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BULSTRAD: ML-BASED PRICING AND RATING ENGINES

Winner of the 2022 Celent Model Insurer Award for Data, Analytics and AI

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CASE STUDY AT A GLANCE

The process of rating and pricing risks have evolved from essentially cost-based models to more sophisticated algorithms leveraging various parameters. Today, machine learning, new sources of data, and pricing optimization techniques allow insurers to differentiate their tariffs and be more reactive to market changes.

Table 1: Case Study At A Glance

Financial Institution	Bulstrad Vienna Insurance Group
Initiative	ML-Based Pricing and Rating Engine
Synopsis	Bulstrad's ML-based pricing and rating engine initiative consists in applying multivariate rating algorithms leveraging predictive analytics to optimize pricing of specific products.
Timelines	• Start February 2021 • 10 weeks: running portfolio simulations and validating the outcome of these projections • Go-live October 2021
Key Benefits	• Machine learning-based competitive pricing reduces the traditional process from 3 months to 3–5 days including simulation and validation. • Automatic deployment of rating tables reduces a 5- to 10-day process to minutes. • The ruleset technology and subsystem allow an instant deployment by just pressing a button (instead of 15 to 30 days coding and configuration) without requiring IT staff.
Key Vendors	Ablera

Source: AIA Group Limited

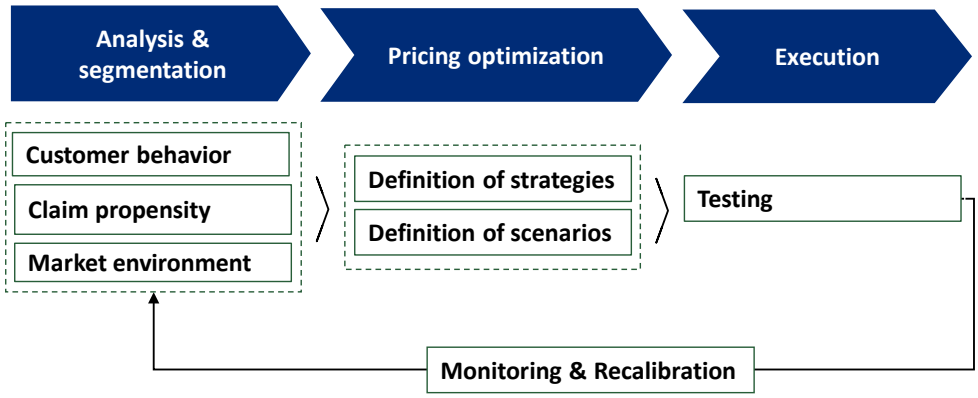
CELENT PERSPECTIVE

Price optimization helps insurers focus on key business questions to refine their pricing decisions. It brings various dimensions into the pricing calculation, balancing profit and sales volume while applying customer behavior and competitive analysis in order to maximize profit. Machine learning, new sets of data, and new risk factors help insurers refine their price components and optimize their rating and pricing tables.

Pricing Optimization

Rating and pricing are particularly important processes because they represent the basis to generate a positive underwriting result. Pricing optimization can be decomposed in various stages as shown in Figure 1:

Figure 1: Pricing Optimization Process



Source: Celent

- **Analysis and segmentation:** The quantity and quality of data are key to price optimization. Indeed, customer data allows insurers to analyze and identify segments through modeling customer behavior, claim propensity, and the market environment. Using behavior models, insurers try to predict how customers' attributes can influence a type of behavior and what impact it can have on sales. Customer behavior models are particularly important in assessing the renewal rate. Claim propensity models help insurers determine the probability that a customer will report a claim, providing useful input to new rating plans or scoring systems to refine underwriting rules. Finally, modeling the market environment provides an analysis of the market in which the company operates. For example, market environment models enable insurers to predict how their competitive position varies by segment or type of market.

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- **Pricing optimization**: Optimization techniques consist of defining strategies and scenarios that integrate the models to predict volume and price, identify the best prices, and measure the impact of price changes. Pricing optimization is the task that finds the optimal tradeoff between the supply and demand sides: profit per customer or per segment versus price elasticity.
- **Execution**: Running simulations and comparing the results with defined scenarios is an important element of testing. Execution of testing can be performed in a test environment on a back office system.

To close the loop, it is important for insurers to monitor and recalibrate the predefined models that have been at the source of the strategy and scenario definition. A specific pricing strategy that is judged to be optimal at a certain time will sooner or later lose its validity—and as new data is collected on the market, customer and market attributes change, triggering new constraints that need to be identified through rigorous monitoring to implement the necessary recalibration on time.

Online Insurance Has Boosted the Adoption of Pricing Optimization Techniques

The boom of online insurance over the past two decades—particularly in motor and home insurance—has forced insurers to improve the speed at which they are able to adapt their premiums in order to remain competitive and win new business online.

In markets where online insurance has become the major sales channel, aggregators have become unavoidable. To gain a competitive advantage, a handful of insurers have launched initiatives around real time price optimization to improve their ranking on aggregators' websites while gathering useful client information directly from the market.

Adoption of Artificial Intelligence

General insurers are increasing their investment in artificial intelligence to improve their core business processes. In 2021, our annual survey of EMEA general insurance CIOs showed that more than three-quarters of them were planning to invest in analytics and artificial intelligence via replacement or significant enhancements of their current tools.

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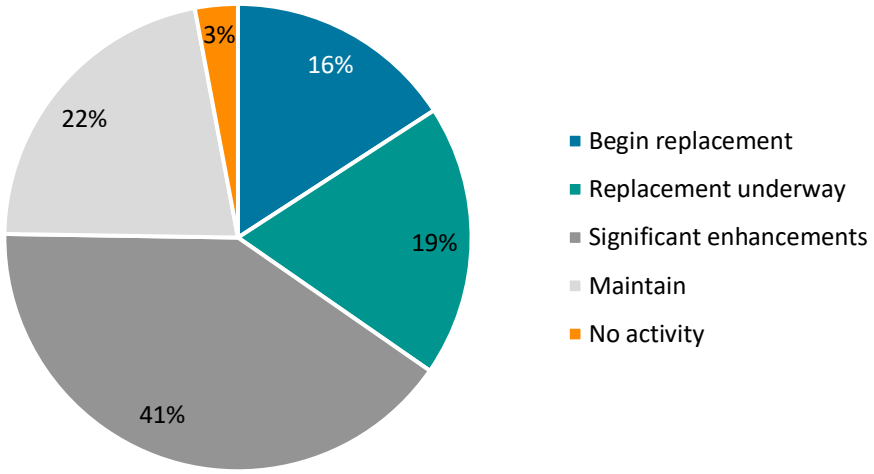
Figure 2: 2021 Planned Investment in Analytics and AI



Source: Celent

Overall, when investing in artificial intelligence general insurers tend to prioritize areas with a strong impact on their loss ratio, including rating, pricing, car damage estimation, claims fraud detection, claims process optimization, and subrogation optimization.

We think the Bulstrad ML-based pricing and rating engines project is particularly interesting. Indeed, it provides a useful example of how machine learning can generate tangible benefits and have a major impact on the fundamental business of an insurer: its underwriting profit.

The next sections of this report detail the Bulstrad project, including the lessons learned by the insurer.

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DETAILED DESCRIPTION

Introduction

Bulstrad Vienna Insurance Group (Bulstrad) is a Bulgarian insurance company active in various lines of insurance businesses including aviation and marine, cargo and property, motor insurance, construction-and-erection risks, and other personal lines. In 2007, Bulstrad was acquired by Vienna Insurance Group, the largest Austrian insurer.

Table 2: Bulstrad Vienna Insurance Group Snapshot

Year Founded	1961
Headquarters	Sofia, Bulgaria
Annual Premium	~€200M
Geographic Presence	Bulgaria
Employees	~500
Other Key Metrics	• More than 350,000 customers. • Bulstrad has a partnership with EIRB London—a Lloyd's broker—which connects them to the London international reinsurance markets.
Relevant Technologies and Vendors	• Artificial intelligence, machine learning, cloud • Ablera

Source: Bulstrad Vienna Insurance Group

In a highly competitive market, Bulstrad decided to enhance its rating strategy and process. Through its machine learning pricing and rating engines initiatives, the company has become more efficient and more responsive to market changes. Bulstrad now provides online rating capabilities to agents and underwriters and increasingly to policyholders, leveraging algorithms trained on abundant data, allowing for motor insurance portfolio optimization and quick response to competitor product strategies and dynamic market conditions.

The next sections provide further detail about Bulstrad's initiative. We think insurers desiring to improve their rating and pricing capabilities should emulate what Bulstrad has been doing and assess how a similar approach can add value to their business.

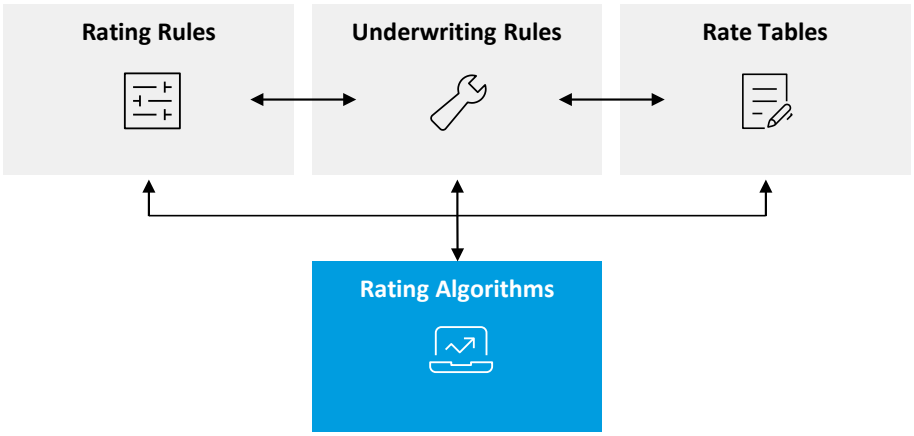
Opportunity

To succeed in the increasingly competitive Bulgarian motor insurance market, and particularly the compulsory motor liability insurance segment, Bulstrad understood it needed to implement a more efficient rating process. The insurer

identified that the Bulgarian motor insurance market had become more challenging, requiring insurers to apply frequent changes in rates and to differentiate themselves in terms of price (e.g., for decreasing rates in specific segments).

Bulstrad had been using a traditional approach for calculating a premium, as depicted Figure 3.

Figure 3: Pricing Factors



Source: Bulstrad Vienna Insurance Group

- **Rating rules**: Rating rules contain the business logic necessary to apply rating algorithms car and drivers attributes. They may also contain other premium rules, such as minimum premiums or rounding rules.
- **Underwriting rules**: Underwriting rules typically contain the logic around appetite and risk selection characteristics. They help assess the risk magnitude and are applied before a rate is calculated.
- **Rate tables**: Rate tables contain the numerical inputs needed to calculate a premium.
- **Rating algorithms**: The rating algorithms outline in detail how to combine the rates and rules to calculate the premium.

Bulstrad identified key requirements to improve calculation of premiums. To meet its objectives to become more efficient and responsive with its pricing process, the insurer sought to implement a new technology enabling more frequent and quicker changes to rating components, and defined specific requirements:

- **Sophisticated predictive scenarios**: Design machine learning-based multivariate rating algorithms using predictive analytics to optimize the rate tables offering lower premiums for less risky customers. This traditional actuarial job normally takes between two to four weeks and requires high-level actuarial resources.
- **Enhanced deployment of rule sets**: After the optimized rate table has been generated, it should be converted into a number of rating rules coded or configured in their underlying policy administration system or an external rating engine. This is the premium rules set up, which prepares the newly generated rating rules to be used in production. This process was one of the

most time-consuming and error-prone requiring sometimes months to execute.

- **Rapid underwriting rules adaptation**: The third issue that Bulstrad faced is the need to adapt underwriting rules quickly in response to market changes. Traditionally, this would require Bulstrad to repeat the entire premium setup deployment process, which could take an additional two to three weeks.

After defining its desired capabilities, Bulstrad looked for specific tools on the market.

Solution

Bulstrad selected ABACUS, a powerful machine learning-based tool that optimizes pricing and rating processes in insurance companies. ABACUS is marketed by Ablera, a Bulgarian technology vendor.

ABACUS comprises two engines that are connected; however, each can operate as a stand-alone solution:

- Pricing engine for use by actuaries in premium model development.
- Rating engine for use by underwriters for premium adjustment rules creation (e.g., loadings, discounts, taxes, fees, caps, etc.), deployment, and management.

ABACUS provides Bulstrad four process steps within the same tool: data pre-processing and exploratory analysis, pricing table generation, rating adjustment, and the run-time mode (rating engine).

Innovation Value

The main innovation leveraged by Bulstrad is that both the pricing and the rating engines are integrated into ABACUS. This allows a direct link between the results of the actuarial effort and rating rules used by the policy administration system.

With their new rating and pricing engine, Bulstrad is now able to include more significant risk factors in their models. For example, for a motor third party liability (MTPL) policy, their traditional models were based on usual risk factors such as the age of the car, engine capacity and power, plate registration location, and fuel type. Their machine learning models include other risk factors and allow for a more granular segmentation of pricing.

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Figure 4: Motor Third Party Liability (MTPL) Increase of Segments with Machine Learning Models

Traditional Regression Model
Single Region, Driver's Age between 30 and 78, Gasoline Fuel Type

		Car Age >15	Car Age 7-15	Car Age <=7
Capacity (<=1500)	Power < 102	250.83	283.24	319.84
	Power 102-150	286.63	323.67	365.49
	Power > 150	327.53	369.86	417.65
Capacity (1500-1800)	Power < 102	258.29	291.67	329.36
	Power 102-150	295.15	333.29	376.36
	Power > 150	337.28	380.86	430.07
Capacity (1800-2500)	Power < 102	265.98	300.34	339.15
	Power 102-150	303.93	343.21	387.55
	Power > 150	347.31	392.19	442.86
Capacity (>2500)	Power < 102	273.89	309.28	349.24
	Power 102-150	312.97	353.42	399.08
	Power > 150	357.64	403.85	456.03

Using Machine Learning To Further Segment Pricing
For Car Age <=7 AND Number of Precedent Claims (NPC) <=4

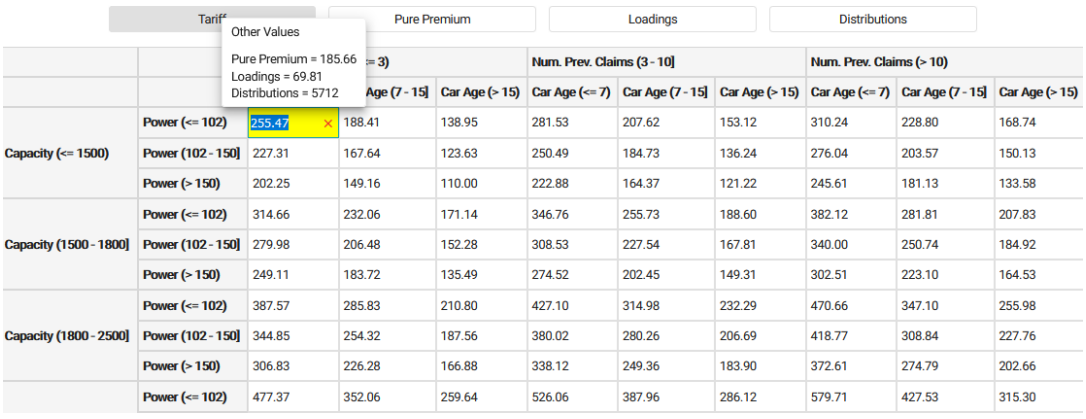
Model 0	Model 1	Model 2
163.62	173.85	514.84
178.26	189.41	560.92
194.22	206.36	611.13
162.83	173.01	512.36
177.41	188.49	558.22
193.29	205.37	608.19
162.05	172.17	509.89
176.55	187.59	555.53
192.35	204.38	605.26
161.27	171.35	507.43
175.70	186.68	552.85
191.43	203.39	602.34

Source: Bulstrad Vienna Insurance Group

With the more granular segmentation of pricing models (models 0, 1, and 2 as shown in Figure 4) leveraging machine learning, Bulstrad has to date experienced a 3.86% increase in number of policies sold and a 4.77% increase in profit in the MTPL business.

Figure 5 provides a screenshot of ABACUS.

Figure 5: ABACUS Screenshot

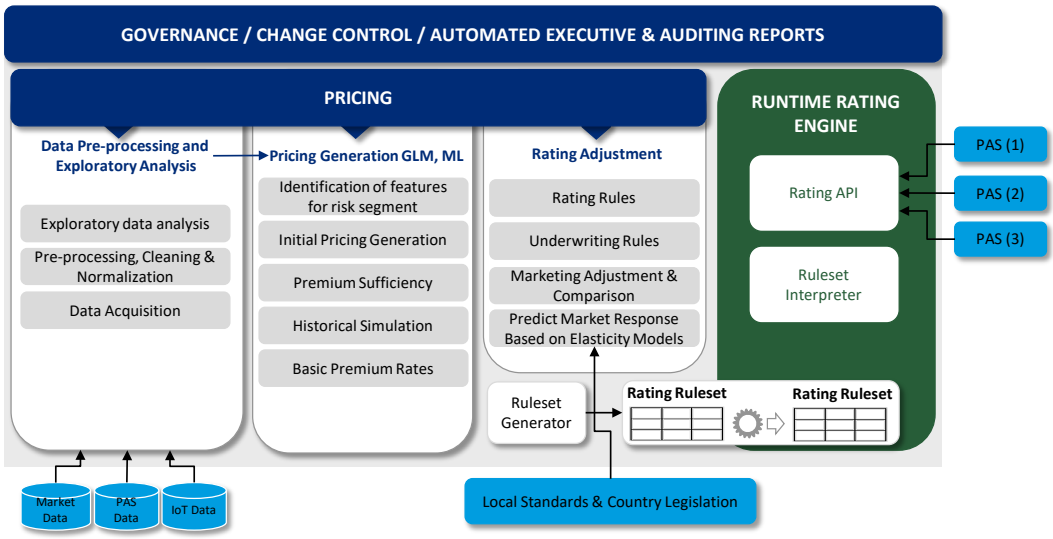


					Num. Prev. Claims (3 - 10]			Num. Prev. Claims (> 10)		
			Age (7 - 15]	Car Age (> 15)	Car Age (<= 7)	Car Age (7 - 15]	Car Age (> 15)	Car Age (<= 7)	Car Age (7 - 15]	Car Age (> 15)
Capacity (<= 1500)	Power (<= 102)	255.47	188.41	138.95	281.53	207.62	153.12	310.24	228.80	168.74
	Power (102 - 150]	227.31	167.64	123.63	250.49	184.73	136.24	276.04	203.57	150.13
	Power (> 150)	202.25	149.16	110.00	222.88	164.37	121.22	245.61	181.13	133.58
Capacity (1500 - 1800]	Power (<= 102)	314.66	232.06	171.14	346.76	255.73	188.60	382.12	281.81	207.83
	Power (102 - 150]	279.98	206.48	152.28	308.53	227.54	167.81	340.00	250.74	184.92
	Power (> 150)	249.11	183.72	135.49	274.52	202.45	149.31	302.51	223.10	164.53
Capacity (1800 - 2500]	Power (<= 102)	387.57	285.83	210.80	427.10	314.98	232.29	470.66	347.10	255.98
	Power (102 - 150]	344.85	254.32	187.56	380.02	280.26	206.69	418.77	308.84	227.76
	Power (> 150)	306.83	226.28	166.88	338.12	249.36	183.90	372.61	274.79	202.66
	Power (<= 102)	477.37	352.06	259.64	526.06	387.96	286.12	579.71	427.53	315.30

Source: Bulstrad Vienna Insurance Group

Figure 6 describes the ABACUS architecture.

Figure 6: ABACUS Architecture



Source: Ablera

- **The pricing engine**: The ABACUS pricing engine uses a variety of machine-learning multivariate rating algorithms leveraging predictive analytics to optimize the rate tables. The objective of Bulstrad is to reward low-risk clients with lower premiums and compensate accordingly for the higher-risk clients is made possible with this technology.
- **The rating engine**: Configuration and/or coding of premium calculation rules is the most time- and effort- intensive process. With ABACUS, Bulstrad has managed to automatically transfer the results from pricing into the rating engine. Also, the deployment happens instantly with a click of a button, instead of the usual 10–15 days, enabling Bulstrad to respond to dynamic market situations. Once the pricing and rating rules have been completed and approved, ABACUS generates a sophisticated rule set (for a particular product, cover, country, and company). Then, it is automatically deployed to the rating engine (Serdica Rating Engine) for production use in runtime. The rating engine has a built-in rule set interpreter and provides an API for integration with the Bulstrad policy administration system.

Implementation

The project began with the implementation of a policy administration system wrapper (technology layer) to an existing system in February 2021. The implementation of ABACUS took 10 weeks. During this period, the main tasks consisted in running portfolio simulations and validating the outcomes of these projections. ABACUS went live in October 2021.

The ABACUS API-oriented architecture allowed for a seamless integration with Bulstrad's back office system. For data modeling, Bulstrad provided Ablera with a large chunk of anonymized client and vehicle data, allowing their data engineers to get full control of the data preparation and manipulation processes.

Bulstrad faced two major challenges during the implementation phase:

- **Data completeness**: Ensuring the Bulstrad and Ablera team could leverage a sufficient volume of clean data was important. The team managed to fix data inconsistencies by running a number of consistency checks and, where possible, via the extraction of information from external data sources.
- **Models comparison**: Another challenge was finding a relevant approach to compare the ABACUS machine learning-based models with the traditional GLM models Bulstrad had been using before. To solve this issue, the Ablera team developed and integrated into ABACUS a fully automated simulation tool employing a specifically designed market elasticity model that was further calibrated for the motor insurance market. This enabled an accurate comparison of the models in terms of business metrics (e.g., impact on revenue, net profit, and increase in new clients).

Results

Table 3 summarizes the major benefits derived by Bulstrad following the implementation of ABACUS.

Table 3: Success Metrics

Benefit	Results
Quick reaction to market changes	After the implementation of ABACUS, Bulstrad managed to reduce time-to-market from several days to just a few hours.
More granular rating	For each rating table, the machine learning algorithms propose an optimal segmentation and check the effects of existing rates with a comparison from past periods when previous rates were applicable. With this approach, Bulstrad can identify potential rate increases or decreases in certain market segments and apply them in the next premium generation, adjusted for market changes.
Efficiency and time gain	Bulstrad is now able to eliminate about 60% of the actuarial effort, reducing implementation time from 3 months to 3–5 days and enabling a wider range of users to work easily with the sophistication of applied mathematics. Once the rating table has been generated and approved, it can be automatically deployed, which transforms a 5 to 10-day process into minutes. ABACUS Ruleset technology and subsystem allows an easier deployment. Instead of 15 to 30 days for coding and configuration, the deployment can be performed by non-IT staff.
Enhanced predictability and underwriting profit	The machine learning models are adjusted to the empirical distribution of the claims. They can easily capture the non-linearity and non-monotonicity in the data as well as any present complex interdependence between the risk factors. The machine learning approach substantially improves the predictability of the model, which leads to: – more efficient risk assessment, and therefore more precise and robust segmentation,

Benefit	Results
	– more accurate premium calculation, achieving superior levels of personalization, and – increased net profit, from 3% to 4.77%, depending on the business line.

Source: Bulstrad Vienna Insurance Group

It is worth mentioning that Bulstrad expects to derive long-term benefits from this initiative. Indeed, the more machine learning-based models run, the deeper the analysis of the rating strategy. The experience gained running ABACUS will help Bulstrad predict and anticipate market changes. This long-term benefit should materialize in a period of six months to one year, depending on the frequency of pricing table changes.

Lessons Learned

Bulstrad learned three lessons with this initiative:

- **Data is a key competitive advantage**: Bulstrad has accumulated substantial data through the years. Combining the robust ABACUS functional capabilities and machine-learning models, the insurer has optimized the value derived from internal data to make it a competitive advantage.
- **Data quality is crucial**: To train models, it is important to have timely and clean data. Bulstrad has learned that data preparation was one of the most important tasks in order to derive value. Indeed, a clean data set provides a more realistic outcome. Based on this finding, Bulstrad is adapting internal communication processes and channels with customers to gather more qualitative data.
- **More data is better**: In light of the many improvements and benefits that this project generated, Bulstrad is planning to integrate with IoT devices (telematics-based insurance). The insurer is confident that this additional data will help enhance the models and refine insurance premiums calculations.

The ML-based pricing and rating engines initiative has allowed Bulstrad to generate significant value in a short period of time. The next section provides a short description of the insurer’s future plans.

PATH FORWARD

Bulstrad's initiative to enhance rating and pricing by leveraging ABACUS is an open door to further improvements. The insurer already has plans to expand the use of ABACUS.

Further Improvements

The lessons learned are a good direction for Bulstrad to carry on its efforts to improve pricing and rating capabilities.

> We gained an excellent tool for optimal segmentation, and together with the added value of time-to-market for the new products, our main goal will be to benefit from the features of ABACUS to the maximum.
>
> Yordan Yordanov, Bulstrad Vienna Insurance Group CIO

Bulstrad's plans regarding this part of the project include adding a new business line in the next couple of months. The insurer also wants to add new data sets and has plans to leverage an IoT model in CASCO insurance going forward.

Key Considerations For Insurers

As the Bulgarian insurer continues to invest in machine learning, we think insurers of all kinds should emulate Bulstrad. We recommend they pay particular attention to all resources required in order to implement similar initiatives:

- **Building a dedicated team:** We believe it is essential that insurers build a dedicated team working exclusively on the subject. The team's goal would be to review how pricing can be improved and how the company could leverage existing technologies to apply more sophisticated pricing models.
- **Leverage external IT expertise**: Bulstrad has built a strong partnership with Ablera that helped them implement the relevant technology and reach tangible outcomes and values. In general, expert IT vendors like Ablera combine IT and business capabilities that help support not only an insurer's IT staff but also its business team, particularly mathematicians and actuaries. We think it is important to provide \ internal stakeholders with the necessary means to achieve concrete results.
- **Promoting a culture of innovation**: Increasingly, specific teams are built within insurance companies to ask questions that have never been asked and

then build models that include dynamic parameters (and not only static parameters) to improve many elements of the traditional insurance value chain, including pricing. We recommend that insurers nurture this type of environment and promote a culture of innovation.

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