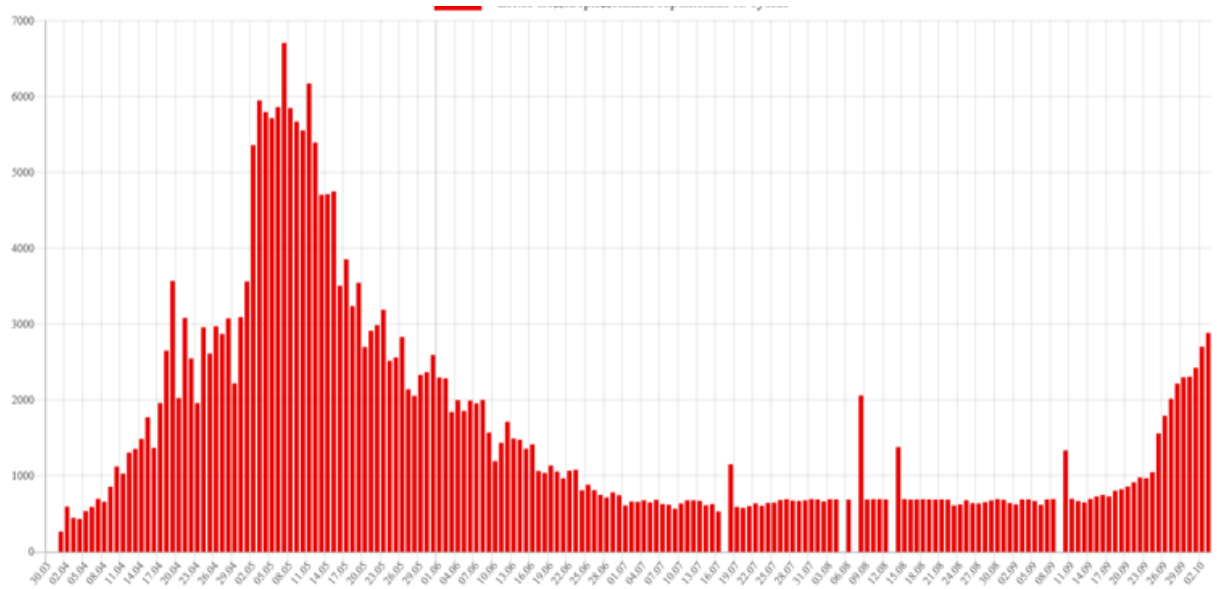

Figure 2: Graph of detected cases of Covid-19 coronavirus infection in Moscow by dates as of October 03, 2020

The statistical data obtained in the form of a time series require significant processing in order to form a training sample of the neural network and obtain the necessary data for the operation of the neural network dataset. This process usually includes the following steps:

- Time series adjustment – smoothing and removing anomalies.
- Study of the time series, highlighting its components (trend, seasonality,
- cyclicity, noise) – auto correlation analysis.
- Data processing using the sliding window method.
- Data processing using a multi-layer neural network, neural network training
- Selecting the appropriate forecasting method.
- Assessment of the accuracy of forecasting and the adequacy of the chosen forecasting method.

The analysis of the above points and numerous experiments allowed us to propose a General scheme for analytical processing of statistical source data in order to obtain a dataset for a neural network with subsequent training of the neural network and forecasting. The block diagram of the dataset generation algorithm for the neural network and predicting cases of Covid-19 coronavirus infection is shown in figure 3.

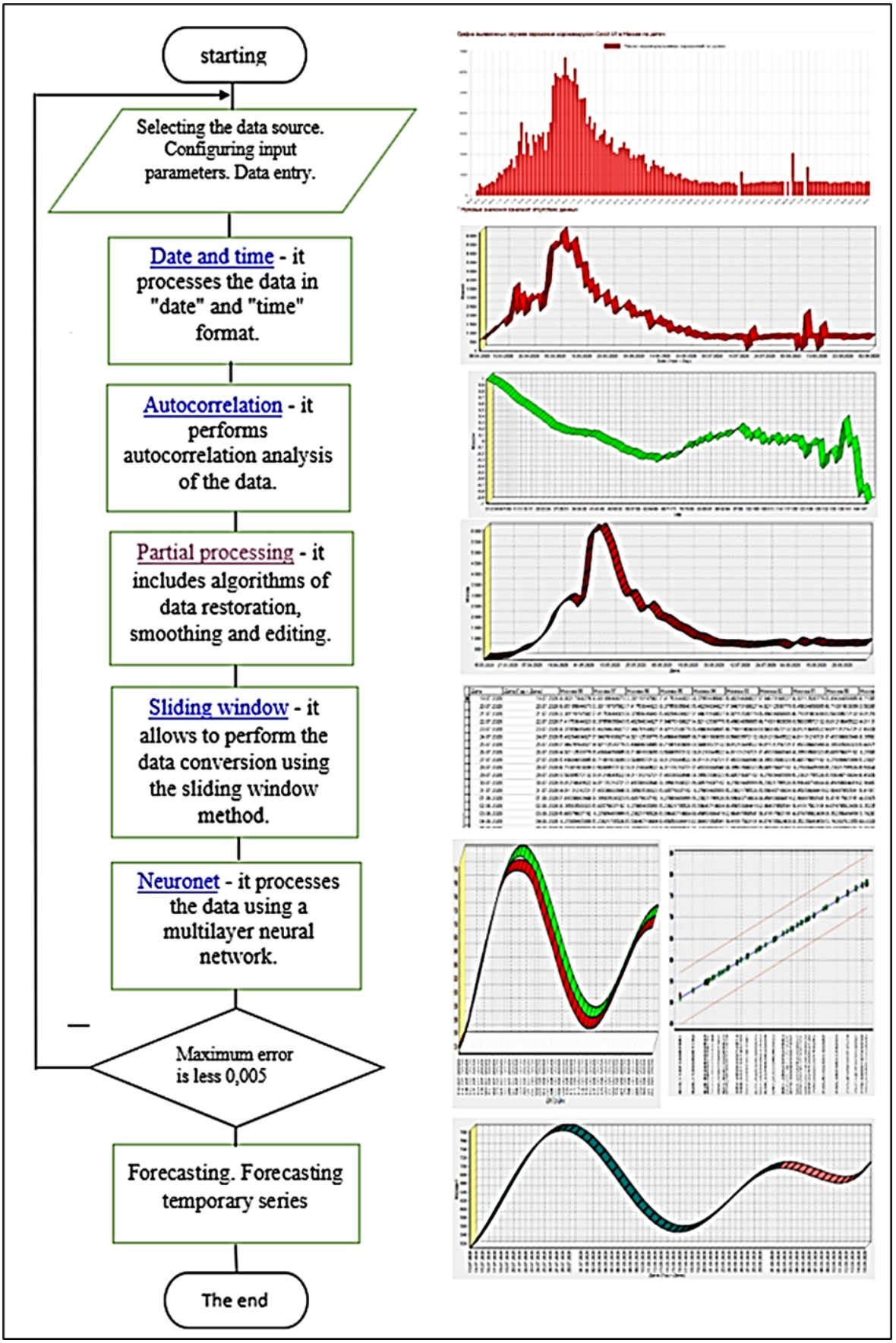

Figure 3: Block diagram of the dataset generation algorithm for the neural network and prediction of cases of Covid-19 coronavirus infection

IV. FORMATION OF DATASET FOR NEURAL NETWORK

4.1. Adjustment of time series

Graphs of detected cases of Covid-19 coronavirus infection in the Russian Federation and Moscow as of September 30, 2020 were shown in figures 1 and 2. to get a forecast in the required scale, you need to change the time scale of the data series in order to optimize it for further processing procedures. If you submit data by day to the input of the predictive model (neural network, linear model), then the forecast will be by day. If you previously convert the data to weekly intervals, then the forecast will be based on weeks. In addition, the date can be converted to a number or string, if necessary, for further processing.

In our case, we proceeded from the need to get a forecast by day, so by performing the necessary transformations of the source data to the " date "scale: Year+Day" we get the corresponding two graphs of the source data for the Russian Federation and Moscow in the specified scale (Fig.4 and Fig. 5):

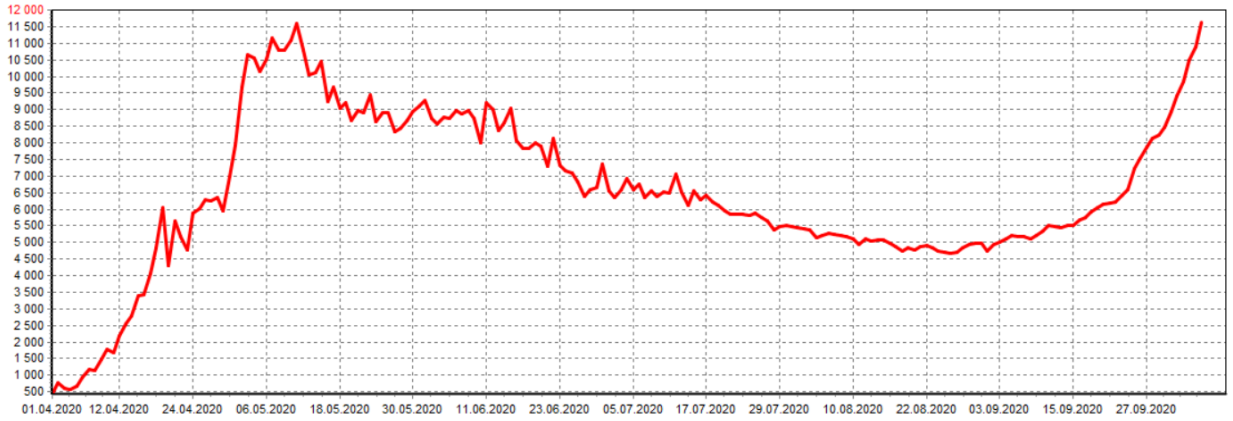

Figure 4: Graph of detected cases of Covid-19 coronavirus infection in Russia by dates as of September 30, 2020 on the "date: Year+Day" scale»

Figure 5: Graph of detected cases of Covid-19 coronavirus infection in Moscow by dates as of September 30, 2020 on the "date: Year+Day" scale»

4.2. Smoothing and removal of anomalies: spectral data processing

The purpose of spectral processing is to smooth ordered data sets using a wavelet or Fourier transform. The principle of such processing is to decompose the original time series function into basic functions. It is most often used for preliminary data preparation in forecasting tasks. At the "Spectral processing" step of the processing wizard, the "Wavelet transform"

method was selected, and the decomposition depth and order of the wavelet were set. The depth of decomposition determines the "scale" of the parts to be filtered out: the larger this value, the «larger» parts in the source data will be discarded. If the parameter values are large enough (about 7-9), the data is not only cleared of noise, but also smoothed (sharp outliers are "cut off"). Using too large values of the decomposition depth can lead to loss of useful information due to too much "coarsening" of the data. The order of the wavelet determines the smoothness of the reconstructed data series: the lower the parameter value, the more pronounced the "outliers" will be, and, conversely, if the parameter values are large, the "outliers" will be smoothed.

Figures 6 and 7 show graphs of the results of smoothing and removing anomalies using spectral processing using the "Wavelet transform" method and setting the average values of the parameters of this method.

Figure 6: Graph of detected cases of Covid-19 coronavirus infection in Russia smoothed using spectral processing using the "Wavelet transform" method

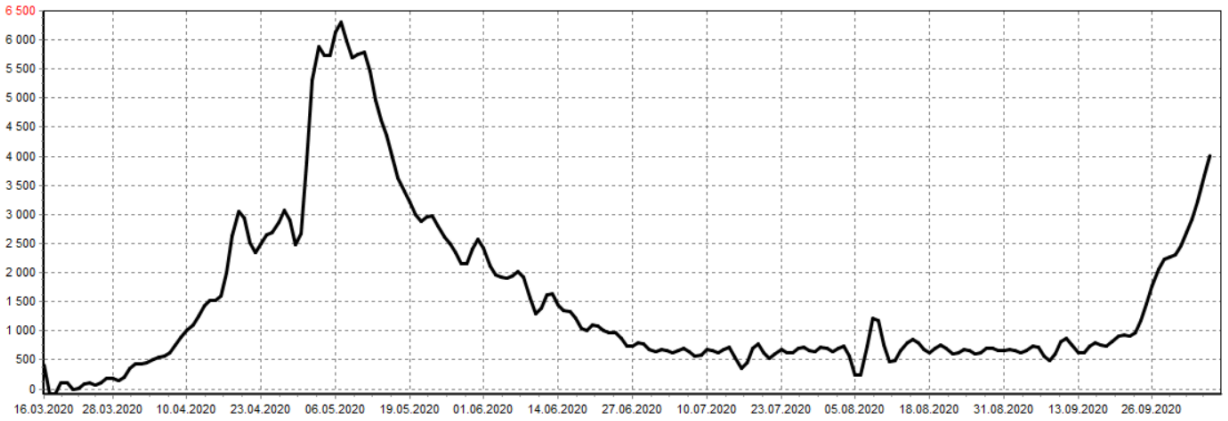

Figure 7: Graph of detected cases of Covid-19 coronavirus infection in Moscow smoothed Using spectral processing using the "Wavelet transform" method

4.3. Autocorrelation analysis of data

The purpose of autocorrelation analysis is to find out the degree of statistical dependence between different values (counts) of a random sequence formed by the data sample field. In the process of autocorrelation analysis, correlation coefficients (a measure of mutual dependence) are calculated for two sample values that are separated by a certain number of samples, also called lag. The set of correlation coefficients for all lags is an autocorrelation function of the series (ACF):

R(t) = corr(X(t), X(t+k)), where k > 0 is an integer (lag).

The behavior of the ACF can be used to judge the nature of the analyzed sequence, i.e. the degree of its smoothness, and the presence of periodicity (for example, seasonal) or a trend.

For k = 0, the autocorrelation function will be maximal and equal to 1.as the number of lags increases, i.e. the distance between two values for which the correlation coefficient is calculated increases, the ACF value will decrease due to a decrease in the statistical interdependence between these values (the probability of occurrence of one of them less affects the probability of occurrence of the other). At the same time, the faster the ACF decreases, the faster the analyzed sequence changes. Conversely, if the ACF decreases slowly, then the corresponding process is relatively smooth. If there is a trend in the original sample (a smooth increase or decrease in the values of the series), then a smooth change in the ACF will also occur. If there are seasonal fluctuations in the original data set, the ACF will also have periodic spikes.

Figures 8 and 9 show graphs of autocorrelation functions of detected cases of Covid-19 coronavirus infection in Russia and Moscow, respectively. Using these graphs, you can visually determine the presence of trends in the first and second curves with lags of 65 and 51, respectively.

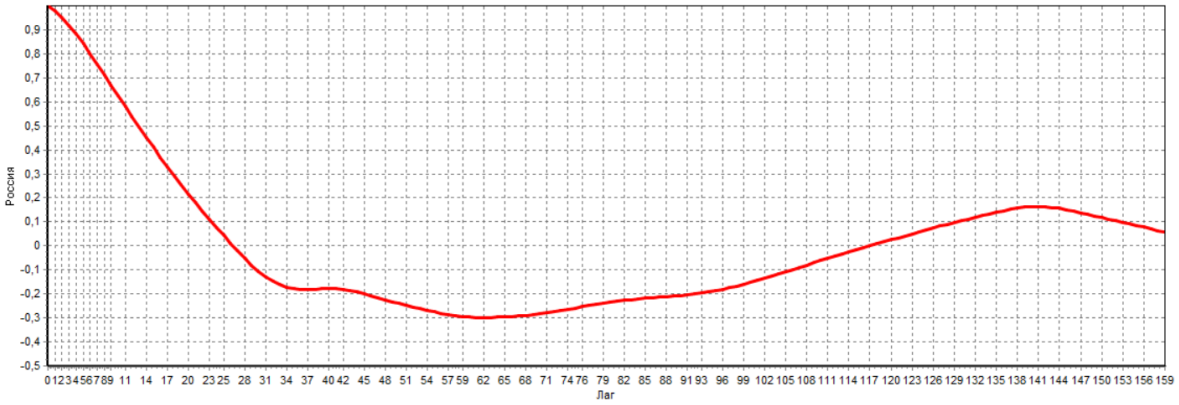

Figure 8: Graph of autocorrelation functions of detected cases of Covid-19 coronavirus infection in Russia

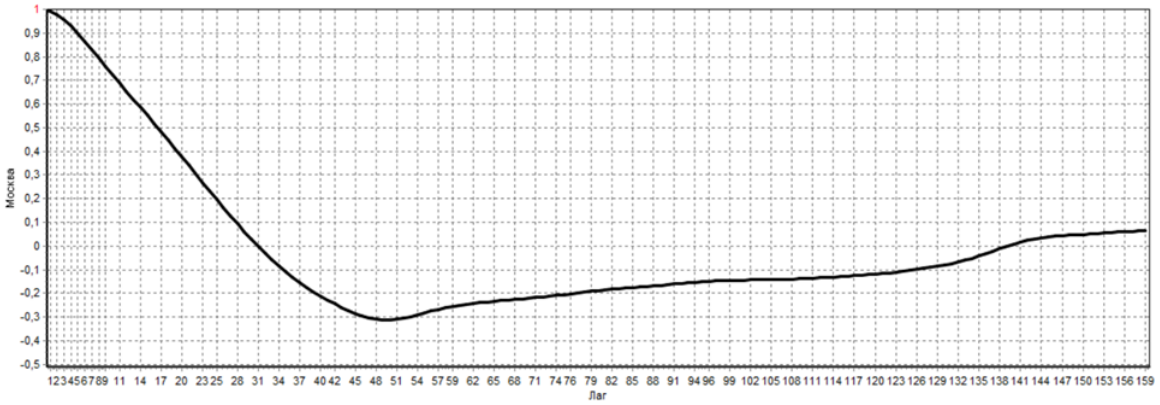

Figure 9: Graph of autocorrelation functions of detected cases of Covid-19 coronavirus infection in Moscow

4.4. Data processing by a sliding window

Data processing using the sliding window method is used for preprocessing data in forecasting tasks, when the input of the neural network requires feeding the values of several adjacent samples of the original data set. The term "sliding window" reflects the essence of processing – a certain continuous piece of data is allocated, called a window, and the window, in turn, moves, "slides", over the entire source data set. This operation results in a sample where each record contains a field corresponding to the current sample (it will have the same name as in the original sample), and to the left and right of it are fields containing samples shifted from the current sample to the past and to the future, respectively.

Processing by the sliding window method has two parameters: the depth of immersion – the number of counts in the "past" and the forecast horizon – the number of counts in the "future".

The paper used the sliding window method to smooth out the graphs of detected cases of Covid-19 coronavirus infection in Russia and Moscow with diving depths of 65 and 51, respectively, using spectral processing. The forecast horizon in both cases was taken equal to one. As a result, two datasets were obtained for training the neural network.

V. THE NEURAL NETWORK TRAINING. DATA PROCESSING USING A MULTI-LAYER NEURAL NETWORK

In this mode, the processing wizard allows you to set the structure of the neural network, determine its parameters, and train it is using one of the algorithms available in the system.

Configuring and training a neural network consists of the following steps:

1. Configure field assignments. Here you need to determine how the fields of the source data set will be used when training the neural network and working with it in practice.
2. Setting the normalization field. The purpose of normalizing field values is to transform data to the form that is most suitable for processing by means of a neural network.
3. Setting the training sample. Here you need to split the training sample for building a model based on a neural network into two sets – training and test. Training set – includes entries that will be used as input data, as well as the corresponding desired output values.

Test set – also includes records that contain input and desired output values, but are used not for training the model, but for testing its results.

4. Set up the structure of the neural network. At this step, parameters are set that determine the structure of the neural network, such as the number of hidden layers and neurons in them, as well as the activation function of neurons. In the "Neurons in layers" section, you can set the number of hidden layers, i.e. layers of the neural network located between the input and output layers.
5. The choice of algorithm and parameters training. At this step, we select the neural network training algorithm and set its parameters.
6. Setting the stop conditions of training. At this step, we set the conditions under which training will be terminated: the condition that the mismatch between the reference and real network output becomes less than the specified value, and we set the number of epochs (training cycles) after which training stops, regardless of the error value.
7. Start the learning process. At this step, we start the actual process of training the neural network.
8. Select the data display method. At this step, select the form in which the imported data will be presented. In our case, the following specialized Visualizers are interesting:

8.1. Contingency table or a scatterplot. The choice of the appropriate forecasting method consists in determining whether this method gives satisfactory forecast errors. In addition to calculating errors, their comparison is carried out

in a special Visualizer – "scatter diagram". The scatter plot shows the output values for two sets of training samples (dataset) for Russia (figure 10) and Moscow (figure 11).

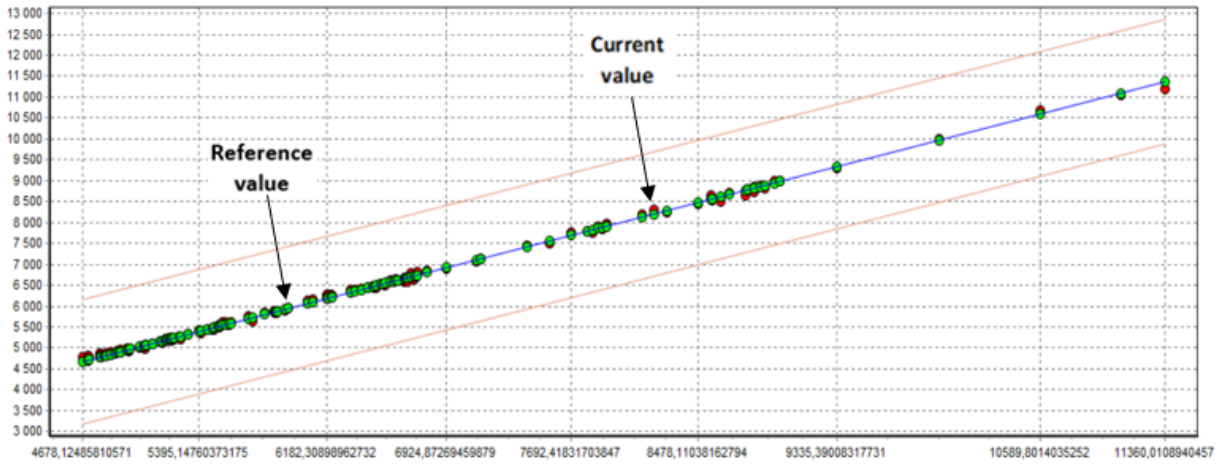

Figure 10: Scatter diagram of a trained neural network for dataset Russia

Figure 11: Scatter diagram of a trained neural network for dataset Moscow

Coordinate the X — axis is the output value on the training sample (reference), and the Y - axis is the Value output calculated by the trained model using the same example. Straight diagonal line it is a reference point (a line of ideal values). The closer the point is to this line, the less model error.

The scatter plot allowed us to compare several models to determine which model provides the best accuracy on the training set.

8.2. Diagram. The diagram visually shows the dependence of the values of one field on another. The most used type of chart is a two - dimensional graph. The values of the independent column are plotted along the horizontal axis, and the corresponding values of the dependent column are plotted along the vertical axis.

After building a model for evaluating the quality of training, we present the data obtained in the form of diagrams for the current and reference values of the dataset for Russia (Fig. 12) and Moscow (Fig. 13).

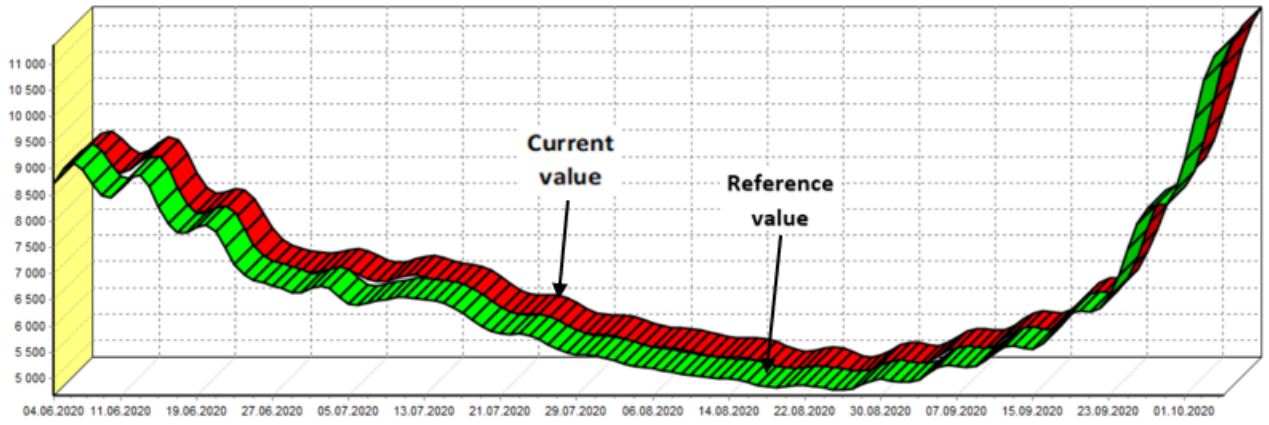

Figure 12: Diagram of a trained neural network for dataset Russia

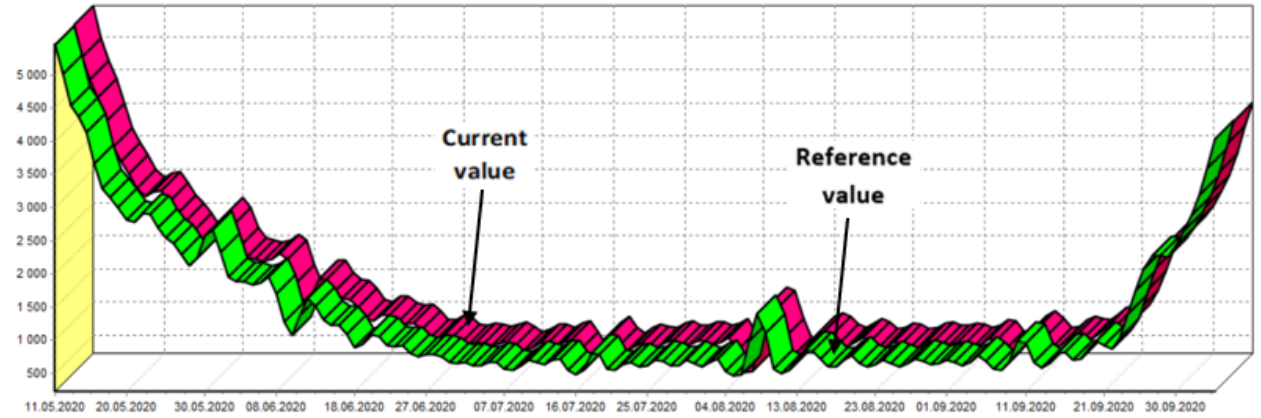

Figure 13: Diagram of a trained neural network for dataset Moscow

Analysis of the scattering diagrams (Fig. 10 and 11) and diagrams of the trained neural network for the dataset of Russia and Moscow (Fig. 12 and 13) allows us to assert that the neural network was successfully trained with both the dataset of Russia and the dataset of Moscow.

VI. FORECASTING ITSELF. RESEARCH RESULT. POINTS FOR DISCUSSION

Forecasting allows you to get a prediction of the values of a time series for the number of samples corresponding to the specified forecast horizon. What is the maximum forecast horizon? The following rule is recommended: the amount of statistical data should be 10-15 times greater than the forecast horizon [24]. This means that in our case, the maximum forecast horizon can be 20-25 days.

When performing the actual forecast, we pre-configure several fields: forecast horizon (set 20 days), request the "forecast step" and "source data" fields, and set color and scale parameters. Adding the" forecast step "field (check the box) allows you to add an additional" forecast Step " field to the resulting selection, which will indicate the number of the forecast step that resulted in it for each record.

"Source data" – selecting this check box allows you to include in the resulting selection not only those records that contain the predicted values, but also all those that contain the source data. In this case, the records containing the forecast will be located at the end of the resulting selection.

The final graphs for predicting the number of COVID-19 infections by date using neural technologies are shown in figures 14 (Russia) and 15 (Moscow)

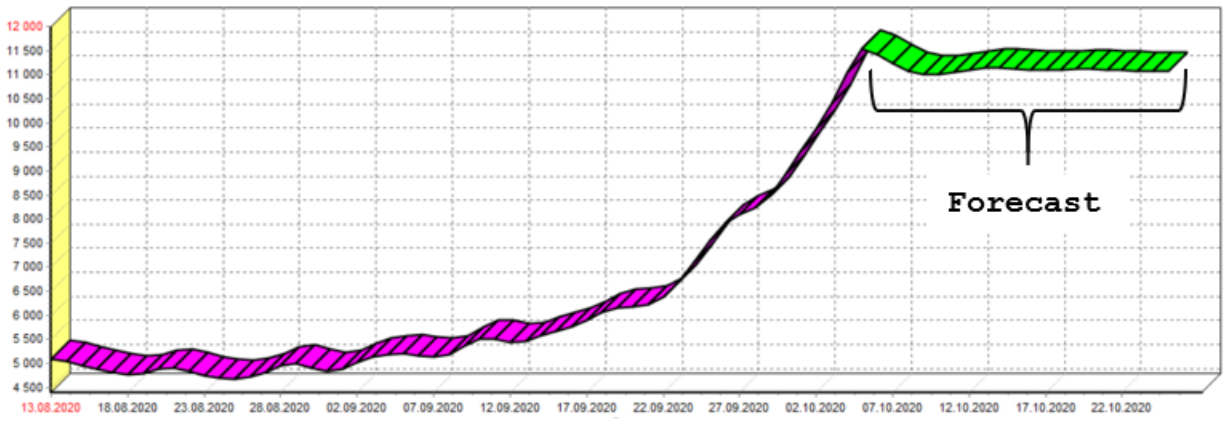

Figure 14: Graph for predicting the number of COVID-19 infections by date using neural technologies (Russia)

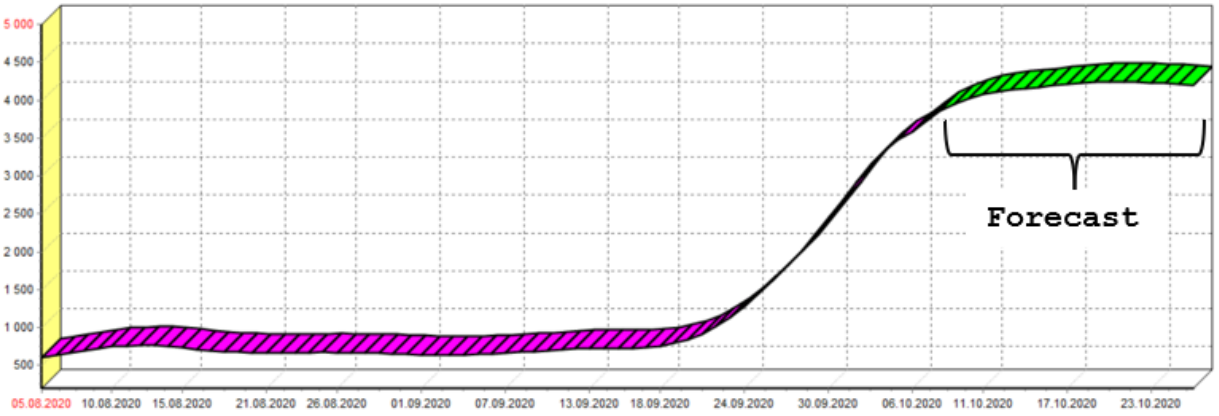

Figure 15: Graph for predicting the number of COVID-19 infections by date using neural technologies (Moscow)

The proposed model for predicting the number of COVID-19 infections by date using neural technologies, built once, cannot "work" indefinitely. There are new data on the number of infections in Russia and Moscow. Therefore, the model should be periodically reviewed and retrained.

VII. THE FORECAST ERROR

A forecast error is the difference between the actual value of yt and its forecast yt* at time t. Deviations and errors of the forecast and fait accompli calculated using standard expressions are used to evaluate accuracy. The most common are the following: Mean Absolute Deviation (MAD):

$$MAD = \frac{1}{n}\sum_{i=1}^{n} | y_t - y_t^* | .$$

Mean Squared Error (MSE):

$$MSE = \frac{1}{n}\sum_{i=1}^{n}\left(y_t - y_t^*\right)^2.$$

Mean absolute percentage error (Mean Absolute Percentage Error, MAPE):

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|y_t - y_t^*|}{y_t},$$

where n is the number of training examples.

In our case, using the data values shown in figures 1, 2, 14 and 15 in the calculations, the average absolute error was 2.32%.

The choice of the appropriate forecasting method consists in determining whether this method gives satisfactory forecast errors. In addition to calculating errors, their comparison is carried out in a special Visualizer – "scatter diagram" (Figures 10 and 11). The scatterplot displays the output values for each of the training sample examples, whose X - axis coordinate is the output value in the training sample (reference), and Y – axis coordinate is the output value calculated by the trained model in the same example. A straight diagonal line is a reference point (a line of ideal values). The closer the point is to this line, the smaller the model error. The scatter plot is useful when comparing multiple models. It is often enough to look at the spread of points from the diagonal line to determine which model provides the best accuracy on the training set. The work performed by the author on estimating the scatter diagrams of various forecasting models showed that the neural network provides the smallest spread within the boundaries of a given error.

VIII. CONCLUSION

This paper solves the problem of predicting Covid-19 diseases in Moscow and the Russian Federation using neural networks. This approach is useful in cases where it is necessary to overcome difficulties related to non-stationarity, incompleteness, unknown distribution of data, or when statistical methods are not completely satisfactory. The forecasting problem is solved using the Deductor Studio analytical platform developed by BaseGroup Labs (www.basegroup.ru, Russian Federation, city of Ryazan). When solving the problem, we used mechanisms for clearing data from noise and anomalies, which ensured the quality of building a forecast model and obtaining forecast values for tens of days ahead. The principle of time series forecasting was also demonstrated: import, seasonal detection, cleaning, smoothing, building a predictive model and predicting Covid-19 diseases in Moscow and the Russian Federation using neural technologies for twenty days ahead.

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