Independent research by

Chartis

RiskTech Quadrant® 2017

Enterprise Stress Testing Systems

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About Chartis

Chartis Research is the leading provider of research and analysis on the global market for risk technology. It is part of Incisive Media, which owns market-leading brands such as Risk and Waters Technology. Chartis's 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 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 including Basel 2 and 3, Dodd-Frank, MiFID II and Solvency II

Chartis is solely focused on risk and compliance technology, which gives 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 implementing and developing risk management systems and programs for Fortune 500 companies and leading consulting houses.

Visit ***www.chartis-research.com*** for more information.

Join our global online community at ***www.risktech-forum.com***.

1. In this research paper

This Chartis research paper covers the following:

- RiskTech Quadrant® for Enterprise Stress Testing Systems
- SAS Enterprise Stress Testing Systems – capabilities and market position
- RiskTech Quadrant® methodology

2. RiskTech Quadrant® for Enterprise Stress Testing Systems

Figure 1: RiskTech Quadrant® for Enterprise Stress Testing Systems

Quadrant Key:

- = *Primary focus is banking book*
- = *Primary focus is trading book*
- = *Covers both trading and banking book*

Source: Chartis Research

Figure 1 above describes Chartis's view of the vendor landscape for Enterprise Stress Testing Systems.

The RiskTech Quadrant® is a proprietary methodology developed specifically for the risk technology marketplace. It takes into account product and technology capabilities of vendors as well as their organizational capabilities.

Appendix A sets out the generic methodology and criteria used for the RiskTech Quadrant®.

Specifically we have considered the following criteria as particularly important:

Completeness of offering:

- Macroeconomic integration
- Drill down/decomposition
- Reporting and alerts
- Regulatory interfaces with business-as-usual processes and BCBS 239
- Integration of Profit and Loss (P&L) balance sheet
- Pricing and risk analytics
- Interface with non-vendor models
- Completeness of asset classes
- Completeness of risk categories
- Regulatory tests and templates
- Revaluation methods
- Simulation methods
- Market factor modeling approaches
- Asset class roll-ups
- Back-testing and reverse stress testing
- Weighting methods
- Data management
- Model validation and management
- Workflow tools
- Domain knowledge

Market potential:

- Existing EST client base
- Track record of delivering successful EST projects

- Growth strategy and brand
- Post-sales implementation and support capabilities
- Strategy for and investment in continued innovation in risk technology relating to EST
- Domain knowledge and thought leadership in risk and finance
- Potential volume of EST wins
- Potential value of EST deals (i.e. Tier 1 clients vs. Tier 2 or Tier 3 clients)
- Scalability of business model (i.e. repeatable sales and delivery capabilities)
- Geographical reach
- Financial strength

3. SAS Enterprise Stress Testing Systems – capabilities and market position

Founded 41 years ago, SAS is one of the largest software companies in the world, with over 14,000 employees, 400 offices in 56 countries, and customers in 139. SAS's solution set covers a range of enterprise risk management needs, including credit risk, market risk, Asset Liability Management (ALM), operational risk/Governance, Risk Management and Compliance (GRC), liquidity risk, enterprise stress testing, model risk management and financial crime. In this market, SAS has more than 250 clients using its stress testing modules, including:

- 150 clients in EMEA, focused on end-to-end stress testing, and typically for Bank of England (BoE), Prudential Regulation Authority (PRA), European Banking Authority (EBA) and European Central Bank (ECB) reporting.

- 70+ financial institutions in the US with assets of between $10bn and $50bn (for end-to-end testing for Dodd-Frank Act Stress Tests (DFAST)); and 30+ banks (including US-based large international banks) for Comprehensive Capital Analysis and Review (CCAR) stress tests.

SAS provides a platform-based enterprise stress-testing framework driven by a workbench, 'hub' approach that integrates and leverages its other enterprise risk management modules.

The system focuses on financial institutions' enterprise level to help them define, orchestrate and streamline the stress-testing process for easier traceability, auditability, transparency and scalability. Clients can perform scenario exploration, sensitivity analysis and capital planning and management, and explore model dependencies. The solution can also leverage and integrate existing in-house applications and legacies – this means it is not a pure 'lift and shift' vendor relationship, but can be a progressive integration.

SAS also offers coordinated, systematic support, ranging from data management to model lifecycle management and integration, scenario management, aggregation, capital planning and reporting. For client use cases driven mainly by regulators, this enables improved data management, hands-on governance, lower integration costs, reduced modeling gaps in the results, fewer Excel dependencies, and a greater confidence in handling 'on-the-fly' requests from regulators.

The SAS Model Governance module centrally manages model development, calibration, validation and documentation, and can be applied at a granular level to a bank's portfolio. It can then be appropriately versioned so that different model iterations can be tracked and documented. Model templates for commonly used modeling methods are provided and can be customized to save time.

The SAS workbench was updated in 2016 to the Risk and Finance Workbench (RFW), which can serve as a hub for third-party stress tests. The workbench provides capabilities for orchestration, execution and reporting for risk issues in stress testing, International Financial Reporting Standards (IFRS) 9 and general Basel reporting. It also provides out-of-the-box basic accounting capabilities, such as balancing a balance sheet, rolling over line-item values across multiple projection horizons, and auditing all the adjustments and overrides.

An end-users' Graphical User Interface (GUI) provides an editable and configurable spreadsheet-like view. The reporting system has standard report templates, a full history of every report, a snapshot of the source data used and a supporting audit trail.

The SAS Scenario Manager enables users to explore scenarios graphically, comparing projected scenario values with historical values for the same risk factor. Baseline scenarios, stored and managed in a library, can be modified (new horizons can be defined, for example), while balance sheets and earnings can be tested according to prescribed macroeconomic scenarios.

After a model is run the results are analyzed and aggregated. Using in-memory grid, results can be aggregated quickly through a user-defined hierarchy, before being 'sliced and diced'. Both a batch programming interface and a graphical user interface are available to make the aggregation intuitive. Once a scenario is defined, the system's workflow streamlines the scenario input, model execution from the model inventory, risk aggregation, and exploration through to collaboration and planning. Users can also enter hypothetical transactions and positions/exposures to assess their impact.

SAS's stress testing framework supports analytical approximation methods (e.g., delta-normal analysis), simulation methods (e.g., covariance matrix, historical, scenario, mixed and advanced Monte Carlo simulations with user-defined and calibrated models), scenario and stress testing analysis (including mixing stress scenarios with simulation methods), and advanced scenario-based portfolio optimization. Different risk methodologies can be used on different cross-sections of portfolios, and can combine in-house custom risk models with SAS's out-of-the-box models.

SAS has recently produced a new set of stress testing modeling algorithms for credit risk on the SAS Model Implementation Platform. Addressing the market in light of the forthcoming IFRS 9 requirements, as well as different stress testing requirements around the world, SAS has introduced new modeling approaches to adapt to new regulatory requirements. These new methods introduce Point in Time (PiT) modeling paradigms, as well as multiple-horizon credit modeling.

4. Appendix A: RiskTech Quadrant® methodology

Chartis is a research and advisory firm that provides technology and business advice to the global risk management 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's RiskTech Quadrant® reports are written by experienced analysts with hands-on experience of selecting, developing, and implementing risk management systems for a variety of international companies in a range of industries including banking, insurance, capital markets, energy, and the public sector.

Chartis's research clients include leading financial services firms and Fortune 500 companies, leading consulting firms, and risk technology vendors. The risk technology vendors that are evaluated in the RiskTech Quadrant® reports can be Chartis clients or firms with whom Chartis has no relationship. Chartis evaluates all risk technology vendors using consistent and objective criteria, regardless of whether or not they are a Chartis client.

Where possible, risk technology vendors are given the opportunity to correct factual errors prior to publication, but cannot influence Chartis's opinion. Risk technology vendors cannot purchase or influence positive exposure. Chartis adheres to the highest standards of governance, independence, and ethics.

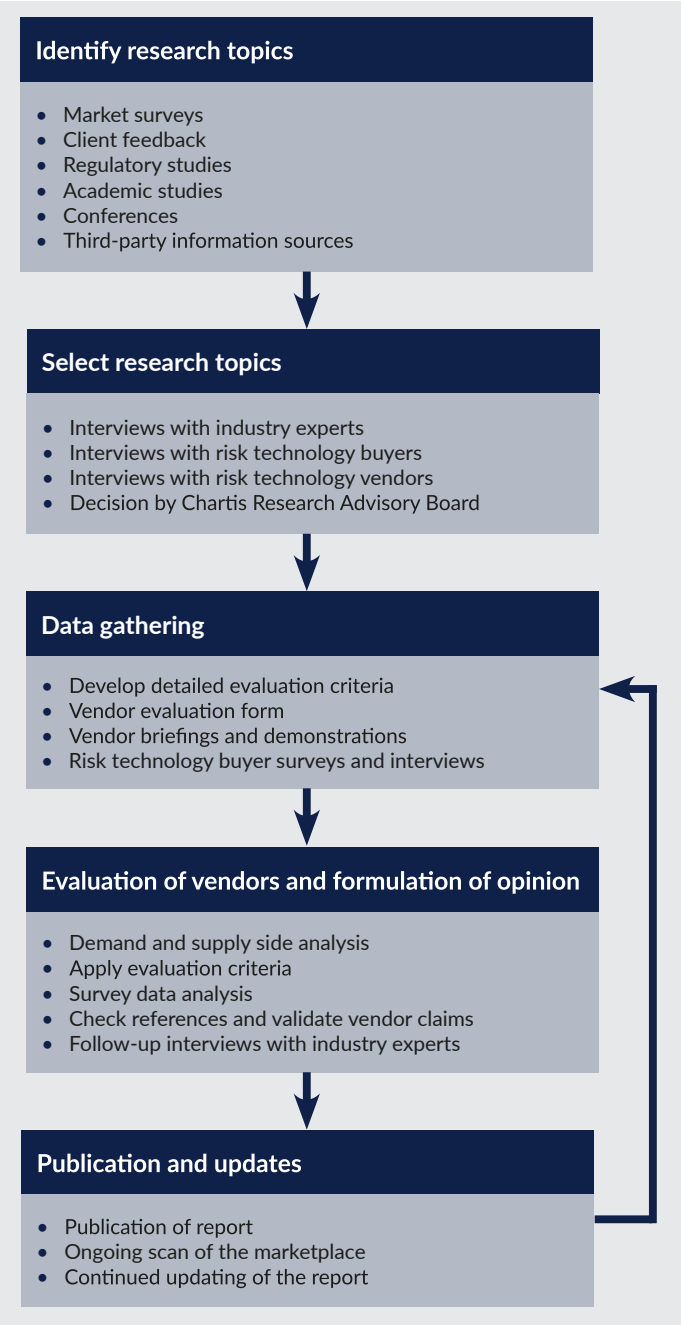
Inclusion in the RiskTech Quadrant®

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

Research process

The findings and analyses in the RiskTech Quadrant® reports reflect our analysts' considered opinions, along with research into market trends, participants, expenditure patterns, and best practices. The research lifecycle usually takes several months, and the analysis is validated through several phases of independent verification. Figure 2 below describes the research process.

Figure 2: RiskTech Quadrant® research process



Source: Chartis Research

Chartis typically uses a combination of sources to gather market intelligence. These include (but are not limited to):

- **Chartis vendor evaluation forms.** A detailed set of questions covering functional and non-functional aspects of vendor solutions, as well as organizational and market factors. Chartis's vendor evaluation forms are based on practitioner level expertise and input from real-life risk technology projects, implementations, and requirements analysis.

- **Risk technology user surveys.** As part of its ongoing research cycle, Chartis systematically surveys risk technology users and buyers, eliciting feedback on various risk technology vendors, satisfaction levels, and preferences.

- **Interviews with subject matter experts.** Once a research domain has been selected, Chartis undertakes comprehensive interviews and briefing sessions with leading industry experts, academics, and consultants on the specific domain to provide deep insight into market trends, vendor solutions, and evaluation criteria.

- **Customer reference checks.** These are telephone and/or email checks with named customers of selected vendors to validate strengths and weaknesses, and to assess post-sales satisfaction levels.

- **Vendor briefing sessions.** These are face-to-face and/or web-based briefings and product demonstrations by risk technology vendors. During these sessions, Chartis experts ask in depth, challenging questions to establish the real strengths and weaknesses of each vendor.

- **Other third-party sources.** In addition to the above, Chartis uses other third-party sources of information such as conferences, academic and regulatory studies, and collaboration with leading consulting firms and industry associations.

Evaluation criteria

The RiskTech Quadrant® (see Figure 3) evaluates vendors on two key dimensions:

1. Completeness of offering

2. Market potential

Figure 3: RiskTech Quadrant®

Source: Chartis Research

The generic evaluation criteria for each dimension are set out below. In addition to the generic criteria below, Chartis utilizes domain-specific criteria relevant to each individual risk. These are detailed in the individual vendor evaluation forms, which are published as an appendix to each report. This ensures total transparency in our methodology and allows readers to fully appreciate the rationale for our analysis.

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 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, 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

- **Market penetration.** Both volume (i.e. number of customers) and value (i.e. average deal size) are considered important. Also, rates of growth relative to sector growth rates are evaluated.

- **Brand.** Brand awareness, reputation, and the ability to leverage current market position to expand horizontally (with new offerings) or vertically (into new sectors) are evaluated.

- **Momentum.** Performance over the previous 12 months is evaluated, including financial performance, new product releases, quantity and quality of contract wins, and market expansion moves.

- **Innovation.** New ideas, functionality, and technologies to solve specific risk management problems are evaluated. Developing new products is only the first step in generating success. Speed to market, positioning, and translation into incremental revenues are critical success factors for exploitation of the new product. Chartis also evaluates business model or organizational innovation (i.e. not just product innovation).

- **Customer satisfaction.** Feedback from customers 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) is evaluated.

- **Sales execution.** The size and quality of sales force, sales distribution channels, global presence, focus on risk management, messaging, and positioning are all important factors.

- **Implementation and support.** 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.

- **Thought-leadership.** Business insight and understanding, new thinking, formulation and execution of best practices, and intellectual rigor are considered important by end users.

- **Financial strength and stability.** Revenue growth, profitability, sustainability, and financial backing (e.g. the ratio of license to consulting revenues) is considered as key to scalability of the business model for risk technology vendors.

Quadrant descriptions

Point solutions. Providers of point solutions focus on a relatively small number (typically two or three) of component technology capabilities. These vendors meet a very important need in the risk technology market by solving specific risk management problems with domain-specific software applications and technologies. Point solution providers also provide a strong engine for innovation as their deep focus on relatively narrow subject areas generates thought leadership and intellectual capital. These vendors often have gaps relating to the broader enterprise risk management functionality and do not have the integrated data management, analytics, and business intelligence capabilities found in enterprise technology platforms. Furthermore, these vendors have not yet developed the organizational characteristics for capturing significant market share. Their growth is often constrained by lack of financial and human resources, or relatively weak sales and marketing execution.

Best-of-breed. Providers of best-of-breed solutions have best-in-class point solution capabilities together with the organizational characteristics to capture significant market share in their chosen target markets. Providers of best-of-breed solutions usually have a growing client base, superior sales and marketing execution, and a clear strategy for sustainable profitable growth. Best-of-breed solution providers can also demonstrate a healthy rate of investment in research and development, and have specific product or 'go-to-market' capabilities that give them a competitive advantage. Best-of-breed solution vendors have depth of functionality, but lack the breadth of technology and functionality required to provide an integrated enterprise-wide risk management system. Best-of-breed solutions are often considered as a subset of more comprehensive risk technology architecture and are required to co-exist with other third-party technologies or in-house systems to provide an integrated solution to a given risk management problem.

Enterprise solutions. Enterprise solution providers have a clear strategy and vision for providing risk management technology platforms. They are characterized by the depth and breadth of their technology capabilities, combining functionally rich risk applications with comprehensive data management, risk analytics, and business intelligence technologies. A key differentiator is the openness and flexibility of their technology architecture and their 'tool-kit' approach to risk analytics and reporting. Enterprise solution providers support their technology solutions with comprehensive infrastructure and service capabilities, ensuring best-in-class technology delivery. Moreover, enterprise solution providers have clear strategies for combining risk management content and data with their risk management software to provide an integrated 'one-stop-shop' for risk technology buyers.

Category leaders. Category leaders are risk technology vendors that have the necessary depth and breadth of functionality, technology, and content, combined with the organizational characteristics to capture significant market share by volume and value. Category leaders can demonstrate a clear strategy for sustainable, profitable growth, matched with best-in-class solutions. Category leaders also have the range and diversity of offerings, sector coverage, and financial strength to be able to absorb demand volatility in specific industry sectors or geographic regions. These vendors benefit from strong brand awareness, a global reach, and strong alliance strategies with leading consulting firms and systems integrators. Category leaders can also demonstrate an appetite for ongoing investment in innovation, often matched by deep pockets and a strong financial performance. Ultimately, category leaders combine deep domain knowledge in various risk topics with deep technology assets and capabilities. They can demonstrate this by addressing the needs of very large clients with complex risk management and technology requirements, as well as addressing the needs of smaller clients with standardized requirements looking for integrated solutions from a single vendor.

5. Further reading

- *Enterprise Stress Testing Systems 2015*
- *Credit Risk Management Systems for the Banking Book 2016*
- *Enterprise Collateral Management Systems for the Trading Book 2016*
- *RiskTech100® 2017*
- *Data Integrity and Control in Financial Services 2016*

For all of these reports see: ***www.chartis-research.com***