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DETERMINATION OF THE OPTIMAL CONTROLLABLE KEY INDICATOR OF CALL CENTER IN ORDER TO INCREASE EFFICIENCY FOR GENERATING INCOME

Abstract: This paper focuses on call centers, which have become a common means of communication with potential customers in various companies. Specifically, this paper analyzes call center data and the importance of assessing key indicators for evaluating call center performance. The questions this paper addresses are the criteria for evaluating call center quality and the methods for analyzing call center data. Previous research has shown the significance of call centers as the "face of the company," with the quality of their work reflecting how efficiently a company will serve its customers ' requests in the future. The main goal of this paper is to fill a gap in previous research by identifying the main controlled key indicator for call center quality and to suggest ways to improve efficiency. By using analytical methods to examine call center data, this paper identifies the most important criteria for call center quality and provides recommendations for enhancing service quality.

The main findings of this paper show the importance of call center operator performance in determining call center performance which affects company revenue. By evaluating key indicators such as the number of operators, this paper demonstrates how call centers can reduce service costs and improve efficiency. During the analysis using call center data for two years, it turned out that the company had expenses 1/3 of the total amount of maintenance compared to the previous year, which is not effective in terms of economy. Operational planning has a direct impact on operators' costs and the main cost component is the hourly cost of operators. If optimal planning turns out to be at least 10% better than the arrangement set in the call center, company will save a good amount. The significance of this paper lies in its potential to improve the quality of service in call centers and its contribution to the field of customer

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service management. By providing insight into the importance of call center efficiency, this research offers recommendations for predicting the optimal number of operators to improve the customer experience with reducing service costs.

Keywords: call center; indicators; operator; call service center; data analysis; machine learning; call center quality; optimization.

Introduction

In conditions of high availability with customers, call centers become a guarantee of the activity of organization. Call centers are an essential tool for managing customer inquiries and providing quality customer service. The relevance of call centers lies in the fact that they allow companies to process customer requests, improve the quality of service and increase customer satisfaction quickly and efficiently. In addition, call centers can help companies reduce customer service costs, increase sales, and improve a company's reputation. Global call center trends include: implementation and use of artificial intelligence in call centers to automate processes; the development of cloud computing technologies, which allows companies to use remote call centers to process calls and customer requests; expanding the capabilities of call centers to process requests through various communication channels, such as email, social networks and instant messengers; development of data analytics features that help companies analyze customer interaction data and identify trends and issues related to customer service.

The company tries to minimize temporary misunderstandings between them and satisfaction with customer loyalty, to strengthen and continue further mutually beneficial relationships. Companies strive not only to retain their customers, but also to increase the self-sufficiency ratio. Some call centers have quality control teams that monitor and evaluate the quality of their work. The quality-of-service provision is the main factor of economic efficiency in the info communication sphere. The expansion of the range of telecommunication services leads to the determination of the number of customers, that the need to improve the work of call centers, to the quality of the characteristics meet for ever higher requirements.

The application of call centers can be very wide, they can be used in various industries. For example, in the banking sector, call centers can be used to handle customer inquiries related to banking products and services such as loans, debit and credit cards, bills, and so on. In government organizations, call centers can be used to process inquiries from citizens related to social services, tax issues, medical services, etc. In private companies such as taxis and carsharing, call centers can be used to process customer inquiries related to booking and payment for services. In general, call centers can be useful for any company to ensure efficient and high-quality communication with customers. This improves customer satisfaction, reduces request processing time, and increases employee productivity. Thanks to modern technologies and data analytics capabilities, call centers can become even more efficient and versatile tools for managing customer requests in the future.

Consulting companies such as McKinsey, Deloitte and PwC regularly publish reports and research on call centers. These reports [1-3] provide insights and recommendations for companies looking to optimize their call centers and improve customer satisfaction. The reports explore new technologies and approaches to call center management, such as the use of artificial intelligence and data analytics, service personalization, increasing the value of customer loyalty, and strengthening data security and privacy. The reports also predict new trends in the call center industry, such as the development of chatbots, the use of voice control, and service personalization.

Also, call centers play a significant role in applications such as carsharing, taxi and other shared mobility services of smart city, providing a crucial point of contact between service providers and their customers [4].

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The relevance of the paper is to define the main indicators in assessing the quality of the call center. The purpose of the paper is to analyze the indicators of the quality of the work of operators. The paper defined indicators that affect to quality and methods of theoretical research were used: literature review and statistical analysis.

Literature review

Call centers are an effective means of communication between a company and its customers. Koole [5] notes that call centers have become an essential part of many businesses, as they provide a means for customers to interact with companies and receive assistance. The most important issue is the quality of services provided to subscribers. This is since many firms have recently experienced a need for call centers due to increased competition and/or increased demand for services among the population. The author also highlights that call centers are often subject to a range of challenges, including high variability in call volume, unpredictable arrival rates, and customer impatience. The author provides a detailed description of the key indicators used to evaluate call center performance, such as service level, average speed of answer, abandonment rate, number of incoming calls, the average of talking time. The author also discusses the importance of effective call center staffing and scheduling, noting that these are critical factors in managing call center operations.

Leschinskiy and Tumanbayeva [6] consider the problem of forecasting outgoing traffic in call centers. They explore various forecasting methods, including exponential smoothing and time series methods, and compare their performance in predicting outbound call center traffic. The study showed that time series methods demonstrate the best forecasting accuracy and can be used to optimize the work of call centers. The authors also discuss the possibility of using outbound traffic prediction to optimize the use of call center resources and improve customer experience. In general, their work is of interest to researchers and practitioners in the field of call center management and can be used to improve the efficiency and quality of customer service.

Statistical survey data, presented on the website of the Association of Call Centers, indicates an insufficient level of first-hand customer service. With an increase in the load and an increase in the types of traffic processed in call centers, problems with ensuring the quality of service will worsen. Consequently, call centers have to pay attention to the quality of customer service.

Indicators of the quality of service are the probability of refusal in needs, the average waiting time for service in the queue, the average queue duration, and the average service time as mentioned earlier [7]. These indicators characterize the efficiency of the technical means and software of the call center. But the quality of customer service is also influenced by the quality of operators' work.

The quality indicators of the call center could be divided into: indicators of the quality of customer service by the operator; indicators of the quality of service of the call center; degree of customer satisfaction. Participants discuss processing indicators associated with several key characteristics, including customer focus, credibility, performance, and efficiency, as they relate to customers.

There are such areas of activities where the use of call centers would be an effective solution. In the service sector modern organizations are working strive for round-the-clock and operational interaction with real and potential customers. Features and organizational aspects of the activity of the call center operator provide a basis for building a group of specialists into the high-risk category in terms of monitoring the development of professional stress.

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There are several works, as shown by Malov [8], that describe a method for monitoring the operation of the call service center based on the use of mathematical modeling. According to [9, 10], the performance indicators are determined by the organization of the work of the call center and the patterns of the incoming flow of calls.

As mentioned in [11] service quality can be measured in terms of customer waiting time, service time, and the abandonment rate. The waiting time refers to the time a customer waits in the queue before being served, while the service time is the time taken to serve the customer. The abandonment rate refers to the percentage of customers who hang up before being served. The authors also mention that service quality can be measured by the percentage of calls answered within a specified time limit. This is commonly known as the service level and is often used as a key performance indicator in call centers. These indicators are important for call center management to monitor and improve service quality, which can ultimately lead to higher customer satisfaction and increased revenue.

In the paper by Jouini, Koole, and Roubos [12] the authors propose a performance measurement framework that considers the impatience of callers, which refers to the tendency of callers to abandon the queue if their waiting time exceeds a certain threshold. The main performance indicators proposed in the paper include average speed of answer, probability of abandoning, waiting time distribution, loading operators (utilization of agents). These metrics help evaluate call center performance, identify problem areas, and optimize call center processes. Overall, the authors provide a comprehensive discussion of various performance indicators used to evaluate the quality of call centers.

To improve the quality of work of call center operators, monitoring is necessary. As seen in [13] monitoring the quality of the work of operators is conditionally divided into two types: regular (scheduled) control of all operators; control of specific operators, carried out if necessary. The decision to monitor individual operators is made, as a rule, based on statistical data on their performance. For example, the average call processing time of one operator is significantly worse than that of other center operators.

Truth, here it is necessary to differentiate by operators, for example, the average call processing time for a beginner should be compared with the average time of other operators hired in one time, and not with the average time of experienced operators. When scheduling monitoring sessions, the specifics of the work of each specific call center are considered. Factors affecting the schedule include hours and days of the greatest load, time of change of operators, qualification of operators.

As a result of monitoring, data is collected on the performance of the call center, and the data can be large. Difficulties may arise in the processing of such data. The work of Balakaeva and Darkenbaev [14] investigates the problem of processing large amounts of data and proposes a method for modelling the process of processing such data. As part of their work, the task of optimizing the processing process was set, which can be relevant for many areas, including call centers. They propose the use of a data flow processing system and the development of a model based on machine learning technologies to optimize the data processing process, and to test the effectiveness of the model, experiments were carried out on real data.

The classic example of a call center is a structural one, designed to receive and process telephone calls from subscribers. However, result of the widespread use of Internet technologies in the entire sphere of human activity, new possibilities for using their services, such as e-mail, web chat etc., have appeared.

Companies with their own call centers incur significant costs associated with the purchase of licenses and special equipment, maintenance of premises, organization of workplaces, recruiting, and remuneration of employees. In turn, the number of operators might amount to

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hundreds, and often thousands of staff units. Chen and Henderson [15] paid attention on two important issues in call center staffing levels. The first issue addressed in the paper is the determination of the appropriate number of service representatives to hire for a call center. The authors provide a formula for calculating the optimal staffing level based on the trade-off between service level and cost. The second issue addressed in the paper is the assignment of service representatives to different types of calls. The authors propose a method for assigning service representatives to different types of calls based on the expected waiting times for each type of call. Overall, the paper provides useful insights into call center staffing strategies and highlights the importance of considering both service level and cost in staffing decisions. Reckless staff cuts perform a risk of a decrease in the quality of the work of the call center, which could lead to a decrease in customer loyalty and their outflow, and hence a reduction in income from call center service. Under these conditions, the accuracy of planning the number of call center personnel is one of particular importance. It should be highlighted that call service centers work in an environment where there is inherent uncertainty about the behavior of the external environment. This uncertainty is reflected in the intensity of the applications received by call centers with a limited number of operators, among other factors as shown by Zarubin, as previously stated.

Currently, call centers are embracing issues with their operators, including low productivity due to staffing shortages and high employee turnover. Gans and Zhou [16] address the challenges of managing employee staffing in the presence of learning and turnover. The authors propose a model to determine the optimal level of staffing and training investment, considering the costs associated with training and the benefits of a more experienced workforce and the shift planning.

One approach to solving the shift planning problem is to formulate it as an integer programming. An integer programming allows you to determine the optimal shift schedule based on certain objective functions and constraints. This programming uses integer variables that represent the distribution of operators across shifts during a work period. By formulating the shift scheduling problem as an integer programming and using the appropriate formulas to calculate personnel costs, it is possible to optimize shift scheduling in a call center, considering goals and constraints. We will calculate the calculation of staff costs for the period of the call center using the formula below:

$$\sum_{j=1}^{n} C_j x_j \quad , \tag{1}$$

where C is the cost of assigning an operator to the j-th shift. If x represents the number of operators assigned to shift j, we get the integer programming formula originally proposed by Dantzig [17].

Data Acquisition

The data from "city of Cincinnati" website was chosen as the object of the study, in which dataset contains the record of all Citizen Service Request (CSR) calls received at the call center at the Department of Public Services. Data is generated by incoming calls received and refresh frequency is daily, renewal of data we can find in [18]. The downloaded file contains data from 2014 to 2022 about 856315 rows. The initial view of the data is shown in Table 1.

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Table 1. Dataset

AGENT DISPID	CALL STAR TDT	CALL ACTIO NID	CALL ACTION REASONID	CALL ID	CONN CLEARDT	QUEUEEN DDT	QUEUE STAR TDT	ANSWER_ SPEED_ SECS	TALK_ TIME_ SECS	ABAN DONED	ANSWE RED
255	12.06.2021	8	44	944	12.06.2021 21:00	12.06.2021 20:58	12.06.2021 20:52	383	93	N	Answered
255	12.06.2021	8	44	902	12.06.2021 20:58	12.06.2021 20:56	12.06.2021 20:50	388	119	N	Answered
255	12.06.2021	8	44	864	12.06.2021 21:04	12.06.2021 20:51	12.06.2021 20:49	113	812	N	Answered
256	12.06.2021	8	6	698	12.06.2021 20:50	12.06.2021 20:49	12.06.2021 20:47	121	79	N	Answered
256	12.06.2021	8	6	693	12.06.2021 20:49	12.06.2021 20:47	12.06.2021 20:47	27	78	N	Answered
...	...	...	...	...	...	...	...	...	...	...	...

We utilized data from the years 2020- and 2021-month December for our analysis, since for the specified period there were more records without gaps. Before estimating the average service time and examining the factors that impact this indicator, we needed to gather statistical data on several variables, including the date of incoming calls, the volume of incoming calls, the number of calls that were served or unserved, the average time it took to answer a call in seconds, and the number of available operators (as depicted in Figure 1).

	date	answered	abandoned	talk_time_secs	call	season	weekday	year	agent
0	2020-01-04	209	18	83.013216	227	WINTER	2020-01-04	2020	6
1	2020-01-05	151	18	103.294118	169	WINTER	2020-01-05	2020	6
2	2020-01-06	876	428	84.733232	1304	WINTER	2020-01-06	2020	6
3	2020-01-07	329	115	98.280269	444	WINTER	2020-01-07	2020	6
4	2020-01-09	338	118	88.484848	456	WINTER	2020-01-09	2020	6
...	...	...	...	...	...	...	...	...	...
506	2021-12-27	365	52	112.110312	417	WINTER	2021-12-27	2021	5
507	2021-12-28	306	57	95.972603	363	WINTER	2021-12-28	2021	5
508	2021-12-29	288	71	90.319444	359	WINTER	2021-12-29	2021	5
509	2021-12-30	250	27	93.845878	277	WINTER	2021-12-30	2021	5
510	2021-12-31	0	0	0.000000	0	WINTER	2021-12-31	2021	0

511 rows × 9 columns

Figure 1. Input data

Our research paper provides exploratory data analysis using quantitative methods. The method of exploratory data analysis includes the data that contains the information that was analyzed to answer the research question and data visualization. During conducting an exploratory data analysis, we tried to determine whether there is a statistically significant relationship between the variables in the dataset. As a result of studying the relationship of attributes in the dataset, we determined the correlation of data with the number of operators. The results are presented in Figure 2 and Figure 3 below.

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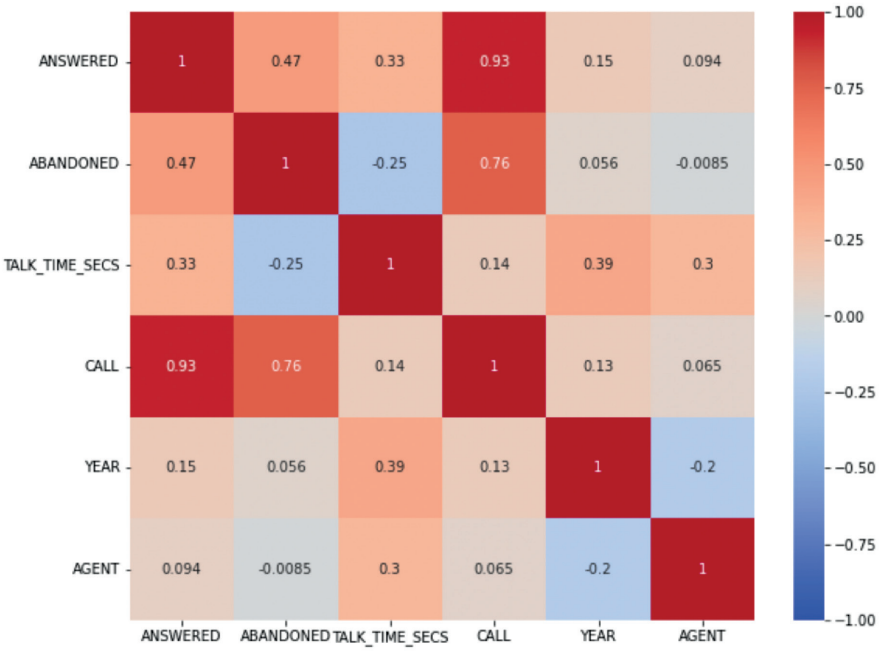

Figure 2. Correlation matrix with key values

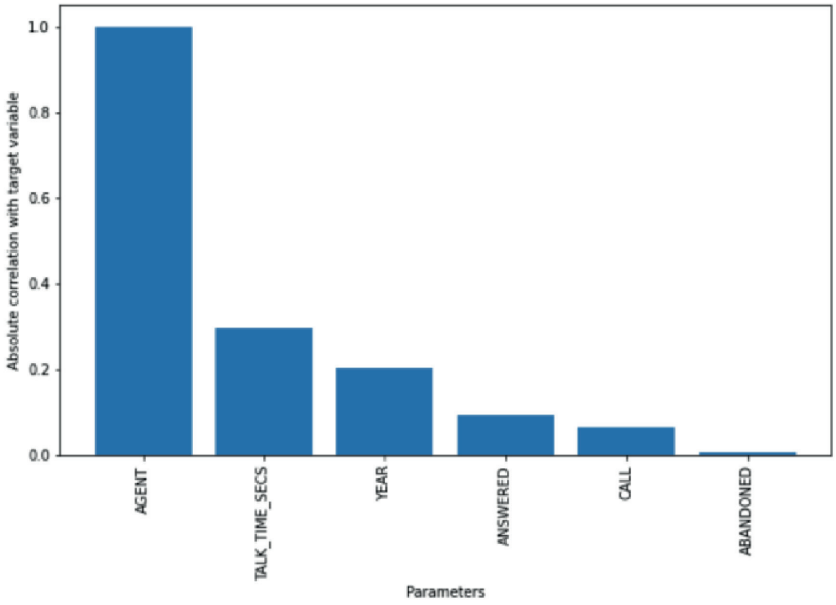

Figure 3. Prioritized key parameters of correlation

Solution methods and discussions

The paper provides exploratory data analysis using data visualization tool. The method of exploratory data analysis includes the data that contains the information that was analysed to answer the research question. Since the data type is a time series, we can analyse weekly, monthly, seasonally, and yearly. The average indicators for call center are below in Table 3: the number of incoming calls per month, answered calls, abandoned calls, average waiting time, average talk time, the number of operators, % of received calls.

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Table 3. Statistical data of call center

INDICATORS	DECEMBER 2020	DECEMBER 2021
The number of incoming calls	7617	7809
The answered calls	6083	6275
The abandoned calls	1534	1534
The average waiting time	167,6 sec	134,7 sec
The average talk time	95,3 sec	103,1 sec
The number of operators	14	9
The answered calls / The number of incoming calls (% of received calls)	79,9%	80,4%

Analysing call center data using statistical inference opens opportunities for a deep understanding of the effectiveness and quality of customer service. With the help of statistical methods, we can evaluate the overall performance of a call center. We calculated the average call processing time, the average queue time, or the average number of calls handled in a certain period. These metrics will help us understand call center performance and identify opportunities for improvement. This approach to call center data analytics helps companies make informed decisions to improve experience and increase revenue. Comparing the data from Table 3, it might be seen the result of an analysis of the number of calls served and lost calls. In December 2020, call center receives 192 times lower calls, compared to result of December 2021, but the percentage of serviced calls seems similar (~ 80%). Lost calls in both years are equal.

Based on the obtained statistical data, with similar indications the number of operators differs, which is not economically viable. Let's consider that the call center works according to the schedule of 8 hours, and one 8-hour day of work of the call center operator costs to the company 14,000 tenge. If we assume that there are 250 working days in a year (n = 250), then the call center costs 49million tenge in 2020 and 31.5million tenge in 2021 according to the integer programming formula (1), the company was in expenses by 17.5 million tenge more compared to 2021.

Thanks to advances in the field of artificial intelligence, namely in the direction of machine learning, it is becoming increasingly important to predict the optimal value using classical models. We can predict the optimal number of operators based on historical data to vary the number of operators on duty depending on the predicted workload. The study conducted an experiment using machine learning techniques such as linear regression, moving average, and decision tree to predict the optimal number of operators to increase efficiency to generate revenue. Linear regression, moving average, and decision tree methods offer ease of use, interpretability, and the ability to consider various aspects of the data, making them attractive for predicting [19]. Before applying these methods, we split our dataset from Figure 1 into three parts: training set (60%), validation set (20%) and test set (20%) and the visual division of the dataset we can see in the Figure 4 below. This approach allows us to efficiently use data to train the model, tune hyperparameters, and evaluate its performance.

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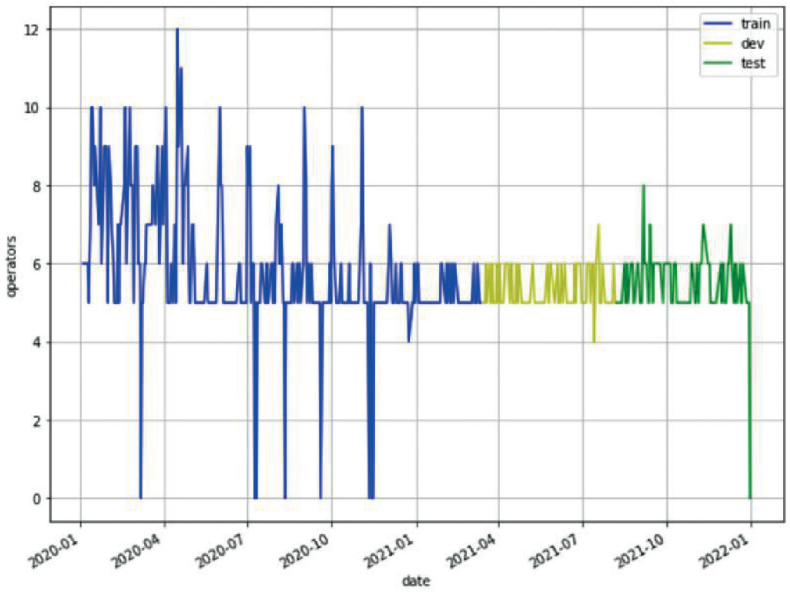

Figure 4. Split dataset into 60% train, 20% validation, and 20% test.

After splitting the data, we work using the methods machine learning that are mentioned above in the part of going through the work with the training set, where patterns and relationships in the data are studied, and the validation set, where the hyperparameters of the model are tuned to achieve its optimal performance and prevent overfitting. Finally, we move on to the test set, which is used to finally evaluate the performance of the model and check its ability to generalize to new data. This approach provides more reliable and objective machine learning results. The test result with our test data showed us good metrics with an accuracy of 90%. We can see a visual representation of the prediction and the average optimal number of operators derived from the prediction is presented in Figure 5 and Table 4 respectively below.

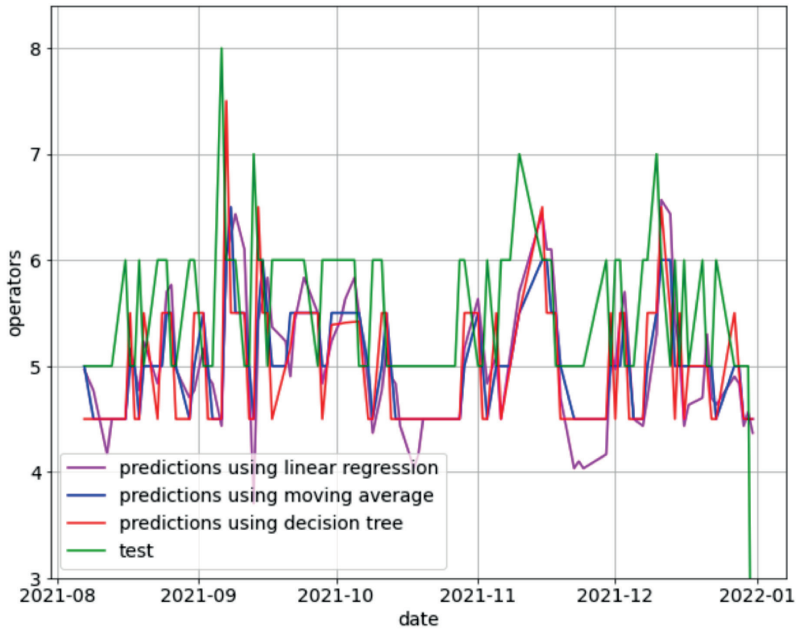

Figure 5. Predictions using linear regression, moving average, decision tree.

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Table 4. The average numbers of operators from testing data

Indicator	Actual Data	Predicted Data		
		Linear regression	Moving average	Decision Tree
The average number of operators (x)	5.47	5.03	5.02	4.99
The calculation of the cost using integer programming formula (n=102, C=14000tg)	7 811 160	7 182 840	7 168 560	7 125 720
The calculation of the average cost for one shift (n=1, C=14000tg)	76 580	70 420	70 280	69 860
The calculation of profit using formula 100-(Predicted cost*100/Actual cost)(%)	-	8,04%	8,22%	8,77%

As a result, the application of machine learning techniques in our prediction enables a cost reduction of at least 8% in comparison to the current operator placement in the call center. This translates to annual savings for the company. Considering the economic importance of these calculations, opting for our prediction would empower the company to make well-informed decisions regarding operator placement, leading to potential resource and cost savings. It is crucial to acknowledge that the performance quality of an organization heavily relies on considering external factors while adjusting the number of operators based on predicted workload. Often, these factors are overlooked, resulting in decreased efficiency and effectiveness. However, by leveraging comprehensive historical data encompassing all relevant metrics, we can accurately predict the optimal number of operators. Our forecast showed a 90% accuracy metric with an average of the optimal number of agents as shown in Table 4 and as a result, the organization receives a savings of 8% compared to a predetermined distribution of agents in the call center.

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Conclusion

Collection and analysis of statistical data of call center were carried out.

The main indicators in assessing the quality of the call center are defined, and the controlled parameter of the systems was defined the number of operators in the call service center. As criteria for optimality, the call service center should bring the maximum possible profit with a minimum number of operators considering the correct distribution of the number of operators. In the context of optimizing the work of the call center, the study made it possible to determine the most significant parameters that should be considered when distributing operators to achieve maximum efficiency and profitability. Moreover, the analysis of the data showed that the correct distribution of operators can significantly increase the efficiency of the service center, even when using a minimum number of operators.

Based on the analysis of statistical data for 2020- and 2021-month December, it turned out that with the same number of calls received, the number of operators in each of these years is different. This discrepancy is a non-economically justified indicator. The results of comparative calculation according to statistical data showed that the company suffered a loss of 35% compared to the previous year. The prediction using machine learning methods based

on the same data showed a benefit of 8%. Based on this, it can be determined that workplace planning plays a crucial role in ensuring the efficiency of the company and generating income at minimal cost.

The obtained result of the experiment proves the possibility of using machine learning methods in order to increase efficiency to generate income with the optimal distribution of operators and it can be used to optimize the work of the call center in a changing flow of customers, which will significantly reduce resource costs while increasing the quality of customer service. Various machine learning algorithms can be used to achieve this goal, that will more accurately determine the optimal distribution of operators depending on the current load on the call center.

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