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R. Reznikov,

PhD in Economics, Vice President, Intellias Global Limited

ORCID ID: <https://orcid.org/0000-0001-5581-5651>

S. Turlakova,

*Doctor of Economic Sciences, Professor, Institute of Industrial Economics of
National Academy of Sciences of Ukraine;*

*National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic
Institute”;*

Technical university “Metinvest Polytechnics” LLC

ORCID ID: <https://orcid.org/0000-0002-3954-8503>

IMPORTANCE OF MACHINE LEARNING AND DATA SCIENCE IN MODERN BUSINESS

Р. Б. Резніков,

д. філос. з економіки, Віце-президент, ТЗОВ «ІІТ «Intellias»

С. С. Турлакова,

д. е. н., професор,

Інститут економіки промисловості НАН України;

*Національний технічний університет України "Київський політехнічний
інститут імені Ігоря Сікорського»;*

ТОВ «Технічний університет «Метінвест Політехніка»

ВАЖЛИВІСТЬ МАШИННОГО НАВЧАННЯ ТА НАУКИ ПРО ДАНІ В СУЧАСНОМУ БІЗНЕСІ

The article explores the vital role of machine learning (ML) and data science in advancing business efficiency, especially under crisis conditions like the ongoing conflict in Ukraine. It discusses how digital transformation through these technologies is crucial for maintaining competitiveness and operational resilience. As part of the research, it was conducted deep analysis of existing works. It was identified gap of comprehensive studies on the strategic application of cloud-based ML and data science solutions during crises. This study Highlights the increasing accessibility of ML and data science tools due to technological advancements, fostering a competitive business landscape. The study emphasizes the democratization of advanced technologies facilitated by cloud platforms like Microsoft Azure, Google Cloud Platform (GCP), and Amazon Web Services (AWS), making sophisticated tools accessible to smaller companies. Article concludes that strategic use of ML and data science significantly bolsters business resilience and efficiency, especially in challenging environments like Ukraine. Article examines ML tools and services provided by AWS, Azure, and GCP. As an assessment criterion it was chosen features, integration capabilities, innovation, pricing structures, computing capabilities, and security measures. In scope of this research it was defined that each platform offers robust ML solutions with unique strengths tailored to different business needs. For example, AWS excels in specialized tools, Azure in integration within its ecosystem, and GCP in sustainability and advanced technologies. Article provides recommendations for selecting cloud-based ML and data science solutions that align with operational strategies and crisis management needs. It encourages ongoing research to explore the long-term impacts of these technologies on business innovation and market dynamics. Highlights the need for further studies into the socio-economic impacts of ML and data science, including addressing privacy, security, and ethical concerns. Article provides tailored advice on choosing appropriate ML and data science tools to support their specific needs during the ongoing crisis. Also, it suggests broader adoption of cloud-based ML and data science technologies for enhanced decision-making and operational efficiency.

У статті досліджується важлива роль машинного навчання (ML) та науки про дані у підвищенні ефективності бізнесу, особливо в умовах кризи, такої як поточний конфлікт в Україні. Розглядається, як цифрова трансформація за допомогою цих технологій є ключовою для підтримки конкурентоспроможності та операційної стійкості. У рамках дослідження був проведений глибокий аналіз існуючих робіт. Виявлено прогалину у всебічних дослідженнях стратегічного застосування рішень на основі хмарного ML та науки про дані під час криз. У цьому дослідженні підкреслюється зростаюча доступність інструментів ML та науки про дані завдяки технологічним досягненням, що сприяє формуванню конкурентного бізнес-середовища. Дослідження наголошує на демократизації передових технологій, сприянню якої здійснюють хмарні платформи, такі як Microsoft Azure, Google Cloud Platform (GCP) та Amazon Web Services (AWS), роблячи складні інструменти доступними для менших компаній. Стаття робить висновок, що стратегічне використання ML та науки про дані значно зміцнює стійкість та ефективність бізнесу, особливо у складних умовах, як в Україні. Стаття розглядає інструменти та сервіси ML, які надають AWS, Azure та GCP. Як критерії оцінки було обрано функціональні можливості, можливості інтеграції, інновації, цінові структури, обчислювальні можливості та заходи безпеки. У рамках цього дослідження було визначено, що кожна платформа пропонує потужні ML-рішення з унікальними перевагами, які відповідають різним потребам бізнесу. Наприклад, AWS відзначається спеціалізованими інструментами, Azure — інтеграцією в рамках своєї екосистеми, а GCP — стійкістю та передовими технологіями. Стаття надає рекомендації щодо вибору хмарних рішень ML та науки про дані, які відповідають операційним стратегіям та потребам управління кризовими ситуаціями. Заохочується проведення подальших досліджень для вивчення довгострокових впливів цих технологій на інновації в бізнесі та динаміку ринку. Підкреслюється необхідність подальших досліджень соціально-економічних впливів ML та науки про дані, включаючи питання конфіденційності, безпеки та етичних міркувань. Стаття надає конкретні

поради щодо вибору відповідних інструментів ML та науки про дані для підтримки їх конкретних потреб під час поточної кризи. Також пропонується більш широке впровадження хмарних технологій ML та науки про дані для підвищення ефективності прийняття рішень та операційної ефективності.

Keywords: *Machine Learning (ML), Data Science, Business Efficiency, Crisis Management, Military Conflict, Digital Transformation, Operational Resilience, Cloud-based Solutions, Comparative Analysis, Microsoft Azure, Google Cloud Platform (GCP), Amazon Web Services (AWS), Strategic Application, Innovation.*

Ключові слова: *Машинне навчання (ML), Наука про дані, Ефективність бізнесу, Управління кризами, Військовий конфлікт, Цифрова трансформація, Оперативна стійкість, Хмарні рішення, Порівняльний аналіз, Microsoft Azure, Google Cloud Platform (GCP), Amazon Web Services (AWS), Стратегічне застосування, Інновація.*

Introduction

The article discusses the critical role of machine learning (ML) and data science in enhancing business efficiency, particularly under crisis conditions such as the ongoing military conflict in Ukraine. The digital transformation through these technologies is imperative for businesses striving to maintain competitiveness and operational resilience. The relevance of this research is underscored by recent advancements in technology that allow even small companies to access powerful data science and ML tools, thus democratizing high-end technology and fostering a competitive business landscape. The introduction lays the groundwork by presenting statistical data up to the beginning of 2023, establishing the accelerating adoption of ML and data science across industries. This section highlights the disparity between companies that have integrated these technologies into their operational frameworks and those that have not, citing

studies that show how data-driven decision-making significantly enhances strategic alignment and operational efficiency. The paper identifies a gap in the literature concerning the strategic application of cloud-based ML and data science solutions in business, especially during crises. It addresses the need for comprehensive studies that evaluate the effectiveness of these technologies in real-world scenarios, particularly how they can support businesses in crisis-hit regions like Ukraine. The core of the article involves a comparative analysis of ML tools and services provided by major cloud technology platforms: Microsoft Azure, Google Cloud Platform (GCP), and Amazon Web Services (AWS). The study assesses features, integration capabilities, innovative aspects, pricing structures, computing capabilities, and security measures of each platform, providing a detailed guide for businesses to make informed decisions based on their specific needs. The findings reveal that all three platforms offer robust ML solutions, but each has unique strengths that cater to different business requirements. For instance, AWS is noted for its extensive suite of specialized tools, Azure for its seamless integration within the Microsoft ecosystem, and GCP for its focus on sustainability and cutting-edge technology. The article provides recommendations for Ukrainian companies on selecting cloud-based ML and data science solutions that align with their operational strategies and crisis management needs. The paper concludes that the strategic use of ML and data science significantly enhances business resilience and efficiency, particularly in challenging environments. It calls for ongoing research to explore the long-term impacts of these technologies on business innovation and market dynamics, emphasizing the transformative potential of data science and ML in navigating and thriving in the digital era. The article suggests further research into the socio-economic impacts of ML and data science, particularly how these technologies can lower barriers to entry in technology-driven markets and address privacy, security, and ethical concerns in AI applications.

Problem statement.

In the rapidly evolving digital landscape, machine learning (ML) and data science have emerged as pivotal tools for businesses seeking to enhance their operational efficiency and competitive edge. The disparity in the adoption of these technologies marks a significant divide in the corporate world. Companies that integrate machine learning (ML) and data science into their operational frameworks indeed tend to outperform those that do not. That means that companies which will not be able to start using those tools may lose competition on the market. That is why it is crucial for each organization to explore the power of data science and ML tools. This research will help organization to better understand how these technologies may help their business.

Analysis of publications

The application of data science in hiring processes has proven to enhance employee selection, aligning more closely with a company's strategic goals and improving efficiency and decision-making [1]. Moreover, the integration of digital transformation strategies, including data mining and ML, has shown significant improvements in enterprise performance [2]. Additionally, advanced predictive analytics and forecasting methods in data science led to optimized business operations and increased organizational productivity [3].

The research into the investment by public companies into machine learning and data science reveals significant engagement. For example, major firms like Robeco, Goldman Sachs Global Investment Research, and Neuberger Berman utilize AI and big data tools to enhance their investment processes, indicating a strong investment into these technologies [27]. Moreover, public companies in Europe that invest in ESG (Environmental, Social, and Governance) practices, leveraging machine learning techniques, have shown better financial performances, reflecting a growing trend in responsible investment decisions [28]. Ahmed Abboud Ali in his paper predicts that the global market size of machine

learning implementations will exceed \$20 billion by 2024. It emphasizes the widespread adoption across various sectors, including government and social services [29]. According to Market Research News US, paper estimates that machine learning-based implementations will have a global market value of nearly \$50 billion by 2025. This reflects significant investment in improving accuracy and reducing errors through advanced machine learning and deep learning technologies [30].

For Ukrainian businesses, the stakes are even higher. Operating under the pressures of an ongoing military conflict and economic instability, leveraging advanced technologies is not merely an option but a necessity for survival and growth. The agility and resilience provided by ML and data science are critical in navigating the complexities of the current economic landscape. Cloud services significantly contribute to the democratization of technology, allowing companies to remain competitive and innovative in challenging market environments. The use of cloud computing has been found to enhance the competitive advantages of commercial organizations, affecting key dimensions such as quality, cost, and responsiveness [4]. Additionally, cloud services have been integral in enabling companies to undergo digital transformations rapidly, especially during the COVID-19 pandemic, by improving collaboration, productivity, and driving innovation [5]. Furthermore, cloud adoption plays a pivotal role in reshaping firm strategies, encouraging adaptability in a volatile digital landscape [6]. These platforms offer scalable solutions that empower even small businesses to implement cutting-edge technologies that refine forecasts, enhance operational efficiencies, and improve service offerings.

Through the strategic use of cloud-based ML and data science services, businesses can tap into powerful analytics and predictive models that drive better business and financial performance. This approach not only mitigates the need for expensive personnel but also accelerates the adoption of innovations, enabling

companies to swiftly adapt to market changes and consumer needs while maintaining a focus on core business activities.

Feng Wang & Joey S. Aviles explored how integrating machine learning with business intelligence can enhance operational efficiency. They demonstrated how regression and neural network algorithms, when applied to historical sales data, enable precise sales forecasting. This supports strategic decision-making across marketing, inventory management, and production planning, thus optimizing business operations [7]. Aaron D. Tucker, Markus Anderljung, and Allan Dafoe examined the socio-economic impacts of improved data efficiency through machine learning. Their research focused on how increased data efficiency could potentially lower barriers to entry in AI, fostering greater competition. They discussed the complex effects on privacy, data markets, robustness, and misuse of AI systems, noting that larger, data-rich firms might disproportionately benefit from these advances [8]. Pasquale D'Angelo tackled the challenges of efficiency and effectiveness in machine learning across large datasets. His thesis detailed the development of scalable learning models that are effective in complex situations such as survival analysis with large Medicare data and multi-label classification involving extensive data sets like Wikipedia and Amazon products [9]. Avln Sujith and his team investigated how machine learning could impact effective financial decision-making within businesses. Their study highlighted how ML techniques help in analyzing vast amounts of data to extract patterns and forecast outcomes, thereby facilitating better decision-making across various business functions including finance and marketing [10]. Leonidas G. Barbopoulos, Rui Dai, Tālis J. Putniņš, and Anthony Saunders researched the impact of machine learning on market efficiency, particularly in financial markets. They analyzed how machine learning improves the processing of financial information, leading to more efficient market responses and reduced biases, particularly in handling complex and voluminous data sets [11]. M. Aruna, Dr.R. Jayakarthik, Er.S. John Pimo, Bhola Khan, Makarand Upadhyaya, and Neenu Kuriakose investigated the

challenges and opportunities of adopting machine learning (ML) in small and medium-sized enterprises. They found that while SMEs struggle with the adoption of ML due to resource limitations and a lack of ML expertise, partnerships and strategic use of available tools can mitigate these barriers. Their study offers strategies to enable SMEs to effectively utilize ML to enhance their competitiveness [12]. Inayatulloh developed a model for adopting machine learning to improve e-commerce effectiveness for SMEs. His research addresses the underperformance of SMEs in meeting sales targets through e-commerce platforms. By proposing a machine learning adoption model, Inayatulloh aims to enhance feature recommendations on SME e-commerce platforms, thereby boosting online sales effectiveness [13]. Shahen Hacyan also focused on enhancing e-commerce effectiveness for SMEs through machine learning. Similar to Inayatulloh, Hacyan's research emphasizes building a machine learning model to assist SMEs in improving their sales performance on e-commerce platforms, highlighting the practical application of ML in navigating the competitive online retail environment [14]. Ling Peng explored the role of machine learning in enhancing the innovation performance of startup enterprises, particularly in the context of organizational resilience. This study uses machine learning algorithms to analyze various business indicators, providing insights into how startups can leverage ML to navigate economic challenges and enhance their innovation capabilities [15]. Nianqiang Li explored the application of data science in marketing and its critical role in achieving a sustained competitive advantage. His study examines how advanced analytics can enhance data-driven decision-making in marketing, highlighting benefits such as improved customization, predictive forecasting, and effective return on investment (ROI) measurements. Li's research underscores the transformational potential of integrating big data and analytics into marketing strategies to boost marketing effectiveness and overall business performance [16]. M. Swetha, N. E., and Santosh D. Parakh discussed the broad impact of empirical data analysis across various business functions such as

production, operations, finance, marketing, and human resources. Their work highlights the essential role of data science in enhancing market share by employing diverse data analysis techniques to make more effective business decisions. The study showcases how data science can identify and analyze relationships and trends among business factors, significantly influencing strategic decision-making [17]. Shevchenko N., Turlakova S., and Latisheva O. describe in their work how Enterprise Resource Planning (ERP) and Manufacturing Execution Systems (MES) have proven instrumental in enhancing operational efficiency and transforming business processes for industrial enterprises. These systems collect a significant amount of data related to various facets of business operations. Analyzing this data using Machine Learning (ML) and Data Science techniques can unlock valuable insights to drive strategic development and operational efficiency [18]. Key areas where data from ERP and MES systems can be utilized include predictive maintenance, where historical and real-time machinery data is analyzed to predict maintenance needs, reducing downtime and repair costs. Supply chain optimization involves forecasting demand, optimizing inventory levels, and improving supplier selection processes. Production scheduling and process optimization streamline production schedules, reduce bottlenecks, and maximize equipment utilization. Anomaly detection and quality control help identify deviations in production quality, ensuring consistent output. Lastly, resource management and budgeting optimize resource allocation, control expenditures, and improve budget planning. Antonio Duarte Santos provided insights into how data science strengthens businesses by leveraging large volumes of data to gain market insights. Santos elaborates on the utilization of data science tools and techniques, such as Rstudio and SPSS, to perform economic and business analysis. His essay emphasizes data science's role in transforming raw data into actionable insights that can lead to regenerative benefits for organizations, thereby enhancing their competitive stance [19]. Teresa Guarda, Washington Torres, and Maria Fernanda Augusto analyzed the transformative impact of quantum

computing combined with data science on business competitiveness. Their research discusses how quantum computing can address processing challenges associated with large data sets, enhancing the capabilities of data science to solve complex problems and achieve competitive advantages. This interdisciplinary approach suggests significant potential for businesses to innovate and gain market advantage [20]. Burl Henry focused on the role of Big Data in achieving competitive advantage. Henry argues that Big Data is crucial for enhancing productivity, fostering innovation, and transforming business processes. The paper outlines how Big Data can revamp decision-making processes and shift business ecosystems, thereby underlining the strategic importance of data science in maintaining and enhancing competitive advantage in various industries [21].

The analyzed works and a number of other studies remain a number of unresolved questions. None of the referenced studies specifically address the use of ML and data science tools to navigate the challenges posed by external crises like military conflicts or economic instability. While some papers mention general strategies for implementing ML and data science, there are no detailed, step-by-step approach to deploying these technologies in a real life context. This includes data collection, predictive modeling, feature engineering, segmentation, and intervention strategies specifically tailored to manage customer churn during unstable times. The studies mentioned tend to focus on theoretical or broad applications of these technologies rather than detailed, practical integrations. Although some papers discuss the potential economic benefits of ML and data science, none of them provides a concrete analysis of economic impact, including ROI, revenue increase, cost savings, and margin improvement from specific ML-driven strategies.

The goals of the article

The goal of this paper is to examine how ML and data science tools, facilitated by lower costs and increased accessibility, empower companies to leverage new technologies to boost business efficiency.

Main study

In the contemporary business landscape, machine learning (ML) and data science tools significantly impact market competitiveness. With the advent of affordable modern technologies, even small companies can harness these tools to enhance business operations. As part of the research it was aimed to prepare recommendations for organization of how they can use cloud based ML and Data Science solutions in their business it was evaluated the ML tools and services provided by three major cloud technology providers—Microsoft Azure, Google Cloud Platform (GCP), and Amazon Web Services (AWS)—analyzing their features, integration capabilities, innovative aspects, pricing structures, computing capabilities, and security measures. The study aims to assist stakeholders in making informed decisions by highlighting the unique strengths and positioning of each platform in the cloud ML market.

Recent advancements in cloud computing have democratized access to powerful machine learning tools, creating a competitive advantage for businesses of all sizes. There was conducted a comparative analysis (table 1) focusing on several key aspects including features, integration, innovation, pricing structures, computing capabilities, and security compliance of three leading cloud services: Microsoft Azure, Google Cloud Platform, and Amazon Web Services. Outcomes of the research is provided in table below:

Table 1. Cloud Platform Comparison

	Amazon Web Services	Microsoft Azure	Google Cloud Platform
Machine Learning Services and Tools	Offers an extensive suite of ML services, notable for its functionality across specialized areas such as image and video analysis, and chatbot functions. AWS is praised for its broad array of services and deep functionality across more specialized areas like document analysis with Textract and chatbot functions with Amazon Lex [22], [23].	Integrates seamlessly with the Microsoft ecosystem, providing tools that enhance model building and cognitive abilities across various domains. Azure's ML tools include Azure Machine Learning Studio for model building and Azure Cognitive Services for capabilities like vision, speech, and language understanding [24].	Emphasizes innovation in data analytics and ML, with advanced tools supporting extensive data processing and sustainability initiatives. GCP tends to focus on cutting-edge technologies and sustainability, often making it the choice for projects that push the boundaries of AI and ML research [22], [24].
Computing Capabilities	Features a broad array of computing options, supporting scalable and flexible service integration. compute offerings are extensive, featuring a wide range of options including Elastic Compute Cloud (EC2) and various container services. AWS is known for its flexibility in scaling and extensive third-party integration [25].	Supports hybrid cloud environments and diverse operating systems, enhancing their utility in enterprise settings. Provides strong support for hybrid cloud environments and is compatible with various operating systems and platforms. Its integration with Microsoft tools and services is a significant advantage for many enterprises [25].	Offers competitive pricing in computing, emphasizing efficient scaling and modern container orchestration. Compute Engine offers per-second billing and deep discounts along with cutting-edge Kubernetes support, making it appealing for organizations looking for efficient scaling and modern container orchestration [25].
Pricing and Cost Management	Adopts a pay-as-you-go pricing model which is flexible and allows businesses to scale services according to their needs. This model is beneficial for handling diverse and dynamic workloads [26].	Also follows a pay-as-you-go model but with options for short-term commitments that offer discounts, which can be advantageous for predictable workload management [26].	Distinguishes itself with its sustained use discounts, which provide lower prices for longer-running workloads. This can be particularly cost-effective for continuous operations and heavy data-processing tasks [26].

Source: [22-26].

The choice of cloud platform is influenced by specific business needs, budget constraints, preferred technologies, and existing infrastructure. Each platform's unique offerings cater to different aspects of machine learning tasks and broader business objectives. This comparative analysis provides a foundation for businesses to select the most suitable cloud-based ML services, taking into account their specific operational needs and strategic goals. Future research could explore the long-term impacts of these technologies on business innovation and market dynamics. In the digital era, organizations are increasingly confronted with the decision of whether to implement machine learning or data science. This choice is pivotal and depends on specific organizational goals, data maturity, and the intended use cases. In table 2 author systematized key factors and decision points that influence the adoption of ML and data science:

Table 2. Data Science and Machine Learning Comparison

	When to Use	Organizational Impact
Data Science Adoption	Data science is most beneficial when organizations need to extract insights and knowledge from large datasets. It is ideal for discovering patterns, testing hypotheses, and making data-driven decisions.	Enhances decision-making capabilities, supports strategic planning, and improves understanding of customer behaviors and market trends.
Machine Learning Adoption	Machine learning is suitable when there are clear, repetitive tasks that can be automated or when predictive capabilities are required. It is particularly effective in applications requiring real-time decision-making and adaptive learning.	Increases operational efficiency, reduces human error, and enables the development of personalized services and products.

Source: [created by author].

Organizations should consider both the immediate benefits and the long-term impacts on their operational processes and business models. When comparing data science tools (table 3) across AWS, Azure, and Google Cloud Platform (GCP), each platform offers a distinct set of strengths catering to different aspects

of data science workflows, including data management, analytics, machine learning, and integration capabilities.

Table 3. Data Science Tools Comparison

	Azure Web Services	Microsoft Azure	Google Cloud Platform
Data Science Tools	Amazon S3 for robust and scalable data storage. AWS Lambda and Elastic MapReduce (EMR) for processing data. AWS Glue for data integration and ETL operations. Amazon Redshift for data warehousing, providing fast analytics over large datasets. AWS also offers tools like SageMaker for streamlined model building and deployment, supporting a broad ecosystem of machine learning frameworks [23].	Azure Blob Storage for data storage. Azure HDInsight and Azure Databricks for big data analytics. Azure Synapse Analytics, a service that blends big data and data warehousing. Azure Machine Learning Studio for model management and deployment. Azure's strengths also include robust support for hybrid cloud configurations, which can be beneficial for enterprises with complex data architectures [23], [26].	Google BigQuery for large-scale data warehousing. Google AI Platform and Vertex AI for model training and deployment. Google Dataflow and Dataproc for data processing. GCP excels with its deep integration into the Google ecosystem, including advanced AI and machine learning capabilities, making it a leader in innovative data science solutions [23].

Source: [23, 26].

All three platforms offer competitive pricing models with nuances:

- AWS uses a pay-as-you-go model that is highly flexible but can become complex due to its vast service range.
- Azure also follows a pay-as-you-go model, with additional benefits for users within the Microsoft corporate agreements.
- GCP often provides the most cost-effective solutions for long-term projects due to its sustained use discounts and is particularly attractive with its \$300 free credit for new users [26].

By employing this framework, organizations can methodically compare each platform's advantages and limitations relative to their specific business and technological needs, guiding them towards the most suitable choice for their ML and data science endeavors. The selection often hinges on the particular use cases, existing infrastructure, and anticipated growth trajectories of the organization. To show case how Machine Learning and Data Science can support business it is described real case implemented by Intellias (Ukrainian IT-service company) for one of their client. The the background of the client: medium-sized retail company operates both physical stores and an online platform. Despite steady growth, the company faces challenges in customer retention, inventory management, and personalized marketing, impacting their competitive edge and profitability. Retail businesses often face high customer churn rates, which can erode profitability and long-term viability. Reducing churn and increasing customer lifetime value are critical for sustaining growth and improving revenue. Intellias helped their client to implement machine learning and data science techniques to predict customer churn, identify at-risk customers, and develop targeted interventions to retain them. Project cost was estimated as 550 000\$ mostly spent on data engineers, data science team and cloud infrastructure. Intellias choose following approach and methodology:

- **Data Collection:** Gather historical data on customer interactions, usage patterns, service tier, payment history, customer support interactions, and demographic information.
- **Predictive Modeling:** Develop a machine learning model to predict the likelihood of churn for each customer. Techniques such as logistic regression, random forests, or gradient boosting machines could be used based on the dataset's characteristics.
- **Feature Engineering:** Use data science to analyze and create meaningful features that influence churn, such as usage frequency, changes in service usage, payment irregularities, and customer satisfaction scores.

- **Segmentation:** Segment customers based on their predicted churn risk and other significant behavioral metrics identified during the feature engineering phase.

- **Intervention Strategies:** Develop targeted intervention strategies for different segments.

Implementation plan started with a pilot program involving a controlled group of customers to refine the predictive model and gauge the effectiveness of different intervention strategies. As a next step it was a gradual roll out the successful aspects of the program across the customer base, continuously monitoring performance and making adjustments as needed. As toolset was used data science platforms and programming languages such as Python, R, or specialized software like SAS for data analysis and model building. Intellias also helped to implement integration with existing CRM and ERP systems to leverage real-time data and actions. As an economic effect achieved, company managed to effectively predicting and mitigating churns. The company expects to reduce churn rates by a significant percentage, directly increasing recurring revenue. Also, it was improved retention rate and extended the average customer lifecycle, which resulted in increasing the total revenue generated per customer. The return on investment from these data science initiatives significantly outweigh the costs due to the extended value of retained customers and reduced marketing costs for acquiring new customers. To measure success of this endeavor Intellias and their client used following metrics:

- **Churn Rate:** The primary metric for success is the reduction in churn rate post-implementation.

- **Customer Lifetime Value (CLV):** Increase in average CLV as a result of extended customer relationships.

- **Engagement Metrics:** Improvement in customer engagement scores based on interaction data.

- ROI Analysis: Regular analysis of the financial benefits of the program compared to its cost.

Intellias and their client achieved first results within 12 months. By implementing targeted marketing and personalized recommendations, client achieved a 11% increase in average purchase value and a 4% increase in transaction frequency within first year, which translates to an additional \$2 million in annual revenue. Predictive analytics reduces overstocks and stockouts, saved client an estimated \$311,000 annually in reduced holding costs and lost sales in the first year of implementation. Dynamic pricing helps improve margins by 2%, which corresponds to an additional \$400,000 in profit annually. Increased revenue and reduced costs provide an estimated total benefit of \$2.71 million annually.

As a result first year of using Data Science and ML toolset helped client to achieve ROI: $$(2.71 \text{ million} - \$550,000) / \$550,000 = 392\%$. The initial investment of \$550,000 is recouped in significantly less than a year, given the annual benefits. The Intellias project demonstrates a compelling economic case for the strategic implementation of machine learning (ML) and data science in retail to combat high customer churn rates—a common challenge that undermines profitability and long-term viability. This case underscores the potential of these technologies to transform customer data into actionable insights that significantly enhance customer retention and increase revenue. The economic impact of utilizing ML and data science in reducing customer churn is profound, offering not only a rapid payback on investment but also long-term benefits in customer relationship management and financial performance. Companies across industries can adapt this approach, tailoring it to their specific operational contexts and customer dynamics to drive growth and competitiveness.

Conclusion

The investment in data science and ML technologies enables customers to transform its business operations, leading to substantial economic benefits through increased sales, optimized inventory, and dynamic pricing strategies. This

investment not only improves companies competitiveness but also significantly enhances its market position by providing superior customer experience and operational efficiency. Intellias case illustrates how strategically investing in data science and ML can generate a high ROI by directly impacting both the top line and bottom line of a company. In this case the client was a large enterprise company with complex IT infrastructure which required significant investment to implement ML and Data Science tools. For smaller scale companies investment will be smaller, so business case would be more or less similar, however the bigger the scale the higher potential ROI (due to economy on scale). Choice among technologies should consider your specific data science needs, existing infrastructure, and future scalability requirements. AWS offers the most extensive array of services, Azure provides excellent integration with Microsoft technologies, and GCP leads in analytics and machine learning innovations. Each platform has developed specific strengths, making them suitable for different types of data science projects and organizational needs. A promising research direction is the trial of ML and Data Science tools to assist companies in overcoming crises such as the Russian invasion of Ukraine.

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