Power BI in ICT for Monitoring of Insurance Activity Based on Indicators of Insurance Portfolios

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***Abstract*— The article proves the relevance of operational business intelligence in insurance in terms of VUCA-world. For this purpose, the use of Microsoft Power BI software as a method of information and communication technologies, its purpose and benefits for business monitoring are considered. Among the advantages of using Microsoft Power BI is the analysis of existing insurance contracts and current indicators of insurance portfolios. The research substantiates the feasibility of operational analysis of insurance activities based on the calculation of indicators of insurance portfolios that form insurance statistics, which provides results in real-time. This approach eliminates the shortcomings of common means of retrospective operational analysis based on financial statements. Within the research, the insurance portfolio is defined as a set of insurance contracts for a separate line of business of the insurer on a certain date. It is emphasized that for each date of insurance activity the insurance portfolio is a unique set of contracts. A positive factor in the article is the possibility of timely response of managers to fluctuations in the profitability and technical risk of insurance portfolio. The application of the studied elements made it possible to propose a method of monitoring insurance activities based on the calculation of indicators of insurance portfolios and their visualization on analytical panels (dashboards).**

Keywords*— *operational business intelligence; insurance; VUCA-world; information and communication technologies; Microsoft Power BI; monitoring; insurance activity; indicator; insurance portfolio; insurance statistics; real time; insurance contract; line of business; visualization; analytical panel.

I. INTRODUCTION

The insurance industry operates in a complex changing environment. Digitalization of the economy, intensification of competition in insurance markets, strengthening of regulatory requirements for the insurance business, instability of consumer behavior, growth in claims due to increased disasters and cataclysms cause significant transformations of the insurance industry [1].

Current market conditions are volatility, uncertainty, complexity and ambiguity (VUCA), so they are difficult to predict. This environment is called VUCA-world [2]. Multiple unforeseen changes require insurers to quickly adapt and immediately adjust strategies, in particular in terms of the range and conditions of insurance products [3], as well as timely adoption of risk management measures. In this regard, insurers should carry out continuous operational analysis (monitoring) of insurance activities in order to identify new trends.

II. ANALYSIS OF RESEARCH AND PUBLICATIONS

In scientific publications on the analysis of insurance activities [4] – [10] uses a wide range of indicators and different methodological approaches. Diagnostic, retrospective [9] or exploratory analysis [10] designed to identify trends, weaknesses in the activities of the insurer and explain their causes. The purpose of forecasting analysis is analytical prediction and assessment of future financial condition and risks.

The subject of studying insurance portfolios is widely represented in scientific publications, starting with the study of the essence of the insurance portfolio [11], [12], theoretical aspects of its formation [13], [14], issues of analysis and evaluation of portfolio quality [15] – [17], and ending with the management of insurance portfolios, solving problems of their balance and optimization [17] – [22], coordination of parameters of portfolios of assets and liabilities [23]. However, considering scientific research, it is worth noting the existence of contradictions in the understanding of scientists of the essence of the insurance portfolio, which makes it impossible to further adequately analyze its characteristics.

III. THE MAIN METHOD OF RESEARCH

The purpose of this publication is substantiation of theoretical positions and development of practical recommendations on the operative analysis of insurance activity based on indicators of insurance portfolios with use Microsoft Power BI.

Insurance is a data-driven industry [10]. It is advisable to use modern Microsoft Power BI software to track a significant amount of information from various sources, process large data sets and visualize them for business analysis. Its advantages are the prompt receipt of analytical indicators, concentrated presentation of interactive analytical data in grouped sets of reports on dashboards, the ability to work with reports of different specialists of one company. Understanding the current situation based on visualized analytics allows you to respond quickly and change approaches to doing business.

To visualize the results of the analysis, it is advisable to group the indicators of insurance portfolios by categories. The main source of information for calculating the performance of insurance portfolios in Microsoft Power BI is the database of the insurer under insurance contracts, outgoing reinsurance and insured events. Scheduled data refresh - once a day.

Power BI input is processed in the DAX function and formula language used in Analysis Services, Power BI Desktop, and Power Pivot [24] – [27]. The DAX language can perform calculations in measures, columns, tables, row filters, as well as create and execute queries.

IV. THE RESEARCH MATERIALS

For the purposes of analysis and management, the insurance portfolio should be considered as a set of insurance contracts [10]. Definition of the insurance portfolio as the volume or value of insurance liabilities [14], cost assessment of insurance risks under current insurance contracts [11], the amount of received insurance premiums [16], the number of insurance contracts or of insured objects [21] is incorrect. The value of liabilities, the amount of premiums, the number of insured objects - are indicators that characterize the insurance portfolio.

We consider it incorrect to interpret the insurance portfolio as a structure of insurance services [21], as well as to optimize such a structure [20], [22]. Structure optimization operations can be applied to the investment portfolio when the amount of investment asset is determined by the decision of managers. The parameters of the insurance portfolio depend not only on management decisions that establish insurance conditions and marketing activities.

The volume of insurance is significantly affected by consumer demand and the actions of competitors. In the insurance portfolio, you can optimize the level of insurance (technical) risk of the insurer, the possible insufficiency of insurance premiums, insurance reserves and reinsurance protection to cover insurance benefits and costs of doing business [9]. That is why indicators of technical risk and profitability of portfolio are important for operational analysis.

It is expedient to make a separate remark to the publications of the authors who define the insurance portfolio as a general set of contracts for all types of insurance [7], [20], [22]. For further management, the analysis of the total insurance portfolio will be of little information. Each insurance product is designed for the target segment of consumers. It has its own set of insurance risks, its own technology of contracting, underwriting procedures and settlement of losses. Therefore, it is advisable to analyze insurance contracts for a particular line of business in terms of its profitability, level of technical risk and other parameters in order to identify problems that need to be adjusted. “Line Of Business” according to NAIC Glossary [28] – are certain insurance services identified by the insurer in the classification of its own insurance business.

To understand the essence of the insurance portfolio, special attention should be paid to the fact that the set of existing insurance contracts changes over time: new contracts are concluded and others are terminated. That is, the insurance portfolio and its characteristics for each date of insurance activity will be unique.

Summing up, we determine that the insurance portfolio at a certain date of insurance activity is a set of valid insurance contracts (in force) for a separate line of business of the insurer. This wording will be used to develop a methodology for operational analysis (monitoring) in insurance based on indicators of insurance portfolios in Microsoft Power BI. In the future, the day when the performance of insurance portfolios in Microsoft Power BI is evaluated will be called the valuation date. The day for which the indicators of the insurance portfolio are calculated is the date of insurance activity.

The insurance company has the opportunity to build a system of indicators for business analysis. The combination of these data is in fact insurance statistics for actuarial calculations in insurance activities. The types of indicators that can be used by an insurance analyst are presented in Table I.

TABLE I. TYPES OF INDICATORS

Types of indicators	Indicators
Absolute indicators	Number, Amount, Maximum, Minimum
Measures of central tendency	Mean, Median, Mode, Midrange
Measures of variation	Range, Variance, Standard deviation
Measures of position	Quintile
Relative indicators	Ratio, Rate, Coefficient

[a] a. Overview from [10], [17]

We offer the author's grouping of some commonly used indicators in Table II.

TABLE II. SOME COMMONLY USED INDICATORS OF THE INSURANCE PORTFOLIO

Category	Some Commonly Used Indicators
Volume of the Insurance Portfolio	Number of Contracts (N) Total Sums Insured Total Gross Premiums (TGP) Total Net Premiums (TNP) Total Earned Premiums (TEP)

Category	Some Commonly Used Indicators
	Total Net Earned Premiums (TNEP) Unearned Premium Reserve Persistence Ratio
Averages per Contract	Average Sum Insured per Contract (ASI) Average Premium per Contract Average Premium Rate Average Net Premium Rate (ANR) Average Term per Contract
Reinsurance	Reinsurance Retention ratio
Terminations	Number of Terminations Gross Premiums of Terminations Total Return Premium Average Premium per Termination Termination rate
Claims	Number of Claims (M) Total Gross Claims (TGC) Total Net Claims (TNC) Average Cost per Claim (ACC) Claims Frequency Average Degree of Loss Incurred claims ratio Rejection ratio Average time to settle a claim
Technical Risk of the Insurance Portfolio	Maximum Sum Insured Standard Deviation of Sums Insured Konshin Coefficient
Earnings and Profitability	Loss Ratio Net Loss Ratio Expenses Ratio Combined Ratio

For the purposes of operational analysis of insurance activities, all insurance portfolios can be divided into two types:

- insurance portfolios containing valid insurance contracts on the valuation date;
- insurance portfolios in which all insurance contracts have expired on the valuation date.

Features of the calculation of individual indicators for different types of insurance portfolios are given in Table III.

TABLE III. FEATURES OF CALCULATION OF SEPARATE INDICATORS FOR DIFFERENT TYPES OF INSURANCE PORTFOLIOS

Indicators	Type of insurance portfolio	
	The portfolio contains valid insurance contracts as of the valuation date	***The portfolio contains only expired insurance contracts at the valuation date***
Claims Frequency	Not calculated	M / N
Average Degree of Loss	Not calculated	ACC / ASI
Konshin Coefficient	$\sqrt{\frac{1-ANR}{N \times ANR}}$	Not calculated

In Fig. 1 shows a simplified model of input information from the databases of the insurance company for further calculation of indicators of insurance portfolios in Microsoft Power BI.

The "Line of Business" reference table is proposed to be built when importing the database of insurance contracts into Microsoft Power BI. The query for the DAX function DISTINCT ("Contract" [Line of Business]) in Power Query generates unique column entries in this table. This request automatically updates the reference table with an up-to-date list of insurance services provided by the insurance company.

Microsoft Power BI capabilities allow you to quickly process large data sets. The parameters of insurance portfolios can be calculated on the basis of input information (Fig. 1) every day. In Fig. 2 shows a simplified data model of operational business analysis of insurance activities based on indicators of insurance portfolios.

In Fig. 2 presents two new tables: "Calendar" and "Insurance Portfolio". "The Calendar" table is intermediate. It is filled in automatically using the CALENDARAUTO () function. It contains a continuous sequence of dates, based on those found in all input tables of the data model (Fig. 1).

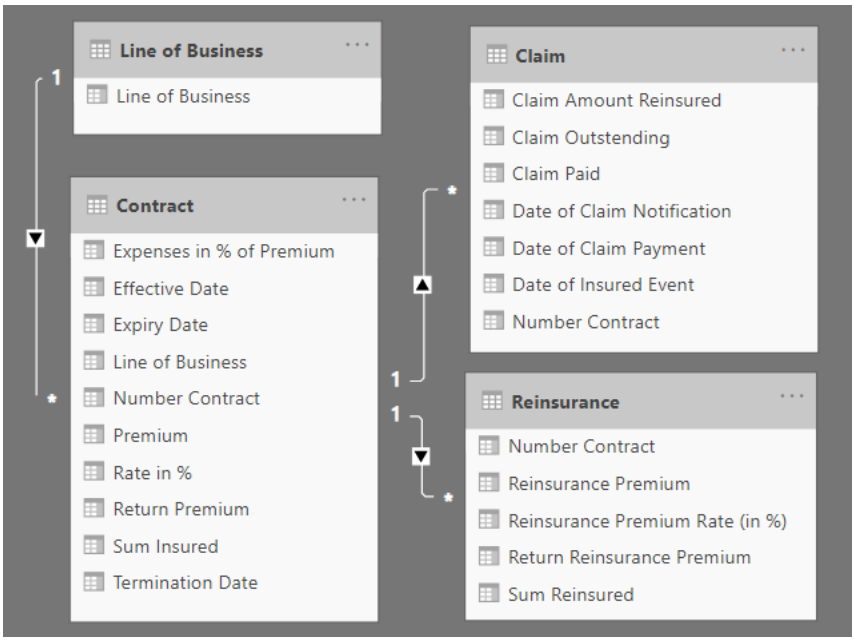

Fig. 1. Simplified model of input data from insurer databases

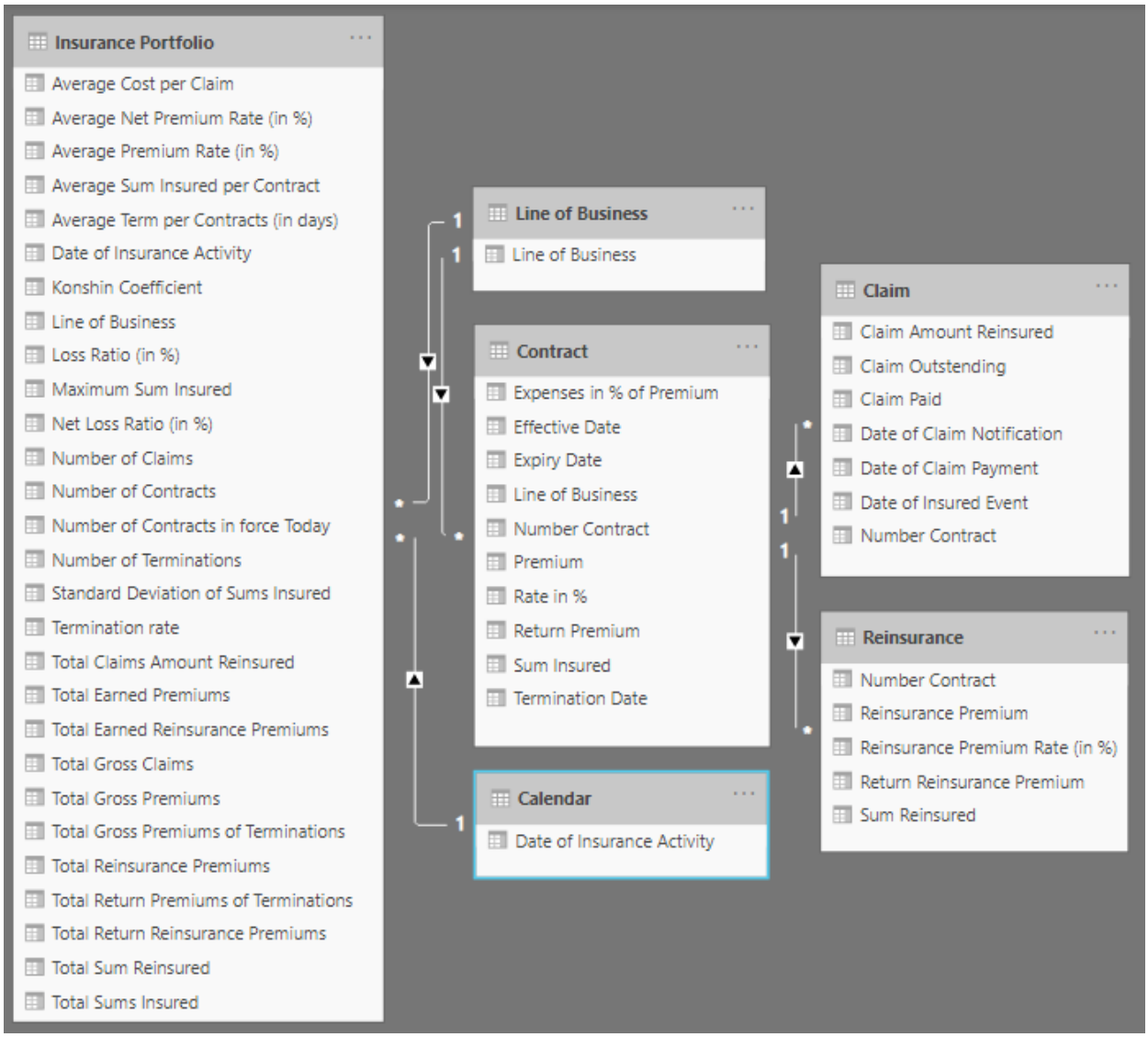

Fig. 2. Simplified data model of operational business analysis of insurance activity based on indicators of insurance portfolios

In the table “Insurance Portfolio”, we have the necessary absolute, statistical and relative indicators of insurance portfolios for each date of insurance activity for all lines of business. The formation of the table begins with filling the unique rows of the first two columns “Insurance Portfolio” [Date of Insurance Activity] and “Insurance Portfolio” [Line of Business] function GENERATE (Fig. 3) by intersecting the rows of the two tables “Calendar” and “Line of Business”. We limit the maximum date of “Insurance Portfolio” [Date of Insurance Activity] to the TODAY ().

```
Insurance Portfolio = Generate(TOPN(1+TODAY()-MIN('Calendar'[Date of Insurance Activity]),'Calendar', 'Calendar'[Date of Insurance Activity], ASC), 'Line of Business')
```

Fig. 3. Formula for generating columns “Insurance Portfolio” [Date of Insurance Activity] and “Insurance Portfolio” [Line of Business]

After completing the first two columns of the “Insurance Portfolio” Table, other indicators are determined based on the input tables “Contract”, “Claim” and “Reinsurance”. It is known that in the DAX language the same calculation can be implemented by different functions. Here are examples of DAX formulas for calculating some other columns of the table “Insurance Portfolio” (Fig. 4 -14).

```
Total Gross Premiums = SUMX(Contract, if('Contract'[Line of Business]='Insurance Portfolio'[Line of Business], if('Contract'[Effective Date]<='Insurance Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry Date]>='Insurance Portfolio'[Date of Insurance Activity],if(Contract[Termination Date]>0,0,'Contract'[Premium]),0),0))
```

Fig. 4. The formula for calculating the column “Insurance Portfolio” [Total Gross Premiums]

Note that when determining most of the indicators, in particular the Total Gross Premiums indicator, the data of contracts that were terminated at the initiative of one of the parties to the contract are not taken into account. However, insurance statistics aggregate the parameters of terminated contracts due to insured events, which would be valid on the date of the insurance portfolio, if there were no insured event.

The total Gross Claims is summed without reducing the result on early termination of contracts, because its

impact on this aspect of insurance activities should be absent or minimal. However, to take into account for operational business analysis should be all claims payments (Fig. 5).

```
Total Gross Claims = SUMX(NATURALLEFTOUTERJOIN(Contract,Claim),
if('Contract'[Line of BuAsiness]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance
Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry
Date]>='Insurance Portfolio'[Date of Insurance
Activity],'Claim'[Claim Paid],0),0))
```

Fig. 5. The formula for calculating the column “Insurance Portfolio” [Total Gross Claims]

The return of insurance premiums by the insurer can be due to various reasons: a change in the terms of insurance contracts or early termination. In this case, the amount of return of insurance premiums under the insurance contract is not always equal to the received. DAX formulas for calculating these aggregate indicators are shown in Fig. 6 and Fig. 7.

```
Total Return Premiums of Terminations = SUMX(Contract,
if('Contract'[Line of Business]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance
Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry
Date]>='Insurance Portfolio'[Date of Insurance
Activity],if('Contract'[Termination Date]>0,Contract[Return
Premium],0),0),0))
```

Fig. 6. Formula for calculating the column “Insurance Portfolio” [Total Return Premiums of Termination]

```
Total Gross Premiums of Terminations = SUMX(Contract,
if('Contract'[Line of Business]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance
Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry
Date]>='Insurance Portfolio'[Date of Insurance
Activity],if(Contract[Termination
Date]>0,Contract[Premium],0),0),0))
```

Fig. 7. Calculation formula for the column “Insurance Portfolio” [Total Gross Premiums of Terminations]

In general, the procedure and formulas for calculating any indicators are determined by the accounting policy of the insurer, so they may differ from one insurance company to another. We offer for consideration a few more examples of DAX formulas.

```
Total Reinsurance Premiums = SUMX(NATURALLEFTOUTERJOIN(Contract,
Reinsurance), if('Contract'[Line of Business]='Insurance
Portfolio'[Line of Business], if('Contract'[Effective
Date]<='Insurance Portfolio'[Date of Insurance
Activity]&&'Contract'[Expiry Date]>='Insurance Portfolio'[Date of
Insurance Activity],if(Reinsurance[Return Reinsurance
Premium]=0,Reinsurance[Reinsurance Premium],0),0),0))
```

Fig. 8. The formula for calculating the column “Insurance Portfolio” [Total Reinsurance Premiums]

As you can see in Fig. 8, the column of aggregate premiums paid in reinsurance, “Insurance Portfolio” [Total Reinsurance Premiums] is calculated using the NATURALLEFTOUTERJOIN () function, which allows to combine the tables “Contract” and “Reinsurance” by insurance contract number and calculate the amount of Reinsurance Premiums under valid contracts on the date of the insurance portfolio.

The formulas for calculating the maximum and standard deviation of the sum insured of the insurance portfolio using the DAX functions MAXX () and STDEVX.S () are shown in Fig. 9 and Fig. 10.

```
Maximum Sum Insured = MAXX(Contract, if('Contract'[Line of
Business]='Insurance Portfolio'[Line of Business],
if('Contract'[Effective Date]<='Insurance Portfolio'[Date of
Insurance Activity]&&'Contract'[Expiry Date]>='Insurance
Portfolio'[Date of Insurance Activity],if(Contract[Termination
Date]=0,'Contract'[Sum Insured ],0),0),0))
```

Fig. 9. DAX formula for calculating the column “Insurance Portfolio” [Maximum Sum Insured]

```
Standard Deviation of Sums Insured = STDEVX.S(Contract,
if('Contract'[Line of Business]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance
Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry
Date]>='Insurance Portfolio'[Date of Insurance Activity],
if(Contract[Termination Date]=0,'Contract'[Sum Insured ],0),0),0))
```

Fig. 10. DAX formula for calculating the column “Insurance Portfolio” [Standard Deviation of Sums Insured]

The calculation of the average term of the insurance contract (in days) can be done by summing up all the terms of the contracts and dividing the amount by the number of contracts in the insurance portfolio (Fig. 11).

```
Average Term per Contract (in days) = DIVIDE(SUMX(Contract,
if('Contract'[Line of Business]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance Portfolio'
[Date of Insurance Activity]&&'Contract'[Expiry Date]>='Insurance
Portfolio'[Date of Insurance Activity], Contract[Expiry Date]-
Contract[Effective Date],0),0)),('Insurance Portfolio'[Number of
Contracts]+'Insurance Portfolio'[Number of Terminations]))
```

Fig. 11. DAX formula for calculating the column “Insurance Portfolio” [Average Term per Contract]

The indicator “Insurance Portfolio” [Number of Contracts in force Today] characterizes the type of insurance portfolio. If its value on the valuation date (as of today) is 0, then it is a portfolio in which all insurance contracts have ended. Otherwise, the portfolio contains valid insurance contracts. This condition will determine the features of the calculation of indicators of different portfolios (Table III).

```
Number of Contracts in force Today = SUMX(Contract,
if('Contract'[Line of Business]='Insurance Portfolio'[Line of
Business], if('Contract'[Effective Date]<='Insurance
Portfolio'[Date of Insurance Activity]&&'Contract'[Expiry
Date]>='Insurance Portfolio'[Date of Insurance Activity],
if('Contract'[Effective Date]<=TODAY()&&'Contract'[Expiry
Date]>=Today(),if(Contract[Termination Date]=0,1,0),0),0),0))
```

Fig. 12. The formula for calculating the column “Insurance Portfolio” [Number of Contracts in force Today]

The indicator “Insurance Portfolio” [Number of Contracts in force Today] (Fig. 12) is used in the formula for calculating the Konshin coefficient (Fig. 13).

```
Konshin Coefficient = if('Insurance Portfolio'[Number of Contracts
in force Today]>0, SQRT((1-'Insurance Portfolio'[Average Net
Premium Rate (in %)]/100)/'Insurance Portfolio'[Average Net Premium
Rate (in %)]/100/'Insurance Portfolio'[Number of Contracts]), 0)
```

Fig. 13. The formula for calculating the column “Insurance Portfolio” [Konshin Coefficient]

Important for operational business analysis, the Loss Ratio is calculated on the basis of already calculated indicators of the table “Insurance Portfolio” (Fig. 14) and is presented in percentage format.

```
Loss Ratio (in %) = DIVIDE('Insurance Portfolio'[Total Gross
Claims],'Insurance Portfolio'[Total Earned Premiums])
```

Fig. 14. The formula for calculating the column “Insurance Portfolio” [Loss Ratio (in%)]

Daily calculated and recalculated parameters of insurance portfolios are visualized on the analytical panels of Microsoft Power BI. An example of a dashboard with aggregate indicators of insurance premiums and payments on the current valuation date is presented in Fig. 15.

The main purpose of data visualization is the analysis of indicators over time while comparing their size and changes relative to other indicators. Examples of information panels for tracking the dynamics of key indicators are shown in Fig. 16 -18.

The dashboards present trends in a compact form. It is possible to review trends in different lines of business and delve into analysis that is more detailed. For convenience of the analysis of the long period in each diagram, there is a scroll bar. This allows decision makers to visually assess the essence of change.

The following example of a dashboard (Fig. 17) visualizes a preliminary assessment of the financial results of insurance activities on the selected line of business. By comparing Loss Ratio and its net Loss Ratio analogue, which takes into account the results of outgoing reinsurance, with the premiums rates, the insurer's management can assess the profitability of insurance activities in advance and, if necessary, quickly adjust the strategy and business conduct.

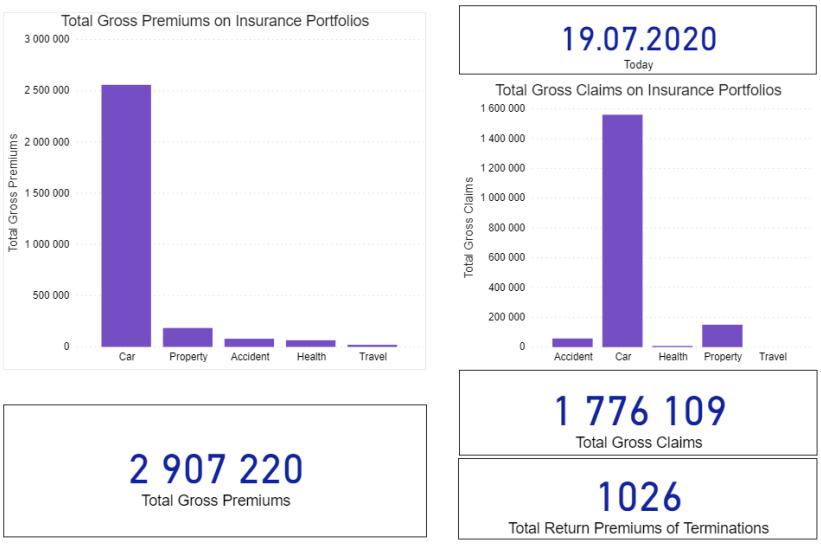

Fig. 15. Analytical panel with information on the structure of the total insurance portfolio by aggregate indicators of insurance premiums and claims payments as of the current valuation date

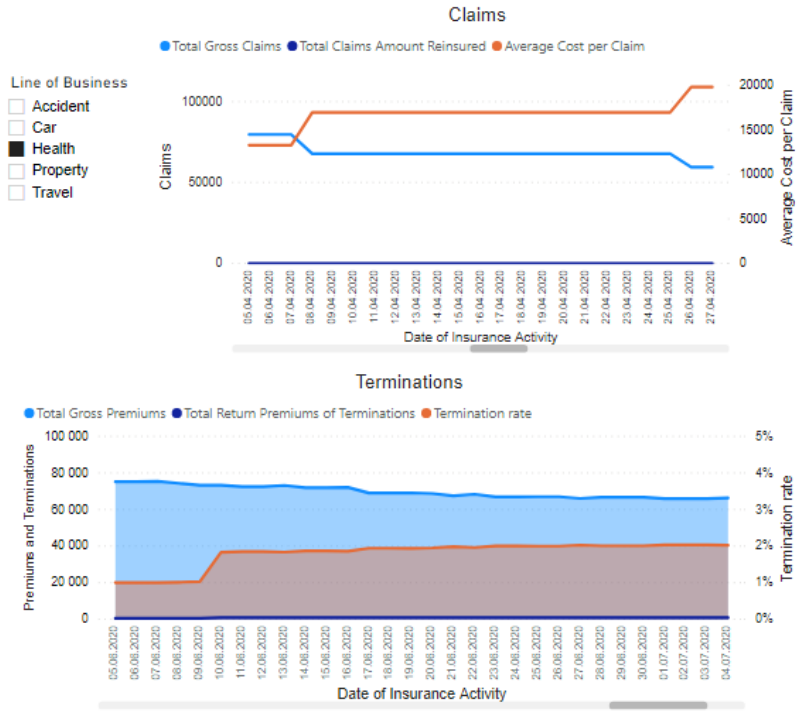

Fig. 16. Analytical panel for tracking trends in the volume of insurance payments and termination of insurance contracts

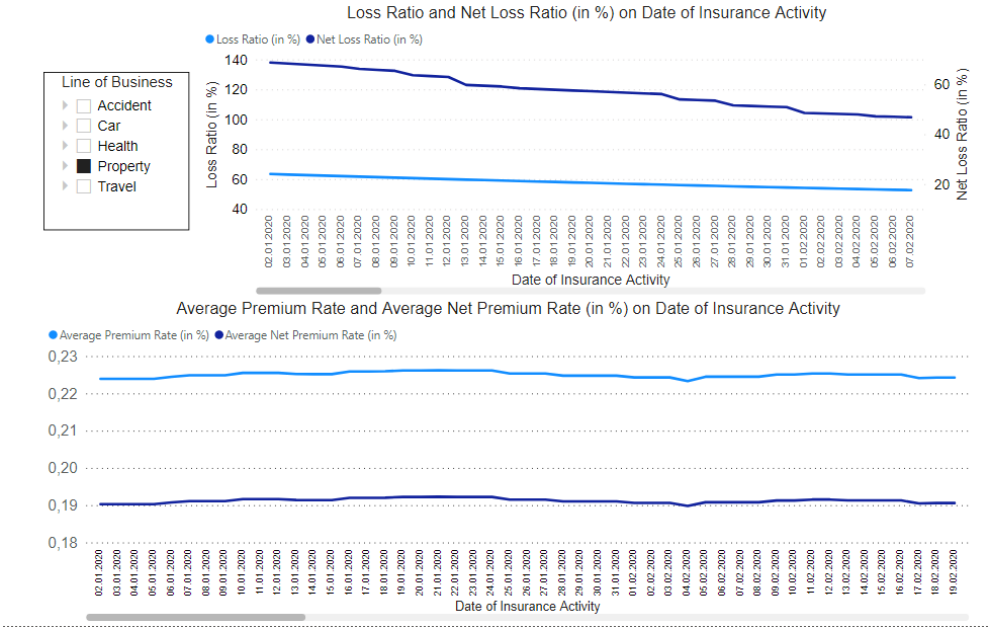

Fig. 17. Analytical panel with dynamics Average Premsum Rates and Loss Ratio on lines of business

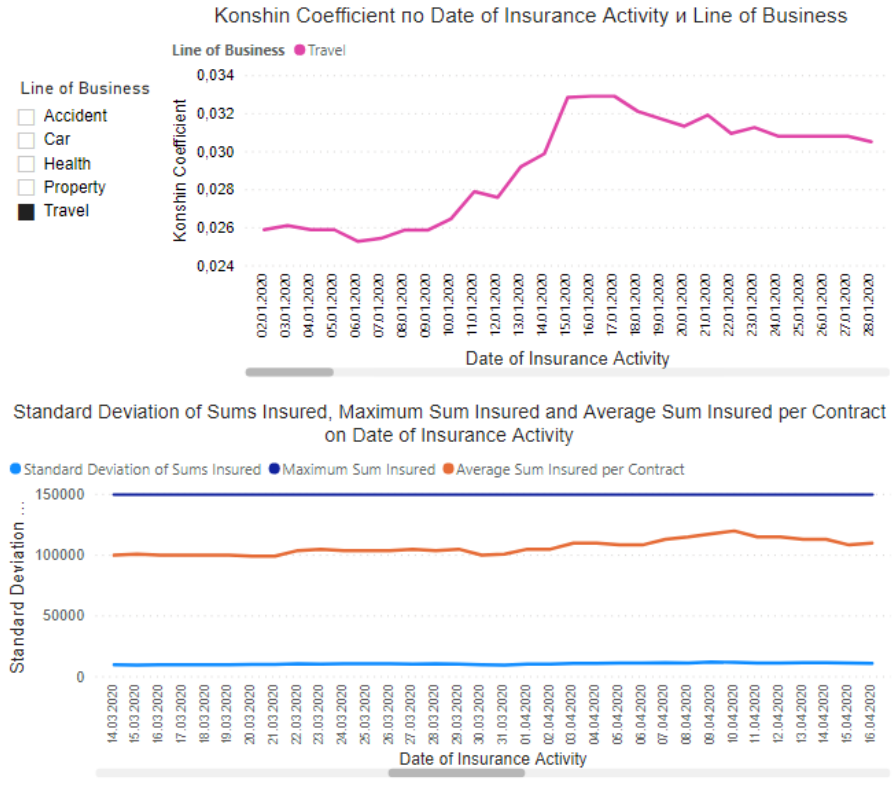

Fig. 18. Analytical panel for analysis of the level of technical risk on lines of business

The last example of the analytical panel (Fig. 18) can be used to monitor the technical risk of insurance activities for portfolios that contain valid insurance contracts. Joint visualization of the dynamics of the average and maximum sum insured, as well as the standard deviation of the sum insured allows you to quickly assess the level of technical risk and make an adequate decision. Most often, this type of risk is reduced by diversification of risks in the insurance portfolio and reinsurance.

These examples of dashboards confirm that Microsoft Power BI is a powerful tool for business analysis of insurance activities. This software product has a wide range of capabilities for monitoring the dynamics of indicators and in-depth analytics.

V. DISCUSSION

A significant number of researchers aim to retrospectively analyze the operation of financial

institutions' supervisory tools in the provision of financial services. For example, for banks, as the main participants in the financial services markets, the central tool of supervision is the reform and compliance with capital standards, weighted by the risks of these institutions [29]. In insurance activities, the issues of using e-technology to finance innovations [30], expressing the capabilities of the insurance portfolio of risks of innovative enterprises are raised [31].

Regarding the introduction of new insurance conditions, there is a practice that provides for early termination of life insurance contracts with appropriate calculated compensation [32] and the establishment of the procedure for risk aversion in such cases [33]. Therefore, the models of calculating the optimal risks for insurance contracts [34] are becoming relevant again. All these examples are not contradicted by the proposed means of visualization of control over insurance contracts with the help of Microsoft Power BI. Visualization of these contracts can be extended to include more control of insurance activity.

It should be noted that the existing scientific works do not pay attention to the specifics of operational analysis (monitoring), which is retrospective in its characteristics. In general, retrospective analysis is often based on financial statements and does not take into account the movement of insurance contracts. That is why the calculated indicators may be inadequate. Given this remark, it will be more correct to monitor the performance of insurance portfolios to identify changes in insurance activities.

VI. Conclusion

Summing up, we note that in terms of VUCA-world conducting operational business analysis is a necessity. Microsoft Power BI meets all the requirements for insurers to develop and implement business intelligence innovations.

The authors proposed to consider the insurance portfolio at a certain date of insurance activity is a set of valid (in force) insurance contracts for a separate line of business of the insurer. This approach to defining the insurance portfolio allows analysis for a particular line of business in terms of its profitability, level of technical risk and other parameters in real-time in order to identify problems that need to be adjusted in the portfolios of insurance contracts.

Monitoring of insurance activity based on indicators of insurance portfolios allows tracking trends in the insurance business, taking into account the movement of insurance contracts. The methodical approach to the operative analysis of insurance activity based on calculation of indicators of insurance statistics for insurance portfolios and their visualization on analytical panels of Microsoft Power BI considered in the article is actual to implement in practice of insurance companies.

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