

Vendor Analysis: SAS

Actuarial Modeling and Financial Planning Systems, 2022



About Chartis

Chartis Research is the leading provider of research and analysis on the global market for risk technology. It is part of Infopro Digital, which owns market-leading brands such as Risk and WatersTechnology. Chartis' goal is to support enterprises as they drive business performance through improved risk management, corporate governance and compliance, and to help clients make informed technology and business decisions by providing in-depth analysis and actionable advice on virtually all aspects of risk technology. Areas of expertise include:

- Credit risk.
- Operational risk and governance, risk management and compliance (GRC).
- Market risk.
- Asset and liability management (ALM) and liquidity risk.
- Energy and commodity trading risk.
- Financial crime, including trader surveillance, anti-fraud and anti-money laundering.
- Cyber risk management.
- Insurance risk.
- Regulatory requirements.
- Wealth advisory.
- Asset management.

Chartis focuses on risk and compliance technology, giving it a significant advantage over generic market analysts.

The firm has brought together a leading team of analysts and advisors from the risk management and financial services industries. This team has hands-on experience of developing and implementing risk management systems and programs for Fortune 500 companies and leading consulting firms.

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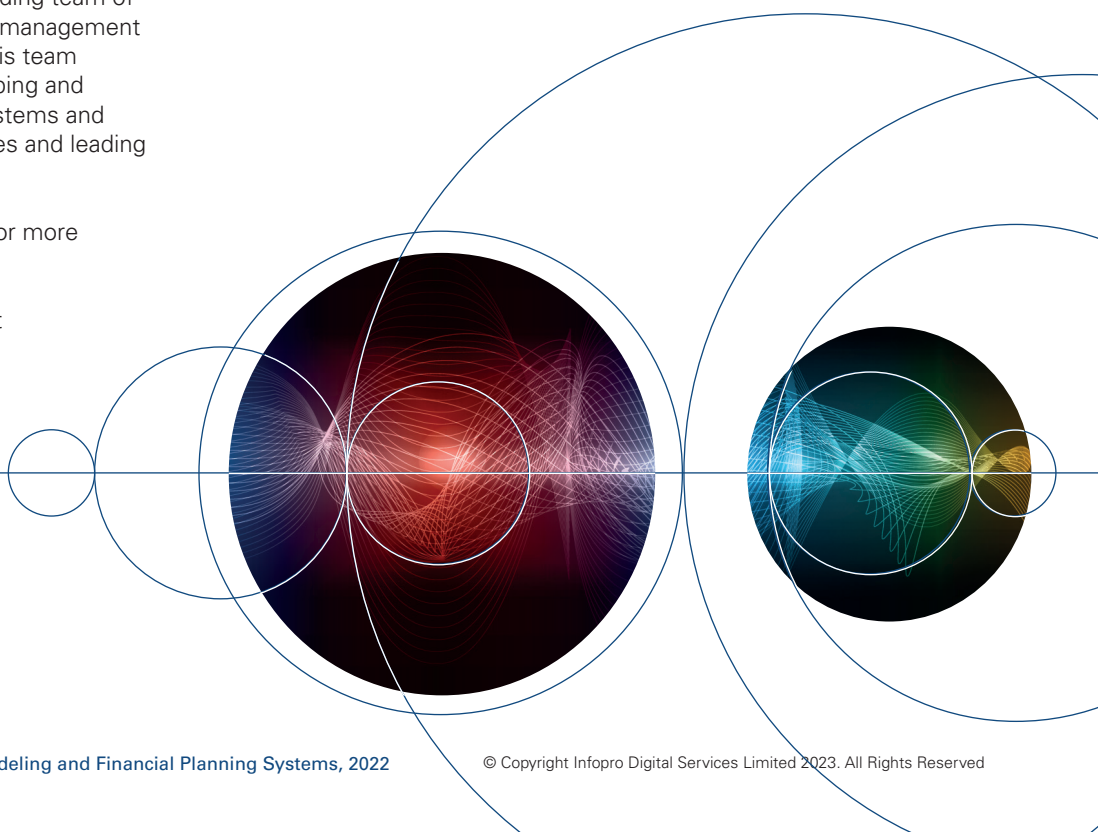


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1. Report context

This Vendor Analysis is based on the Chartis quadrant report *Actuarial Modeling and Financial Planning Systems, 2022: Market and Vendor Landscape* (published in September 2022). This section summarizes the key theses in that report; subsequent sections take a detailed look at SAS' quadrant positioning and scoring, and Chartis' underlying opinion and analysis.

Key thesis

The implementation of risk-based capital calculations and risk-aware accounting standards has put additional pressure on insurers to accurately model complex contingent cashflows, and to manage and hedge financial guarantees.

Overall, there is an ongoing restructuring and modernization of the analytical environment for insurers generally and life insurance firms in particular.

Chartis has identified two key overarching trends in actuarial modeling and insurance risk analytics:

- The implementation of a broader set of advanced analytics in a range of use cases, including pricing, product design, capital management and exposure management.
- A substantial modernization and transformation of the analytics architecture, and increasing emphasis on 'analytics intermediates' and the broader computational and supporting data infrastructure.

Demand-side takeaways

The focus of contemporary actuarial modeling and insurance analytics has evolved considerably:

- Model methodologies now incorporate broad statistical, quantitative and structural frameworks, as well as techniques from the broader financial industry (specifically banking), including a more sophisticated treatment of options and guarantees.
- New supporting technology includes scalable and complex data grids, many of which have been a relatively common feature of banking analytics infrastructure.
- Increasingly, insurers have been looking at data-parallel techniques (including graphics processing units [GPUs]) to scale their computational capabilities.
- Some vendors in the space have developed sophisticated contingent claim-pricing models that leverage state-of-the-art option-valuation techniques.
- Vendors are also providing advanced techniques for curves and volatility surfaces as part of applications and solutions, specifically their scenario generators.

New product strategies, complex market dependencies, increased data availability and evolving capital and risk requirements are all shaping firms' analytics demands and methodologies.

While a range of methodological innovations have been leveraged in the insurance risk and analytics ecosystem, we have focused on neural networks/deep learning/machine learning (ML) because of their flexibility and increased prevalence. The context in which these models operate differs considerably by insurance function (such as life versus general). However, neural networks/AI can be applied in a variety of contexts in insurance risk management:

- As optimizers. Neural networks can be used to facilitate fast optimization processes – particularly in cases of ill-posed optimization problems.
- Neural-network models for solving nonlinear optimization problems may be useful in cases where linear solvers and integer solvers face challenges, such as in asset and liability management (ALM) optimization.
- As functional approximators and in linearization. They can also be used as a reasonably straightforward tool to linearize and simplify complex calculations, for example. For calculations such as modeling optionality, firms can use neural networks to map options to defined risk factors.
- Data management, anomaly detection and time-series analytics. Data applications of neural networks include filtering, mining and automatically detecting anomalies in historical time-series databases.

- Scenario generation. Neural networks can also be used to generate specific scenarios that robustly match the business needs of the day, both for 'look-back' (retrospective modeling) and 'forward-in-time' (forecasting) methods.

Practitioners can use neural networks to define the nature of the curve being constructed, and assess the tolerable gaps and acceptable boundaries of a model before feeding data into it.

Nevertheless, despite these possible applications, the full potential of neural networks and broader AI techniques in the life insurance industry is far from being fully realized.

Supply-side takeaways

The actuarial modeling and financial planning market is mature and dominated by large, established players. Nevertheless, established vendors are being challenged by changing market standards (including an expectation of being able to accommodate faster calculation speeds), evolving product types and technology innovation.

Although cashflow modeling continues to be a significant aspect of actuarial modeling, we take a broader view of actuarial modeling, considering the full value chain of insurance risk, scenario generation, capital and risk management and ALM, and including the planning and budgeting process. Throughout this document, we use this broad definition interchangeably with concepts such as insurance risk, insurance analytics, etc. Some key themes shaping this environment are:

- Sharp growth in data availability and data requirements.
- A drive toward more sophisticated stress-testing environments.
- An emphasis on business optimization that includes efficient balance-sheet management.
- Computational scalability through data-parallel hardware (and leveraging a variety of data-parallel techniques and infrastructures).
- The integration of new risk types.
- Reverse stress testing and scenario generation as core parts of the business model. Scenario generation is becoming more sophisticated, and now includes a much broader range of risk factors (including climate and cyber factors),

while also becoming better at building market-linked scenarios.

- Increased use of heuristic and novel statistical techniques in functions such as approximation, optimization, data filtering, planning and budgeting, and risk modeling.
- A broader array of pricing and analytics (loans, securitized products, fully fledged OTC derivative risk-management frameworks, etc.).
- New development environments and programming languages.

While these different components of actuarial modeling and financial planning can be separated into solution modules, in practice, these processes are often intertwined, and clearly separating them into specific categories is more of an art than a science.

Finally, growth of new computational capabilities has been a standout feature in the past few years. A variety of routes to greater computational scale exist, although the following stand out:

- *Cloud.* Some firms have their own proprietary remote infrastructure environments. Some vendors focus on the cloud as a pure infrastructure stack, while others leverage a broader section of the cloud provider ecosystem, including data management frameworks.
- *GPUs and other data-parallel frameworks.* GPUs can offer significant advantages in terms of processing speed at scale, and are now more available. But vendors' uptake of them in this space varies widely.
- *Optimizers and statistical libraries.* Some vendors have developed strong optimizers, giving them an advantage, especially for ALM and capital solutions.

2. Quadrant context

Introducing the Chartis RiskTech Quadrant®

This section of the report contains:

- Chartis RiskTech Quadrants for actuarial modeling and financial planning systems, 2022.
- An examination of SAS' positioning and its scores as part of Chartis' analysis.
- A consideration of how the quadrant reflects the broader vendor landscape.

Summary information

What does the Chartis quadrant show?

The RiskTech Quadrant® uses a comprehensive methodology that involves in-depth independent research and a clear scoring system to explain which technology solutions meet an organization's needs. The RiskTech Quadrant® does not simply describe one technology option as the best; rather it has a sophisticated ranking methodology to explain which solutions are best for specific buyers, depending on their implementation strategies.

The RiskTech Quadrant® is a proprietary methodology developed specifically for the risk technology marketplace. It takes into account vendors' product, technology and organizational capabilities. Section 4 of this report sets out the generic methodology and criteria used for the RiskTech Quadrant®.

How are quadrants used by technology buyers?

Chartis' RiskTech and FinTech quadrants provide a view of the vendor landscape in a specific area of risk, financial and/or regulatory technology. We monitor the market to identify the strengths and weaknesses of different solutions, and track the post-sales performance of companies selling and implementing these systems. Users and buyers can consult the quadrants as part of their wider research when considering the most appropriate solution for their needs.

Note, however, that Chartis Research does not endorse any vendor, product or service depicted in its research publications, and does not advise technology users to select only those vendors with

the highest ratings or other designation. Chartis Research's publications consist of the opinions of its research analysts and should not be construed as statements of fact.

How are quadrants used by technology vendors?

Technology vendors can use Chartis' quadrants to achieve several goals:

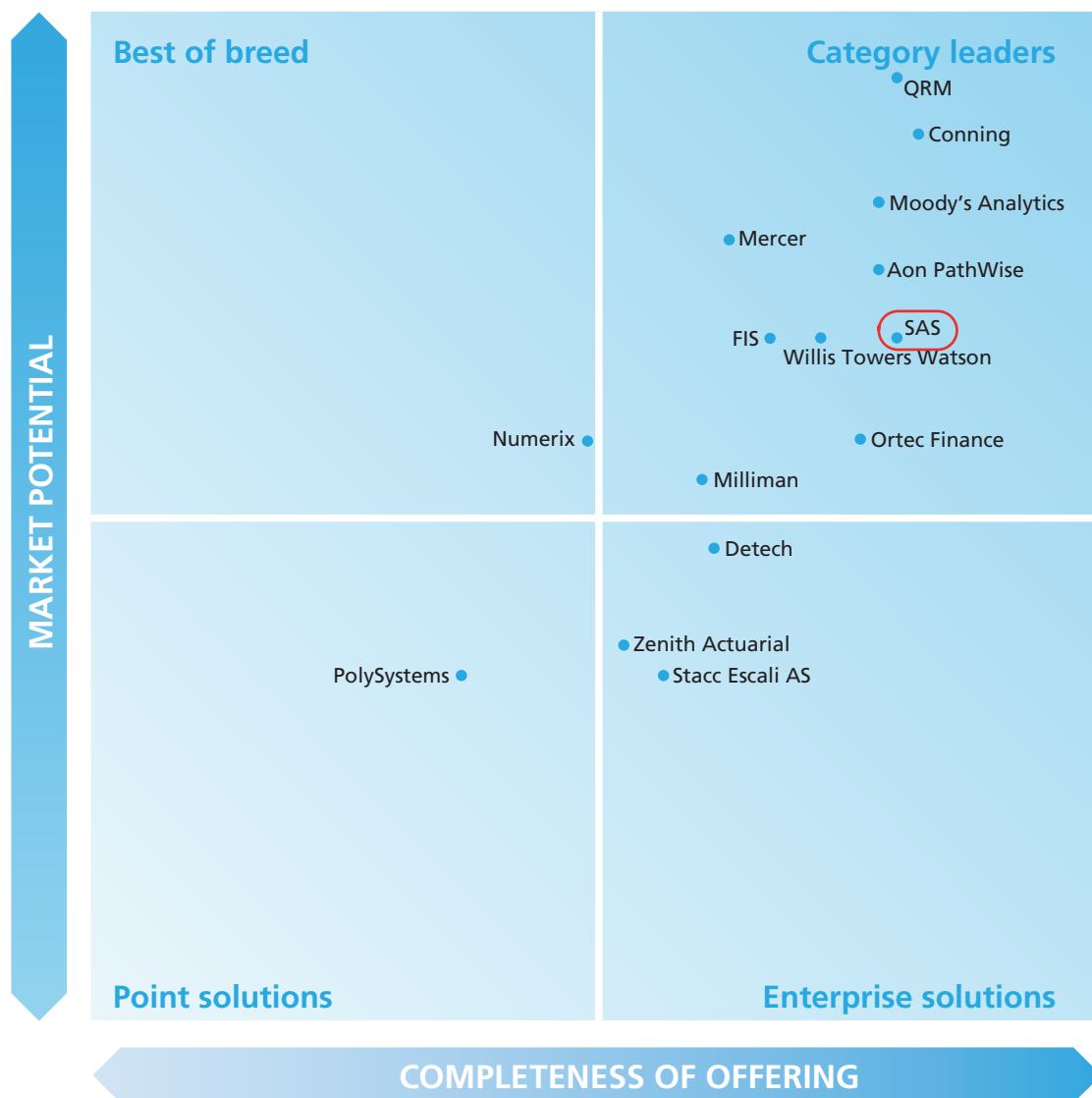
- Gain an independent analysis and view of the provider landscape in a specific area of risk, financial and/or regulatory technology.
- Assess their capabilities and market positioning against their competitors and other players in the space.
- Enhance their positioning with actual and potential clients, and develop their go-to-market strategies.

In addition, Chartis' Vendor Analysis reports, like this one, offer detailed insight into specific vendors and their capabilities, with further analysis of their quadrant positioning and scoring.

Chartis Research RiskTech Quadrants for actuarial modeling and financial planning systems, 2022

Figures 1 to 3 illustrate Chartis' view of the vendor landscapes for actuarial modeling and financial planning systems, 2022: asset and liability management, risk and capital management, and financial planning and analysis, highlighting SAS' position.

Figure 1: RiskTech Quadrant® for actuarial modeling and financial planning systems – asset and liability management, 2022



Source: Chartis Research

Figure 2: RiskTech Quadrant® for actuarial modeling and financial planning systems – risk and capital management, 2022



Source: Chartis Research

Figure 3: RiskTech Quadrant® for actuarial modeling and financial planning systems – financial planning and analysis, 2022



Source: Chartis Research

Quadrant dynamics

General quadrant takeaways

The growing demand for ALM that covers complex asset types is helping to strengthen the position of certain vendors that have experience in investment modeling and handling complex interest-rate exposures. Some vendors also have extensive experience in providing managed services in this space, which can affect their solution offering and the way it is packaged.

The asset side of life insurance contracts has become more complicated, in part because of the growth in credit provisioning by life insurers. For certain vendors, this growth is an opportunity to leverage their expertise in credit modeling. However, for the vast majority, combining credit (banking book products) with non-credit assets presents a significant challenge.

On the liability side, handling the complexity of insurance contract cashflows is an area in which certain vendors distinguish themselves. However, functionality and capabilities for both the asset and liability sides of the contract need to be brought together.

The availability of 'pricers' (specialized pricing libraries) across different asset types is a key feature among mature vendors in the ALM quadrant in particular. Those with significant functional gaps are obliged to partner with other providers.

Vendor positioning in context – completeness of offering

ALM

As the financial services sector has grown more competitive, with newer players offering innovative products and services tailored to an increasingly tech-savvy population, banks and insurers need to manage asset allocation across their portfolios effectively. SAS Asset Liability Management allows clients to plan and manage their balance sheets proactively, offering a rich set of scenario-based analytics on the static or projected balance sheet over a range of business, economic and market assumptions.

Balance sheet management is complicated further by the recent hikes in interest rates, after a prolonged period of low rates. SAS Asset and Liability Management provides flexible, open capabilities for managing interest rate risk and

funding liquidity risk. Clients can stress-test interest rates and other risk factors, by considering repricing, optionality, yield curve and basis risk, as well as behavioral and credit risks. The solution is designed to support open-source and third-party cashflow generation models, and to integrate with other systems.

With demand growing for ALM that covers complex asset types, SAS' capability in handling complex interest rate modeling allows the company to offer clients expertise in navigating a challenging interest rate environment.

SAS' end-to-end solution leverages its vast experience in credit modeling to help insurers and financial institutions involved in money-lending services to develop and track credit risk scores. The solution also helps them manage the entire modeling lifecycle in one comprehensive platform, providing functionality and capabilities for both the asset and liability sides of the contract.

Table 1 shows Chartis' rankings for the vendor's coverage against each of the completeness of offering criteria.

Table 1: Completeness of offering – SAS (ALM systems, 2022)

Completeness of offering criterion	Coverage
Asset class coverage	High
Optimization	High
Data management	Medium
Hedging	High
Sensitivity	High
Liability modeling integration	High

Source: Chartis Research

Risk and capital management

In addition to its pre-existing risk and capital modeling functionality, SAS' experience in risk-based solvency modeling is a principal reason why the company is a category leader in risk and capital management. The ability to leverage subject-matter experts and the company's ongoing investment in its cloud offering makes SAS' solution very competitive.

SAS' compliance-related experience has been enhanced by its recent acquisition of Kamakura, giving the company a significant overall advantage as more jurisdictions adopt risk-based capital regimes.

Capital optimization and strategic asset allocation are key components of risk and capital management. SAS' platform enables its clients to perform capital requirement calculations at different levels of detail and aggregates risk capital across all risk types.

Table 2 shows Chartis' rankings for the vendor's coverage against each of the completeness of offering criteria.

Financial planning and analysis

SAS' optimization solvers streamlined and fine-tuned for performance. As planning and analysis become more analytics-based, pre-solvers reduce the effective size of problems, so that large problems can be tackled and solved faster. SAS employs powerful network-optimization solvers run in parallel in the cloud to enable firms to tackle challenging business problems, including optimal resource allocation.

Moreover, insurance companies have used SAS' forecasting and planning capabilities for a variety of purposes. Time-series analysis models are commonly employed to forecast sales, claims, expenses and derivatives performance indicators. High-performance forecasting models are applied in a large number of time-series cases – such as when sales are projected in a particular division by agents.

In addition, SAS' flexible and scalable architecture can handle a variety of different data types, giving it a considerable advantage over other offerings.

Table 3 shows Chartis' rankings for the vendor's coverage against each of the completeness of offering criteria.

Vendor positioning in context – market potential

Table 4 shows Chartis' rankings for the vendor's coverage against each of the market potential criteria.

ALM

Use of optimization engines within the insurance space has surged, and SAS' continued investment and research – reflected in its category leader rating in the ALM quadrant – emphasize the strategic potential of its recent initiatives. SAS'

Table 2: Completeness of offering – SAS (risk and capital management systems, 2022)

Completeness of offering criterion	Coverage
Solvency and economic capital calculation	High
Portfolio risk analysis and analytics support	High
Data management	High
Jurisdictional coverage	Medium
Visualization	High

Source: Chartis Research

Table 3: Completeness of offering – SAS (financial planning and analysis systems, 2022)

Completeness of offering criterion	Coverage
Business area and vertical coverage	High
Profitability analytics	High
Data management	High
Business forecasting	Medium
Flexibility and scalability	High

Source: Chartis Research

Table 4: Market potential – SAS (actuarial modeling and financial planning systems, 2022)

Completeness of offering criterion	Coverage
Customer satisfaction	High
Market penetration	High
Growth strategy	High
Business model	High
Financials	High

Source: Chartis Research

strong market potential in this area is largely due to its powerful optimization engine – for insurers, a faster optimization engine can give them an edge over the competition.

With its recent acquisition of Kamakura, SAS is well-placed to leverage that company's robust ALM capabilities, alongside its own experience, to enhance SAS Viya and develop a combined offering to cover the entire balance sheet.

Risk and capital management

SAS' strength in this area is due in part to its analytics support for a variety of specifications in a complex, ever changing regulatory environment. As regulatory pressure increases, this versatility reflects its category leader status.

SAS market potential ratings are also bolstered by its experience and expertise in Solvency II compliance. As market conditions remain volatile and interest-rate hikes continue in most countries, impacting insurers' business models, SAS' solution offers a complete package to enable insurers to carry out economic capital calculations alongside other risk assessments.

Financial planning and analysis

SAS strong market potential carries through into this sector, largely because of the variety of modeling approaches it makes available to insurers. By offering planning models with multiple level of detail, the solution enables insurers to gauge the impact of several different factors on their income statements and balance sheets.

As insurers strive to develop an effective planning and performance management capability, being able to generate timely, impactful insights into performance and results can help them produce a persuasive story for external stakeholders. SAS' capacity to provide this analytical function is again reflected in its category leader status.

3. Vendor context

Overview of relevant solutions/capabilities

Table 5 provides a summary of the vendor and its solutions.

Planning and analysis solutions

Planning or projection of the financial condition of a (re)insurance company can be performed in different

ways, depending on the objective. In most cases, operational planning with elements of budgeting is conducted at a detailed level as it relates to the granularity of the portfolio, organizational structure and time intervals. It involves many people, and may take the form of a complex, mixed top-down and bottom-up process, and may require several cycles before arriving at mutually agreed-upon numbers.

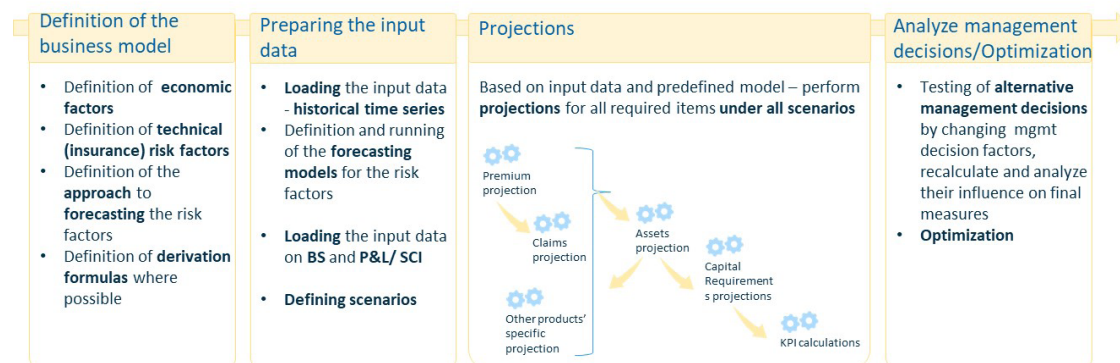
Strategic planning, on the other hand, involves fewer people and is done with a higher level of

Table 5: SAS – company information

Company	SAS
Headquarters	Cary, NC
Other offices	SAS has offices in 56 countries worldwide
Description	SAS is a leading provider of AI and advanced analytics tools and one of the largest privately held software companies in the world. Used by 91 of the top 100 companies in the global Fortune 500, SAS provides innovative software and services to customers around the world.
Solutions	<p>SAS Financial Planning is a cloud-based solution that enables insurance and reinsurance companies to conduct various types of planning processes – whether operational planning of sales, budgeting, strategic planning or risk-oriented stress-based projections for the purpose of own risk and solvency assessment (ORSA). This variety of uses is possible because of flexibility in the definition of the planning model, as well as the high performance of calculations, backed up by a comprehensive library of statistical analytics</p> <p>SAS Asset Liability Management enables risk managers, senior management, shareholders and regulators to analyze, identify and manage risks inherent in the balance sheet. The company's cloud-based solution is designed to operate at any level of granularity, including the most detailed transaction level, and incorporates both static and dynamic (multi-period) aspects of the calculations.</p> <p>SAS Insurance Capital Management (SAS ICM) is a comprehensive risk analytics framework designed to enable life and non-life insurance companies to implement the capital requirements standard model approach for calculating risk-based capital. The solution facilitates the production of regulatory reports according to the various specifications in complex regulatory environments.</p> <p>SAS Dynamic Actuarial Modeling (SAS DAM) supports the end-to-end pricing process, beginning with data management (including data quality controls), through modeling, up to deployment and integrated reporting. The solution allows insurance companies to improve their modeling agility and accuracy by leveraging SAS's modeling and analytical capabilities. It also delivers real-time quotations based on customizable model parameters and decision factors.</p>

Source: SAS

Figure 4: Implementing deterministic models



Source: SAS

detail but for a longer period of time. It makes allowances for certain risks represented by a set of scenarios, and may require the distribution of certain key performance metrics (rather than the value under a few scenarios), or even an efficiency frontier with predefined risk and return metrics. Consequently, these planning processes look completely different and are based on different models. To ensure the consistency of the results and conclusions, however, the detailed data underneath should be consistent.

SAS aims to fulfill the above requirements with the following key features of its planning solution:

- Enhanced data management.
- Flexibility in the definition of the planning model (dimensions, calculation logic).
- User experience (dedicated interfaces for administrator and user; the possibility to define planning form sets for each phase of the process).
- The high performance of calculations on huge dimensions.
- Advanced analytics.
- Reporting capabilities.

Figure 4 illustrates the process of implementing deterministic models with a selected number of scenarios that are applied in operational planning, regulatory stress testing and strategic planning.

The first phase is generally performed only once, at the beginning of the implementation project, while the remaining phases are performed every time the planning process is undertaken by the insurer.

Because the list of dimensions and their members is adjustable, SAS can enable users to define the planning model at any level of detail. The number of risk factors (insurance or economic) and scenarios is not constrained by the system, but rather is driven by the need for the model to be understandable and explainable. Projected values of risk factors may either be derived by the supporting forecasting models or uploaded to the system. The impact of those factors on the accounts of the income statement and balance sheet may be defined by the formulas.

Some measures may be defined as ones to be inputted by the user and then either propagated down, allocated down or aggregated up. This feature is used particularly for budgeting models.

The system supports definitions of the process, users, their role in the process and their access to the data.

Vendor leading practices

The following features are key elements of the SAS planning solution:

- Data management.
 - Support for integration with external systems.
 - Automated data collection, consolidation and quality management.
 - Dedicated graphical user interface (GUI) for planning data upload and processing.

Figure 5: Defining multiple dimensions and hierarchies

Name	Description	Account Type	Balance Type	Exchange Rate Type	Account Aggregation	Formula Type
CHM	CHM					
Income Statement	Income Statement	Revenue	Debit	PeriodAverage	Sum	Reporting
Income	Income	Revenue	Debit	PeriodAverage	Sum	Reporting
Net Earned Premium	Net Earned Premium	Revenue	Debit	PeriodAverage	Sum	Reporting
Fee and commission income	Fee and commission income	Revenue	Debit	PeriodAverage	Sum	Reporting
Investment income	Investment income	Revenue	Debit	PeriodAverage	Sum	Reporting
Net realized gains (losses) on investments	Net realized gains (losses) on investments	Revenue	Debit	PeriodAverage	Sum	Reporting
Other income	Other income	Revenue	Debit	PeriodAverage	Sum	Reporting
Surinder Charges	Surinder Charges	Revenue	Debit	PeriodAverage	Sum	Reporting
Expenses	Expenses	Expense	Debit	PeriodAverage	Sum	Reporting
Income Tax expense	Income Tax expense	Expense	Debit	PeriodAverage	Sum	Reporting
Balance Sheet	Balance Sheet	Revenue	Debit	PeriodAverage	Sum	
Assets	Assets	Revenue	Debit	PeriodAverage	Sum	
Liabilities	Liabilities	Expense	Debit	PeriodAverage	Sum	
Technical provisions - all	Technical provisions - all	Expense	Debit	PeriodAverage	Sum	
Technical provisions - NL	Technical provisions - NL	Expense	Debit	PeriodAverage	Sum	
TP - health risk	TP - health risk	Expense	Debit	PeriodAverage	Sum	
Technical provisions - life (including subordinated and unsecured)	Technical provisions - life (including subordinated and unsecured)	Expense	Debit	PeriodAverage	Sum	
Other technical provisions	Other technical provisions	Expense	Debit	PeriodAverage	Sum	
Contingent liabilities	Contingent liabilities	Expense	Debit	PeriodAverage	Sum	
Provisions other than technical	Provisions other than technical	Expense	Debit	PeriodAverage	Sum	
Reserve benefits obligations	Reserve benefits obligations	Expense	Debit	PeriodAverage	Sum	
Deposits from reinsurers	Deposits from reinsurers	Expense	Debit	PeriodAverage	Sum	
Deferred tax liabilities	Deferred tax liabilities	Expense	Debit	PeriodAverage	Sum	Reporting
Derivatives	Derivatives	Expense	Debit	PeriodAverage	Sum	
Debt owed to credit institutions	Debt owed to credit institutions	Expense	Debit	PeriodAverage	Sum	

Source: SAS

- Flexibility in the definition of the planning model.
 - Possibility of defining any number of dimensions and hierarchies within the dimensions (see Figure 5).
 - Several planning areas may be defined in the context of the same set of dimensions.
 - Possibility of defining formulas for deriving the value of the account, depending on the values from the past, values of other accounts and values of risk factors (see Figure 6).
 - Definition of allocation rules.
- Definition of the form sets/interfaces to be used during the phases of the planning process. They can be defined by administrators, and may look different depending on the user and task to be done (see Figure 7).
- User experience.
 - Dedicated interface for the administrator to define the planning models.
 - Dedicated interface for the planning users. Users have access only to the cross-sections of the model for which permission has been granted.

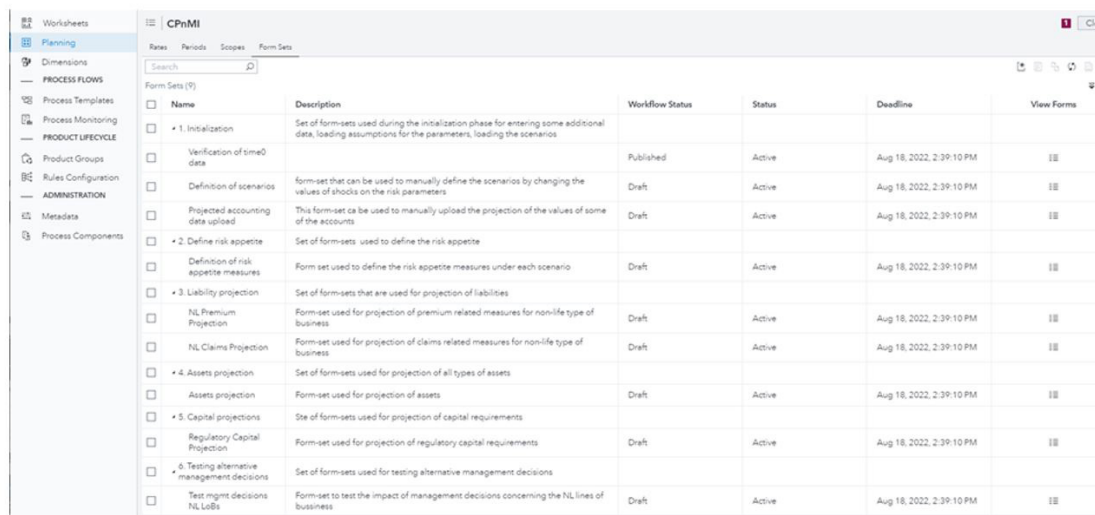
Figure 6: Defining formulas for deriving value

Member Name	Member Description	Member Type	Account Aggregation	Account Type	Account Behavior	Exchange Rate Type	Balance Type	Interact	Source	Roll Forward
BSA_LOANS_ONPOL	Loans on policies	Loans on policies	Additive	Sum	Revenue	Flow	PeriodAverage	Debit		
R_NPOLICES	Number of policies	Number of policies	Additive	Sum	StatisticalFlow	Flow	PeriodAverage	Debit		
IS_PAE	Policy acquisition and o...	Policy acquisition and o...	Additive	Sum	Expense	Flow	PeriodAverage	Debit		
R_PH_BONALLOPERC	Policyholders allocation...	Policyholders allocation...	Additive	Sum	StatisticalFlow	Flow	PeriodAverage	Debit		
R_PH_EGALLOPERC	Policyholders allocation...	Policyholders allocation...	Additive	Sum	StatisticalFlow	Flow	PeriodAverage	Debit		

Formula Type	Formula Text	Formula Scope	Editable	Dis. App.	Change Op. Priority
Reporting	ex[["ACCOUNT"="R_NPOLICES"]*["TIME"="CURRENT"]*["TIME"]>1]*["ACCOUNT"="R_NPOLICES"]*["ACCOUNT"="R_NPOLICES"]	[RISK]([NA]([VALUE]([METH]([SY]([M]([SC]([NA]([PROPERTY] PRODUCT / PROXAPPROACHES_82_74_12			
Reporting	ex[["ACCOUNT"="R_NPOLICES"]*["TIME"="CURRENT"]*["TIME"]>1]*["ACCOUNT"="R_NPOLICES"]*["ACCOUNT"="R_NPOLICES"]	[RISK]([NA]([VALUE]([METH]([SY]([M]([SC]([NA]([PROPERTY] PRODUCT / PROXAPPROACHES_82_74_12			

Source: SAS

Figure 7: Defining form sets and interfaces



Name	Description	Workflow Status	Status	Deadline	View Forms
1. Initialization	Set of form-sets used during the initialization phase for entering some additional data, loading assumptions for the parameters, loading the scenarios	Published	Active	Aug 18, 2022, 2:39:10 PM	IB
Verification of time0 data					
Definition of scenarios	form-set that can be used to manually define the scenarios by changing the values of shocks on the risk parameters	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
Projected accounting data upload	This form-set can be used to manually upload the projection of the values of some of the accounts	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
2. Define risk appetite	Set of form-sets used to define the risk appetite				
Definition of risk appetite measures	Form set used to define the risk appetite measures under each scenario	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
3. Liability projection	Set of form-sets that are used for projection of liabilities				
NL Premium Projection	Form-set used for projection of premium related measures for non-life type of business	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
NL Claims Projection	Form-set used for projection of claims related measures for non-life type of business	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
4. Assets projection	Set of form-sets used for projection of all types of assets				
Assets projection	Form-set used for projection of assets	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
5. Capital projections	Set of form-sets used for projection of capital requirements				
Regulatory Capital Projection	Form-set used for projection of regulatory capital requirements	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB
6. Testing alternative management decisions	Set of form-sets used for testing alternative management decisions				
Test mgmt decisions NL Liab	Form-set to test the impact of management decisions concerning the NL lines of business	Draft	Active	Aug 18, 2022, 2:39:10 PM	IB

Source: SAS

- Users can track the formula employed to calculate a given value.
- Users can view the detailed data under each cell (if it is not a calculated one).
- High performance.
 - It is possible to define dimensions that have thousands of members. This is useful in cases including detailed planning from the perspective of granularity of portfolio or organizational structure. These huge dimensions are then handled using dedicated mechanisms.
 - The planning engine interprets the definition of the formulas and their scope, and creates a graph of the sequence of calculations in the most optimal way.
- Advanced analytics.
 - Additional statistical models may be applied to support the planning process.
 - Time-series analysis models are commonly applied for the forecasting of sales, claims, expenses and derivative performance indicators. High-performance forecasting models are applied in the case of a large number of time series – such as when sales are projected in a division by agent and insurance product. The list of supported time-series analyses includes:
 - Autoregressive error models.
 - Autoregressive integrated moving-average models.
 - Categorical time-series analysis.
 - Error correction models.
 - Exponential smoothing models.
 - Hidden Markov models.
 - Linear Gaussian state space models.
 - Long-memory time series.
 - Market attribution models.
 - Nonlinear non-Gaussian state space models.
 - Polynomial distributed lagged models.
 - Sequential Monte Carlo methods.
 - Unobserved component models.
 - Vector autoregressive moving-average models.
 - Volatility forecasting, Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) models.
 - For some parameters (frequency and severity of claims, for instance), econometric models are applied (such as count regression and severity models).

- SAS can also be used to define (and run) more complex models for optimization purposes. This could include instances where a measure of the surplus is optimized based on basic models for interest rate and inflation on one hand, and the frequency and severity of claims and some ratios for expenses on the other. Some of the impacts may be modeled as deterministic ones, some as stochastic ones. Several constraints may be defined – such as those around investment strategies and risk appetite.

Asset and liability management

A key feature of SAS Asset Liability Management is its ability to solve credit, market and liquidity risks on a consistent, analytical basis. Principal capabilities include:

- User-defined multi-factor interest rate models.
- Multiple approaches to pre-payment analysis.
- Dynamic changes in the balance sheet due to rollovers and/or new business activities.
- Embedded options models.
- Valuation techniques for pricing complex assets and liabilities (such as securitized assets and life and non-life insurance policies).

With these tools, clients can recognize interactions between different types of risk in the balance sheet and maintain consistency with market pricing.

The building blocks in this SAS solution include:

- *Yield curve smoothing.* Gives users the choice of six yield-curve smoothing and credit-spread methods to fit current market yield curves. Among the choices is a proprietary maximum smoothness forward-rate algorithm.
- *Term structure modeling.* Offers several choices of single and multi-factor models (e.g., Vasicek, Hull-White, Ho-Lee and Heath-Jarrow-Morton).
- *Default modeling.* Credit analysis can use a wide range of default models, such as structural and reduced-form models (e.g., Jarrow, Merton and Jarrow-Chava).
- *Customer behavior rules.* Define the conditions under which customers will exercise their options in relation to various economic and non-economic factors. They include pre-payment

functions/tables and early exercise models (including transaction costs).

- *Roll-over and new business.* Allows dynamic balance-sheet evolution utilizing a rich array of user choices around the investment of scheduled and unscheduled cash flows, the amount and nature of new business, and the dynamic evolution of insurance liabilities.
- *Valuation.* Supports a wide range of valuation techniques, such as:
 - Analytical – closed-form for simple instruments.
 - Trinomial lattice – for path-dependent securities.
 - Monte Carlo – for instruments with embedded options.
- *Forecasting.* Income projections enable risk managers to measure and analyze the sensitivity of revenue to potential future changes in the prevailing economic environment.
- *Stress-testing.* Models shocks to various assumptions in the analysis (i.e., risk factors), to measure the sensitivity of the base case results to current/future events.
- *Multi-period dynamic ALM.* Employs the asset and liability market practice of dynamic balance-sheet modeling and Monte Carlo simulation to generate a dynamic multi-period value-at-risk. This recognizes both portfolio evolution and potential losses due to underlying risk-factor changes.

Vendor leading practices

Over the past 20 years, SAS has worked with some of the largest insurance companies in America, Asia and Europe. The company's business advisory teams in different regions have in-depth experience with modeling and valuation of both assets and liabilities. Its risk experts have published hundreds of research papers and dozens of books on different risk management topics.

Risk and capital calculation systems

SAS Insurance Capital Management offers an end-to-end solution approach with comprehensive risk analytics framework. The solution focuses on Pillar I- and Pillar III-linked Solvency II capital requirements, where pre-valued assets and liabilities are aggregated and necessary risk figures are calculated. These then can be provided in the quantitative reporting templates (QRTs) in the necessary

formats. The necessary data needs to be collected from accounting systems, financial data warehouses and valuation engines. Alongside the QRTs, the solution allows users to create supervisory financial condition reports to perform public disclosure.

Similarly, the solution focuses on ICS 2.0 capital requirements, and covers:

- *Market adjusted valuation (MAV)*. Regulatory classification ('bucketing') of the liability portfolios, and the generation of base and stressed yield curves.
- *Risk aggregations*. Aggregating between risk categories and sub-risks, for calculating Insurance Capital Standard (ICS) capital requirements.
- *Scenario analysis*. 'What-if' analysis capability for measuring sensitivity to changes in underlying variables. The results of the scenarios can be explored in out-of-the-box (OOTB) reports.
- *Attribution analysis*. Running different analyses against a dedicated benchmark, with direct results in OOTB reports.

Key features

Risk process

- Includes workflow-enabled capabilities that encapsulate an end-to-end business flow, including various facets of data management and iterative analytical computations on that data. These are augmented with one or more iterations of adjustments, and interspersed with appropriate review/approval stages
- Allows task coordination and people interactions.

Risk data management

- Includes an insurance data model with predefined data structures and definitions.
- Provides integrated data-quality tools that eliminate or reduce data inconsistencies.
- Automates data collection and consolidation, error handling and data processing.
- Supports integration with third-party risk applications.
- Offers security capabilities that let users create and amend user security for access, authentication and authorization.

- Includes self-documenting audit functionality that provides a complete audit trail of all changes to data and risk models.

Risk analysis and aggregation

- Calculates insurance capital charges, such as:
 - Solvency Capital Requirement (SCR) for entities at both solo and group levels.
 - Insurance Capital Standard 2.0.
- Calculates capital requirements at different levels of detail – from contract level to entity level.
- Calculates and aggregates risk capital across all risk types (P&C, life, health, market, credit, catastrophe and operational risk).
- Enables assets and liabilities to be modeled on a market-consistent basis.
- Calculates reinsurance receivables.
- Calculates available capital and solvency ratio.
- Provides full transparency and auditability of calculations.
- Allows changes in assumptions and exploration of the variances based on the changed parameters.
- Supports sensitivity analysis.
- Provides an open and scalable architecture to support an organization's internal model approach.

Risk reporting

- Includes web reporting tools (such as a customizable dashboard) and ad hoc reporting capabilities.
- Pre-built risk reporting includes standard QRTs in both XLS and XBRL formats, as per European Insurance and Occupational Pensions Authority (EIOPA) requirements.
- Provides an extendable validation rules engine that includes more than 600 predefined intra- and inter-report validation checks that meet the latest EIOPA specifications.
- Manages ongoing regulatory updates and support for the local supervisor's preferred language.

SAS Dynamic Actuarial Modeling

The pricing process is a fundamental area of an insurer's business that can directly affect their profitability, brand reputation, market penetration and growth. Many insurers still rely on fragmented systems for their pricing and premium (i.e., insurance-rate) modeling activities, an issue that's compounded by slow, inefficient processes.

SAS Dynamic Actuarial Modeling (SAS DAM) aims to improve the agility and accuracy of insurance companies' modeling, by leveraging industry-leading modeling and analytical capabilities. SAS provides software and services to enable a guided and governed actuarial process, from data preparation and modeling to automatic deployment and organization-wide integrated reporting. It also delivers real-time quotations based on customizable model parameters and decision factors.

Key features

Premium modeling process

- Supports the end-to-end pricing process, from data preparation to modeling and deploying online and batch.
- Enables modeling for pure and gross premiums.
- Enables users to create and include underwriting rules, and verify the impact of the new premium model, including new underwriting rules.
- Allows different users with different responsibilities/roles and rights to work on the same premium modeling process in a traceable and auditable environment.
- Makes ML more accessible for actuaries by offering users a choice of models and guidance throughout the pricing process.
- Drastically reduces the time to market of the new pricing models.

Data management

- Allows data from various sources to be loaded into the system.
- Enables users to define and apply data quality checks and reports of any abnormalities that lie outside the pre-defined ranges. The UI guides users to provide these pre-configured rule sets and pre-defined ranges.

- Allows users to make changes to the data of interest, creating new columns based on formulas.
- Enables data visualization, correlation analysis, box plots and the running of prototype models, in order to validate the variables to be used in the final models.

Modeling

Model estimation

- Provides a list of templates to perform frequency/severity/aggregate modeling. Users can also build their models and/or model templates.
- Enables the use of new modeling techniques (ML model, Generalized Additive Model (GAM) or another SAS Visual Data Mining and Machine Learning (VDMML) model) via the UI, without the need to write SAS code into the pipeline.

- Enables the use of models in R or Python in the modeling process.

- Supports recalibration of the model using different input data/assumptions.

- Allows the results of all selected models to be benchmarked against the classical generalized linear model (GLM).

Interactive grouping node (IGN)

- Enables easy and automatic variable grouping and gives users complete visibility and control of the results. Users may also interactively change the results coming from the automated model.
- If the grouping structure is already known, users may import it from a local file, gaining time and ensuring consistency with previous runs.

Ratemaking node

- Dedicated component that enables users to model the frequency and severity of claims using classical GLMs and more advanced models, with a final comparison of their relative performance.
- Allows users to define different variables in different models and train them simultaneously.

Explainable AI

- Elements are available as global and local interpretability indicators. These elements make the interpretation of the ML models easier and more transparent. The explainable AI indicators are:
- Local interpretable model-agnostic explanations (LIME).
- Individual conditional expectation (ICE).
- Partial dependence (PD).
- Shapley additive explanations (SHAP).
- In addition, at the variable level, there is a bias analysis to avoid unfairness in pricing that can be applied to any technique (including GLM).

Business rules

- Enable users to define underwriting and pricing rules, employing an edition of generic predefined rules or the creation of new ones.
- Enables users to deploy the score code created in the previous step.
- Enables simulation/testing of the full new premium structure on data provided by users. Results may be reviewed, and the differences with previous premium structures are disclosed in a reporting tool, including maps and other segmentation variables.

Integrated reporting

- Enables post-modeling modification of premium modeling parameters.
 - Cap and floor risk factor coefficients, with modifications tracked automatically in the report.
 - Fixes risk factor coefficients to a specific level, with modifications automatically displayed in the relativity plots and tracked in the report.
- Presents the rate book with the parameter estimates for each variable to users in a tabular format. Enables users to select any range of rates and modify an individual or range of rates manually.
- Allows users to discard any changes they made and restart from the original outputted table, or save the modified table as a scoring code.

Automatic deployment

- Enables one-click porting to production – either online or batch – using the business rules defined within the premium modeling process.

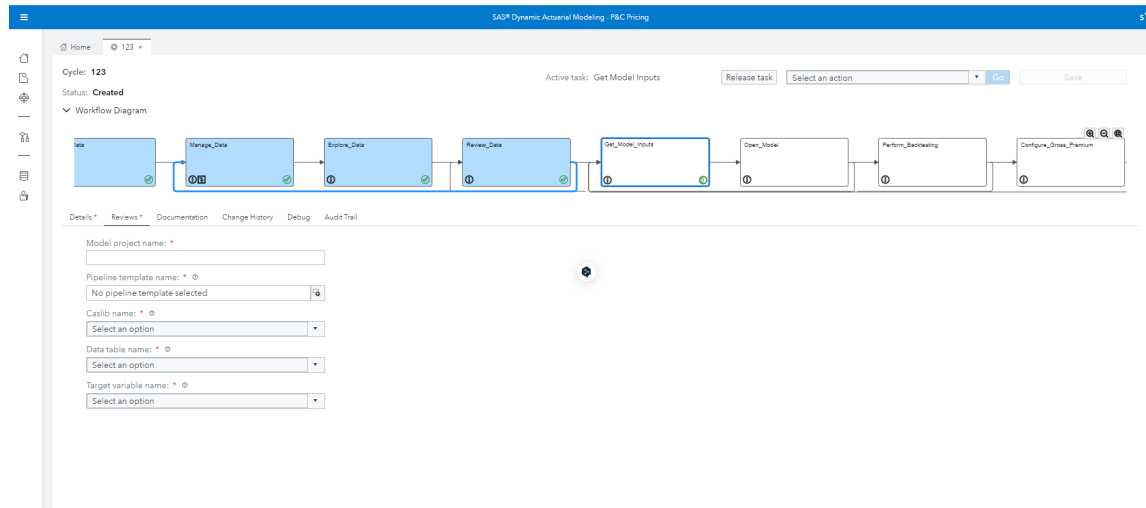
Business assets

SAS DAM includes several business assets to accelerate the adoption of the improved premium modeling process:

- *Example data.* This data comes from a public source and is used as an example to illustrate all the data preparation, analysis and data quality management steps. It is also the basis for creating an analytical table that can be used as a basis for modeling.
- *Data plans.* These include the main data transformations and data quality checks performed during the pricing process (derivation of the analytical table, standardization of column names, data quality checks, data-quality key performance indicators (KPIs), filtering of outliers, capping of large claims, etc.).
- *Visual analytics report templates.*
- *Process workflows.* There are dedicated workflows for the data management element (the transformation of the detailed data into the analytical base table used for modeling) and for the pricing (see Figure 8).

The solution offers an audit trail for processes. It is a declarative one – at each step, users are asked which elements are supposed to be added to the audit trail.

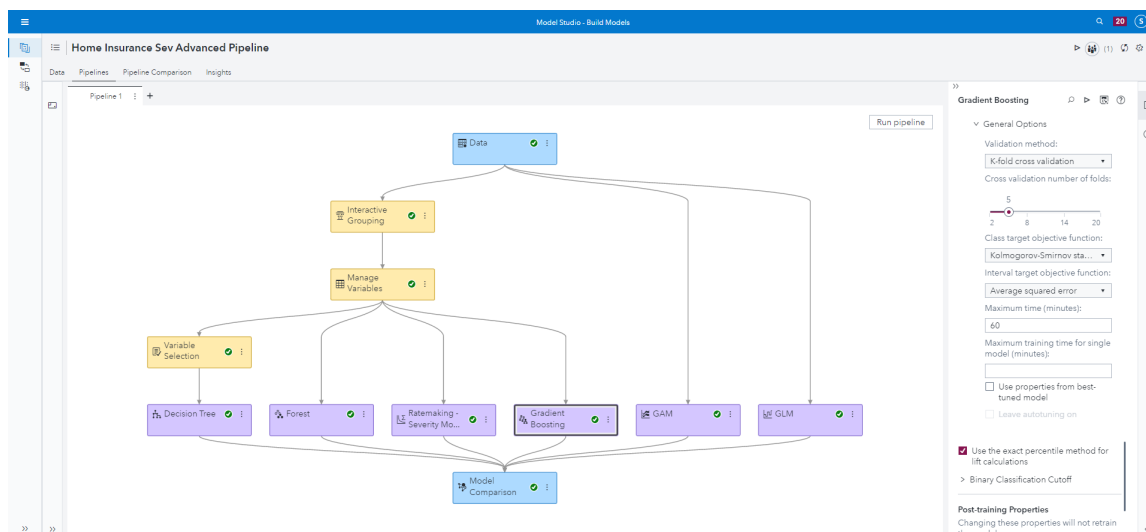
Figure 8: Process workflows



Source: SAS

Modeling templates have been prepared for use as a basis or illustration of potential approaches and they include the essential nodes for building the model. The basic ones include the GLM models, while advanced ones present how ML techniques can be used to support the modeling. Finally, the pure premium model template is designed to use scaled Tweedie and to estimate the total cost directly in a single model (see Figure 9).

Figure 9: Modeling templates



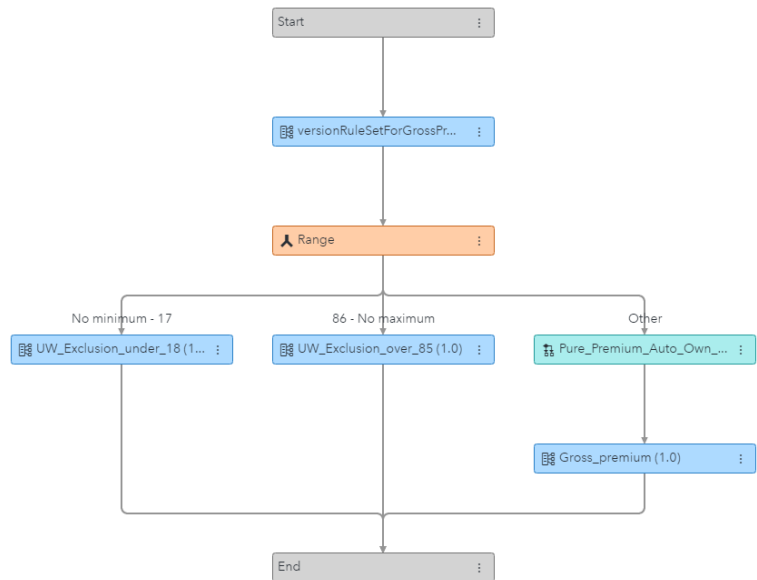
Source: SAS

All model templates include the use of the interactive grouping node and the ratemaking node.

- *Rule sets and decision flows.* Several examples have been prepared to illustrate how additional calculations, rules and decisions may be defined to derive the final premium. They may represent additional loadings or bonuses, specific exclusions or additional logic applied to derive gross premium (see Figure 10).

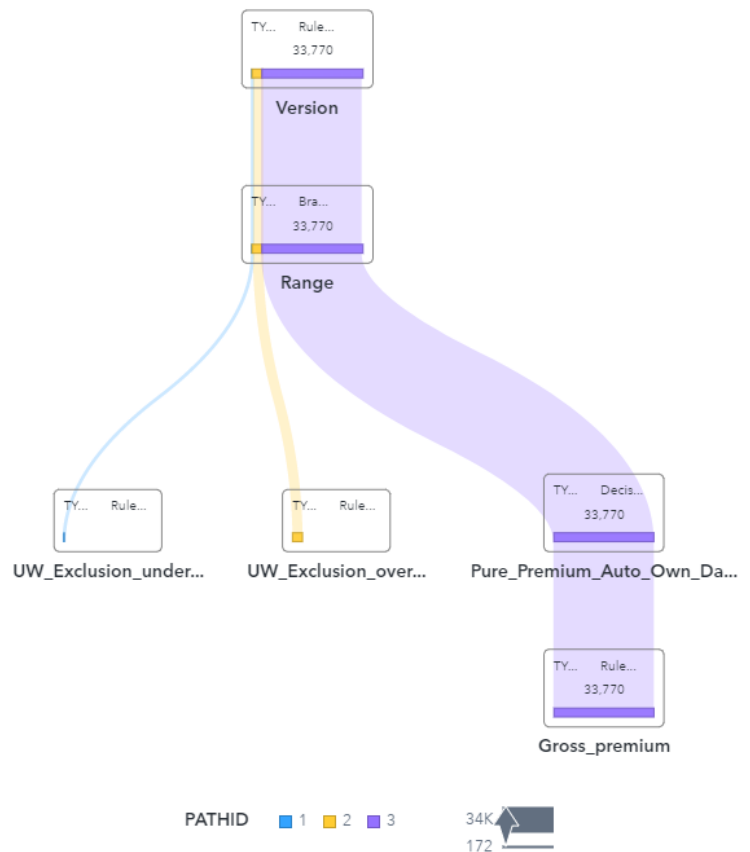
During the gross premium testing process, various tools enable users to view, test and manage the decision flow. The decision-path tracking plot provides a compact view of the scoring results. The path that the data takes is represented in the plot. Figure 11 shows the decision path of the sample data based on the underwriter exclusions. The plot shows the volume of customers that are excluded based on the underwriter criteria, and the customers who are included in the valid range.

Figure 10: Rule sets and decision flows



Source: SAS

Figure 11: Decision path of sample data



Source: SAS

4. Methodology

Overview

Chartis is a research and advisory firm that provides technology and business advice to the global financial services industry. Chartis provides independent market intelligence regarding market dynamics, regulatory trends, technology trends, best practices, competitive landscapes, market sizes, expenditure priorities, and mergers and acquisitions. Chartis' RiskTech and FinTech Quadrants™ reports are written by experienced analysts with hands-on experience of selecting, developing and implementing financial technology solutions for a variety of international companies in a range of industries including banking, insurance and capital markets. The findings and analyses in our quadrant reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns, and best practices.

Chartis seeks to include RiskTech and FinTech vendors that have a significant presence in a given target market. The significance may be due to market penetration (e.g., a large client base) or innovative solutions. Chartis uses detailed 'vendor evaluation forms' and briefing sessions to collect information about each vendor. If a vendor chooses not to respond to a Chartis request for information, Chartis may still include the vendor in the report. Should this happen, Chartis will base its opinion on direct data collated from technology buyers and users, and from publicly available sources.

Chartis' research clients include leading financial services firms and Fortune 500 companies, leading consulting firms and financial technology vendors. The vendors evaluated in our quadrant reports can be Chartis clients or firms with whom Chartis has no relationship.

Chartis evaluates all vendors using consistent and objective criteria, regardless of whether or not they are Chartis clients. Chartis does not give preference to its own clients and does not request compensation for inclusion in a quadrant report, nor can vendors influence Chartis' opinion.

Briefing process

We conducted face-to-face and/or web-based briefings with each vendor.¹ During these sessions,

¹ Note that vendors do not always respond to requests for briefings; they may also choose not to participate in the briefings for a particular report.

Chartis experts asked in-depth, challenging questions to establish the real strengths and weaknesses of each vendor. Vendors provided Chartis with:

- A business update – an overview of solution sales and client satisfaction.
- A product update – an overview of relevant solutions and R&D roadmaps.
- A product demonstration – key differentiators of their solutions relative to those of their competitors.

In addition to briefings, Chartis used other third-party sources of data, such as conferences, academic and regulatory studies, and publically available information.

Evaluation criteria

We develop specific evaluation criteria for each piece of quadrant research from a broad range of overarching criteria, outlined below. By using domain-specific criteria relevant to each individual risk, we can ensure transparency in our methodology, and allow readers to fully appreciate the rationale for our analysis. The specific criteria used for actuarial modeling and financial planning systems are shown in Table 6.

Completeness of offering

- **Depth of functionality.** The level of sophistication and amount of detailed features in the software product (e.g., advanced risk models, detailed and flexible workflow, domain-specific content). Aspects assessed include: innovative functionality, practical relevance of features, user-friendliness, flexibility, and embedded intellectual property. High scores are given to those firms that achieve an appropriate balance between sophistication and user-friendliness. In addition, functionality linking risk to performance is given a positive score.
- **Breadth of functionality.** The spectrum of requirements covered as part of an enterprise risk management system. This will vary for each subject area, but special attention will be given to functionality covering regulatory

Table 6: Evaluation criteria for Chartis' actuarial modeling and financial planning systems report

Completeness of offering	Market potential
ALM systems <ul style="list-style-type: none"> • Asset class coverage • Optimization • Data management • Hedging • Sensitivity • Liability modeling integration 	Customer satisfaction Market penetration Growth strategy Business model Financials
Risk and capital management systems <ul style="list-style-type: none"> • Solvency and economic capital calculation • Portfolio risk analysis and analytics support • Data management • Jurisdictional coverage • Visualization 	
Financial planning and analysis systems <ul style="list-style-type: none"> • Business area and vertical coverage • Profitability analytics • Data management • Business forecasting • Flexibility and scalability 	

Source: Chartis Research

requirements, multiple risk classes, multiple asset classes, multiple business lines, and multiple user types (e.g. risk analyst, business manager, CRO, CFO, Compliance Officer). Functionality within risk management systems and integration between front-office (customer-facing) and middle/back office (compliance, supervisory and governance) risk management systems are also considered.

- **Data management and technology infrastructure.** The ability of risk management systems to interact with other systems and handle large volumes of data is considered to

be very important. Data quality is often cited as a critical success factor and ease of data access, data integration, data storage, and data movement capabilities are all important factors. Particular attention is given to the use of modern data management technologies, architectures and delivery methods relevant to risk management (e.g., in-memory databases, complex event processing, component-based architectures, cloud technology, and Software as a Service). Performance, scalability, security and data governance are also important factors.

- **Risk analytics.** The computational power of the core system, the ability to analyze large amounts of complex data in a timely manner (where relevant in real time), and the ability to improve analytical performance are all important factors. Particular attention is given to the difference between 'risk' analytics and standard 'business' analytics. Risk analysis requires such capabilities as non-linear calculations, predictive modeling, simulations, scenario analysis, etc.
- **Reporting and presentation layer.** The ability to present information in a timely manner, the quality and flexibility of reporting tools, and ease of use, are important for all risk management systems. Particular attention is given to the ability to do ad-hoc 'on-the-fly' queries (e.g., 'what-if' analysis), as well as the range of 'out of the box' risk reports and dashboards.

Market potential

- **Business model.** Includes implementation and support and innovation (product, business model and organizational). Important factors include size and quality of implementation team, approach to software implementation, and post-sales support and training. Particular attention is given to 'rapid' implementation methodologies and 'packaged' services offerings. Also evaluated are new ideas, functionality and technologies to solve specific risk management problems. Speed to market, positioning, and translation into incremental revenues are also important success factors in launching new products.
- **Market penetration.** Volume (i.e. number of customers) and value (i.e. average deal size) are considered important. Rates of growth relative to sector growth rates are also evaluated. Also covers brand awareness, reputation, and the ability to leverage current market position to expand horizontally (with new offerings) or vertically (into new sectors).
- **Financials.** Revenue growth, profitability, sustainability, and financial backing (e.g. the ratio of license to consulting revenues) are considered key to scalability of the business model for risk technology vendors.
- **Customer satisfaction.** Feedback from customers is evaluated, regarding after-sales support and service (e.g. training and ease of implementation), value for money (e.g. price to functionality ratio) and product updates (e.g. speed and process for keeping up to date with regulatory changes).

- **Growth strategy.** Recent performance is evaluated, including financial performance, new product releases, quantity and quality of contract wins, and market expansion moves. Also considered are the size and quality of the sales force, sales distribution channels, global presence, focus on risk management, messaging, and positioning. Finally, business insight and understanding, new thinking, formulation and execution of best practices, and intellectual rigor are considered important.

Quadrant construction process

Chartis constructs its quadrants after assigning scores to vendors for each component of the Completeness of Offering and Market Potential criteria. By aggregating these values, we produce total scores for each vendor on both axes, which are used to place the vendor on the quadrant.

Definition of quadrant boxes

Chartis' quadrant reports do not simply describe one technology option as the best solution in a particular area. Our ranking methodology is designed to highlight which solutions are best for specific buyers, depending on the technology they need and the implementation strategy they plan to adopt. Vendors that appear in each quadrant have characteristics and strengths that make them especially suited to that particular category, and by extension to particular users' needs.

Point solutions

- Point solutions providers focus on a small number of component technology capabilities, meeting a critical need in the risk technology market by solving specific risk management problems with domain-specific software applications and technologies.
- They are often strong engines for innovation, as their deep focus on a relatively narrow area generates thought leadership and intellectual capital.
- By growing their enterprise functionality and utilizing integrated data management, analytics and Business Intelligence (BI) capabilities, vendors in the point solutions category can expand their completeness of offering, market potential and market share.

Best-of-breed

- Best-of-breed providers have best-in-class point solutions and the ability to capture significant market share in their chosen markets.
- They are often distinguished by a growing client base, superior sales and marketing execution, and a clear strategy for sustainable, profitable growth. High performers also have a demonstrable track record of R&D investment, together with specific product or 'go-to-market' capabilities needed to deliver a competitive advantage.
- Because of their focused functionality, best-of-breed solutions will often be packaged together as part of a comprehensive enterprise risk technology architecture, co-existing with other solutions.

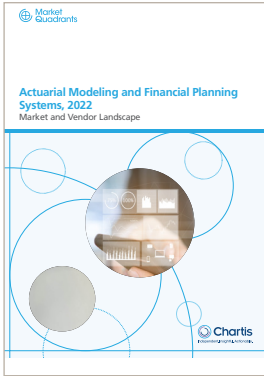
Enterprise solutions

- Enterprise solution providers typically offer risk management technology platforms, combining functionally rich risk applications with comprehensive data management, analytics and BI.
- A key differentiator in this category is the openness and flexibility of the technology architecture and a 'toolkit' approach to risk analytics and reporting, which attracts larger clients.
- Enterprise solutions are typically supported with comprehensive infrastructure and service capabilities, and best-in-class technology delivery. They also combine risk management content, data and software to provide an integrated 'one stop shop' for buyers.

Category leaders

- Category leaders combine depth and breadth of functionality, technology and content with the required organizational characteristics to capture significant share in their market.
- They demonstrate a clear strategy for sustainable, profitable growth, matched with best-in-class solutions and the range and diversity of offerings, sector coverage and financial strength to absorb demand volatility in specific industry sectors or geographic regions.
- They will typically benefit from strong brand awareness, a global reach, and strong alliance strategies with leading consulting firms and systems integrators.

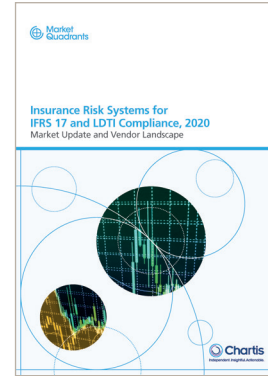
Further reading



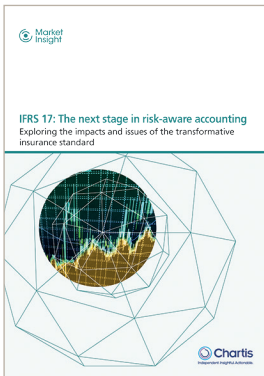
Actuarial Modeling and Financial Planning Systems, 2022: Market and Vendor Landscape



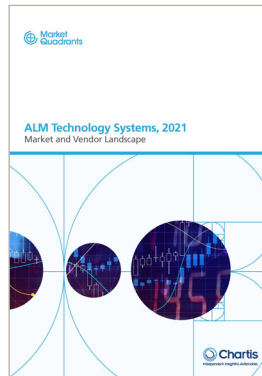
IFRS 17 and LDTI Solutions, 2022: Market Update and Vendor Landscape



Insurance Risk Systems for IFRS 17 and LDTI Compliance, 2020: Market Update and Vendor Landscape



IFRS 17: The next stage in risk-aware accounting



ALM Technology Systems, 2021: Market and Vendor Landscape



RiskTech100 2023

For all these reports, see www.chartis-research.com