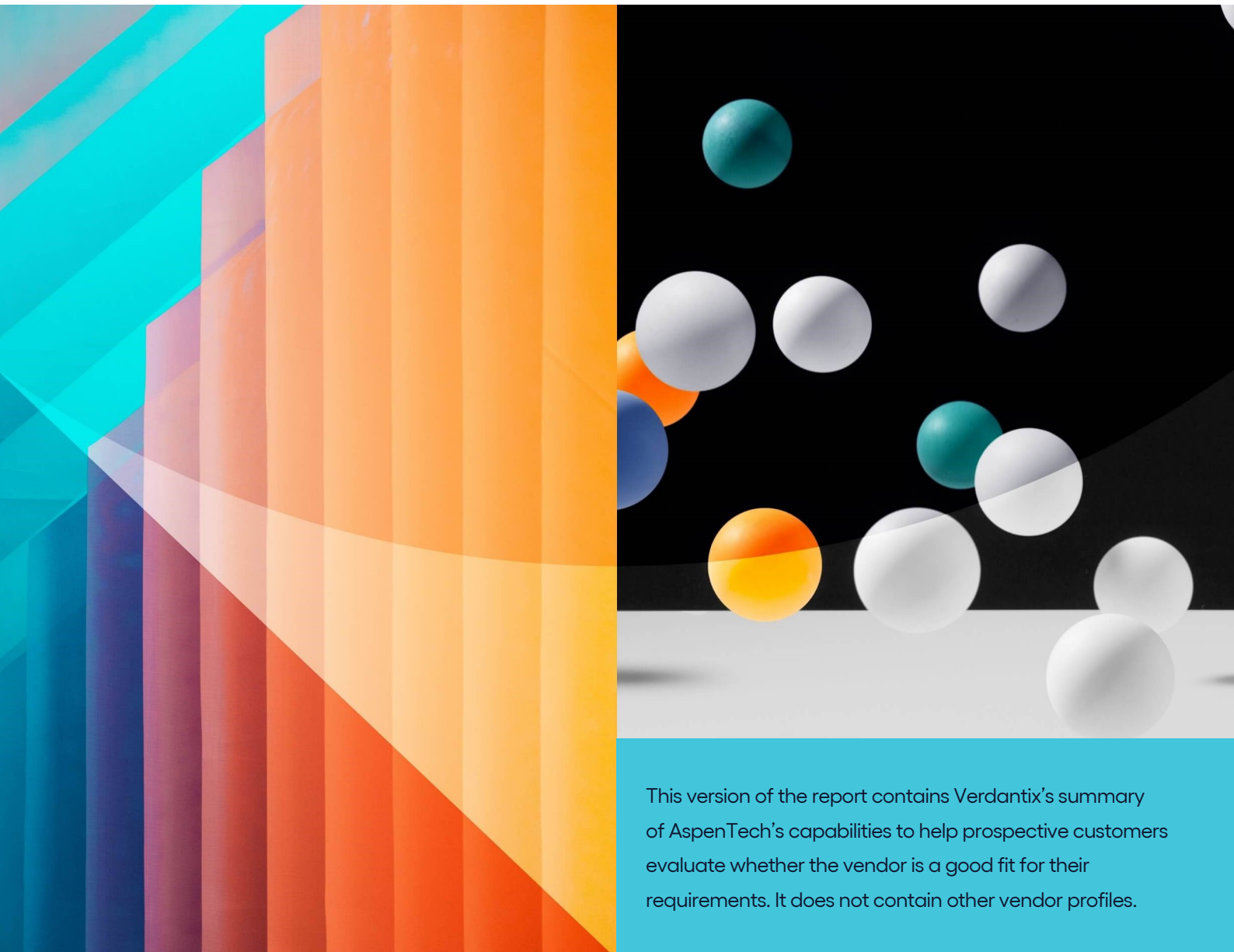# verdantix

Green Quadrant: Asset Performance Management Solutions 2022

By Kiran Darmasseelane
With Malavika Tohani
and Fouad Elias

September 2022

This version of the report contains Verdantix's summary of AspenTech's capabilities to help prospective customers evaluate whether the vendor is a good fit for their requirements. It does not contain other vendor profiles.

Operational Excellence

Green Quadrant: Asset Performance Management Solutions 2022

By Kiran Darmasseelane
With Malavika Tohani and Fouad Elias   September 2022

This report provides a detailed fact-based comparison of the most prominent asset performance management (APM) software vendors in the market today. Based on the proprietary Verdantix Green Quadrant methodology, our analysis encompassed two-and-a-half-hour live product demonstrations with pre-set scenarios, and considered vendor responses to a 206-point questionnaire covering 10 technical, 10 functional and 12 market momentum categories. We also conducted interviews with 10 APM software users and reviewed the data from our global survey of 256 operational excellence decision-makers. Spend on APM software is set to grow, with providers looking to differentiate through partnerships and acquisitions, increased mobile and wearable functionality, 3D visualizations and digital twin simulations, and rapid implementations to garner quicker returns on investment (ROI). Among the software vendors featured in the Leaders' Quadrant, seven firms—AspenTech, AVEVA, Bentley Systems, Cognite, GE Digital, Hitachi Energy, IBM—demonstrated the most advanced all-round APM software capabilities

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Organizations mentioned

ABB, Accenture, Accruent, ADNOC, Air Liquide, Aker BP, Alfa Laval, Alizent, Ameren, American Petroleum Institute (API), Aptean, Arcadis, ARMS Reliability, Ascend Performance Materials, AspenTech, Asset Performance Technologies (APT), Atos, Augury, Autodesk, AVEVA, AWS, Azima Global, Baker Hughes, BASF, Beamex, Bentley Systems, Bently Nevada, Berkshire Hathaway, Bermunda Electric Light Company (BELCO), BHE Renewables, BISTel, Borealis, BP, Braskem, Brightly Software, C3 AI, Camo Analytics, Canadian National Railway, Capgemini, Capital Power, Caterpillar, Caterpillar Ventures, Cenosco, Chevron, Chevron Phillips Chemical, China Southern Power Grid, Clayton Dubilier & Rice (CD&R), CNTXT, Cognite, Cognizant, Cohesive Solutions, Copperleaf, Cosmo Tech, Delek US, Deloitte, Delta Air Lines, Detechtion Technologies, DevonWay, DIREXYON, DNV, Duke Energy, Emerson, Enablon, ENGIE, Envizi, E.ON, Epicor, ExxonMobil, Fidelis Group, FirstEnergy, Flowserve, Fluke, Flutura, Fortino Capital, Fracttal, Framo, GE Digital, General Electric, General Motors, Google, GreatPoint Ventures, Grundfos, GTT, Hatch, Helios, Henkel, Hess Corporation, Hexagon, HighByte, Hitachi Energy, Hitachi High-Tech Solutions, Hitachi Vantara, Honeywell, HS1, HUVR, IBM, IBM Consulting, IFS, Inductive Automation, Industrial Analytics, Infor EAM, Inner Mongolia Power Group, Indian Oil Corporation Limited (IOCL), Innovapptive, Innovyze, Intel, International Council on Large Electric Systems (CIGRE), International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), IPS Group, Isograph, Itus Digital, Kuwait National Petroleum Company (KNPC), L&T Technology Services, Limble CMMS, Lloyd's Register, London Stock Exchange, LUKOIL, Lumis Partners, Lundin Energy, Lupin, MachineMetrics, MaxGrip, Meridium, Metegrity, Metropolitan Atlanta Rapid Transit Authority (MARTA), Micromine, Microsoft, Mitsubishi Heavy Industries, MOL Group, MTell, National Grid US, Natref, Nexus Global, NiSoft, North Caspian Operating Company (NCOC), OCP Ecuador, OMV, OneBridge Solutions, Oniqua, Operations1, Oracle, OSIsoft, Parsable, Patterson-UTI, PepsiCo, Petrogenium, PETRONAS, Pinnacle, Pragma, Probit Consulting, Proceedix, Progress Rail, Quentic, RealWear, Reliability Center Inc. (RCI), Reliance, ReliaSoft, Revolution, Rockwell Automation, SABIC, SAE, SAP, Sasol, Saudi Aramco, Savigent, SCG Chemicals, Schlumberger, Schneider Electric, Seebo, Seeq, Seminole County Water Division, Senseye, Shell, ShookIOT, SIBUR, Siemens, Siemens Energy, Sinopec, SMRT Trains, Société Algérienne de Production de l'Electricité (SPE), SparkCognition, Sparta Systems, SPE, State Grid Corporation of China, Stork, Stress Engineering, Sweco, Symphony AI Group, SymphonyAI Industrial, Tata Power, TechnipFMC, TenForce, Thai Oil, The Cohesive Companies, The Hive, TIBCO, Total, Tüpraş, TwinThread, Ultimo, UpKeep, Uptake, US Army, US Department of Defense, Vertex Ventures, Visionaize, Wintershall Dea, Wipro, Wood, Yokogawa

State of the Asset Performance Management Software Market

Asset performance management (APM) solutions consist of a bundle of software tools, services and digital content, used to collect and stream data to boost the performance of assets by supporting core usage scenarios for asset health monitoring, asset failure analytics, reliability analysis, maintenance optimization and integrity management. APM sits alongside computerized maintenance management systems (CMMS) and enterprise asset management (EAM) and asset investment planning (AIP) solutions within the wider industrial asset management software landscape (see **Figure 1**). APM software helps users in maintenance, reliability engineering, operations and recently developed sustainability roles predict equipment failures, formulate the best strategy to remedy identified problems, minimize associated maintenance costs and maximize asset performance.

When successfully deployed, customers obtain several benefits from APM solutions: cost savings by shifting to predictive from preventative maintenance; elimination of unplanned downtime by intervening before equipment fails; and a reduction in worker injuries and environmental damage by mitigating the risk of industrial accidents. This report provides heads of maintenance and operations with a detailed assessment of 15 prominent vendors of APM software. The study answers the following questions:

- What is the current state of the APM software market?
- How can I benchmark the capabilities of APM software applications?
- Which APM software providers have the capabilities to meet my requirements?
- Which vendors have demonstrated success in my industry?
- How does my current APM software compare with the best-in-class for my industry?
- How well-positioned is APM to satisfy my evolving asset maintenance requirements?
- What factors indicate that an APM vendor is a reliable partner for the future?

To answer these questions, Verdantix assessed 15 suppliers using a 206-point questionnaire; defined five usage scenarios as the basis for two-and-a-half-hour live product demonstrations; interviewed 10 corporate users of APM software; and surveyed 256 decision-makers responsible for operational excellence initiatives. AspenTech, AVEVA, Baker Hughes, Bentley Systems, Cenosco, Cognite, Flutura, GE Digital, Hitachi Energy and SymphonyAI Industrial participated actively in the study, with complete responses to the questionnaire. Honeywell provided a live product demonstration and briefing, but did not complete the questionnaire. DNV, IBM, SAP and Uptake were invited to participate, but either declined or did not respond. The analysis is based on the proprietary Verdantix Green Quadrant methodology, which provides a quantified, evidence-based and objective assessment of vendors of a comparable product or service.

The Evolution Of APM: From Asset Maintenance To Reliable And Sustainable Plant Operations

The APM market has grown out of the desire of maintenance and operations executives to find digital solutions to help optimize asset performance and intervention strategies, in order to counteract demand shocks and supply chain disruptions, such as those resulting from COVID-19, fluctuations in energy prices and the recent Ukraine-Russia war (see [Verdantix Buyer's Guide: Asset Performance Management Software](#)). Firms are being pressured to do more with less, driving the development of APM software beyond traditional condition-based maintenance activities, towards improving and optimizing performance, as well as sustainability-related objectives. When exploring the use of APM software over the last 20 years, Verdantix found that (see **Figure 2**):

Figure 1

Technology Stack And Information Exchange Of Asset Management Applications

Planning and Execution Horizon: Decision Types

strategic — tactical — operational

- Long-Term Capital Planning
- Asset Investment Planning Software
- API

- Data (History)
- Work Order Execution
- Work Order Scheduling
- Enterprise Asset Management System
- Computerized Maintenance Management System
- API
- API

Synchronize

- API
- Asset Failure Prediction
- Asset Health Monitoring
- Asset Performance Management Software
- API
- Data (Future)

- Historian (time-series database)
- Data/IIoT Platform (middleware)
- Ingest
- Ingest

- Sensors
- Programmable Logic Controllers
- Remote Terminal Units

- Distributed Control Systems

- SCADA Systems

- IoT Devices

- API

- Predictive Maintenance
- Supply Chain Optimization
- Performance Optimization
- Quality Assurance
- Data Mgmt Optimization
- Industrial Analytics Software
- Ingest

Planning and Execution Horizon: Decision Period

yearly — weekly/monthly — daily/weekly — by the minute

Figure 2

Evolution Of Asset Performance Management
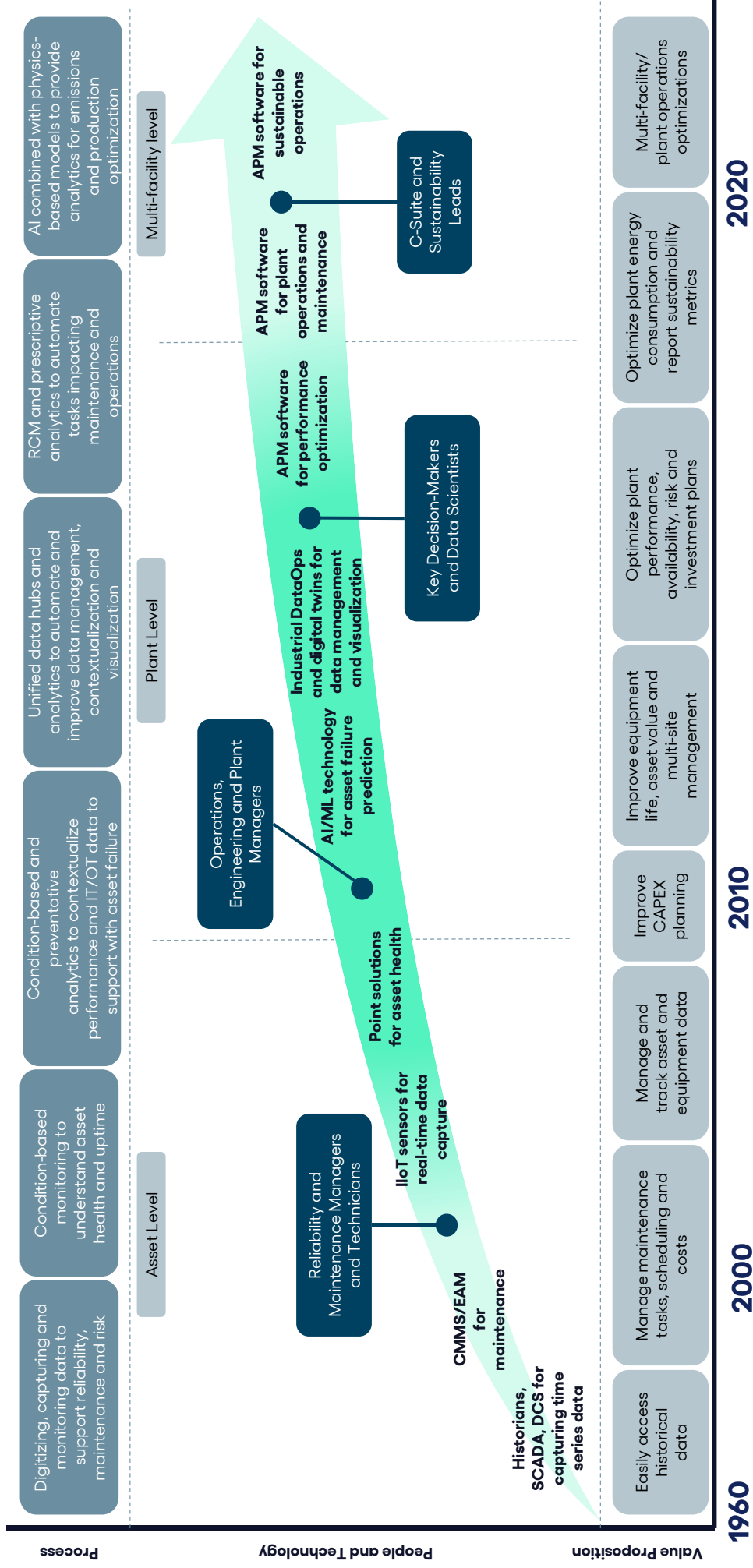
- **Traditional solutions to support asset maintenance activities no longer meet business needs.**
  In the 2021 Verdantix global corporate survey, 62% of the 256 respondents stated that improving process optimization and lean operations was a high priority for their firm over the next 12 months. Eighty-six per cent of respondents also described investment in asset management software to reduce maintenance-related costs as either 'very important' or 'important' (see **Figure 3** and **Figure 4**) (see Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences). It is becoming clear that traditional condition-based maintenance tools are not providing firms with enough insight to address their maintenance challenges. Moreover, asset-intensive industries are attempting to understand how and when assets will fail, as well as which failures are most severe and which would see the greatest benefits from intervention to improve quality, performance, efficiency and safety. As a result, firms are turning to solutions that offer predictive and prescriptive models, such as those provided by APM software.

  "We are most interested in applying predictive failure capabilities for our assets, so that we can optimize the maintenance of our equipment" – Asset and Maintenance Manager, Oil and Gas (Upstream)

- **APM solutions remain under-utilized across the process industries.**
  Across the asset-intensive industries, the use of APM software is limited. Firms are still relying on enterprise resource planning (ERP), EAM and CMMS tools to support the maintenance of assets throughout their life cycle. In the 2021 Verdantix global corporate survey, 54% of the 256 respondents stated that they used ERP software widely across their operations or at multiple facilities, while 34% used EAM and 27% used CMMS solutions. Only 13% of respondents mentioned using APM software widely across their operations or at multiple facilities (see **Figure 5**).

  "Our APM usage is currently growing, but due to previous failures and implementation complexities, we are currently focusing on solutions that are easy to implement" – Senior Asset Manager, Oil and Gas (Refining)

- **Software uptake is impeded by buyers not understanding the benefits.**
  Implementation of APM software is still widely associated with optimizing maintenance, with many executives unsure of use cases outside of predictive maintenance. This narrow view, and a lack of understanding of the value delivered by APM software beyond maintenance, has resulted in stakeholders allocating minimal priorities and budget towards software implementation. Vendors in the market have begun to align their marketing messages to educate potential buyers that not only will an APM solution improve asset reliability and uptime, it will also boost data integration, performance efficiency, asset lifecycle management and sustainability.

  "We are planning on implementing APM software to improve plant-wide maintenance activities, so that we can increase asset uptime. However convincing management and getting people to listen is slowing down adoption rates." – Asset Integrity Manager, Oil and Gas (Upstream)

- **Functionality has evolved to support maintenance, operations and sustainability.**
  Initiatives to boost process performance, and stringent regulations to combat climate change and achieve carbon neutrality, are forcing firms to implement long-term digital strategies to improve operations and sustainability. APM software uses advanced data analytics to evolve maintenance strategies beyond workflow management, to encompass accurate forecasts and the optimization of performance, investment decisions, operational costs and environmental impact. This enables firms to improve process uptime, safety and reliability, optimize investment plans and adhere to environmental constraints, while maximizing economic return.

Operational Excellence Business Priorities In 2022

"To what extent are the following operational excellence initiatives a priority for your firm to improve in the next 12 months?"

Initiative	1. High priority	2. Moderate priority	3. Low priority	4. Don't know
Process optimization and lean operations	62%	18%	19%	1
Safe operations	48%	36%	14%	1
Sustainable operations	48%	19%	31%	2
Process safety management	39%	48%	12%	1
Contractor management	39%	46%	13%	1
Worker health protection	37%	44%	19%	
Quality management	33%	41%	26%	1
Asset reliability and integrity	26%	61%	13%	

■ 1. High priority ■ 2. Moderate priority ■ 3. Low priority ■ 4. Don't know

Note: Data labels are rounded to zero decimal places; percentages less than 6% are written as numbers
Source: Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences

N=256

Drivers Of Investment In Asset Management Software In 2022 And 2023

"How important will the following factors be in causing your firm to invest in software for industrial asset management over the next two years?"

Factor	1. Very important	2. Important	3. Unimportant	4. Don't know
Reducing maintenance-related costs	71%	15%	14%	
COVID-19 induced remote operations	58%	13%	29%	
Declining cost of IoT devices	39%	41%	20%	
Push from executive leadership team	33%	52%	14%	1
Minimizing unplanned downtime	30%	54%	16%	
Firm's operational excellence strategy	27%	48%	24%	
Availability of new digital technology	16%	75%	9%	

■ 1. Very important ■ 2. Important ■ 3. Unimportant ■ 4. Don't know

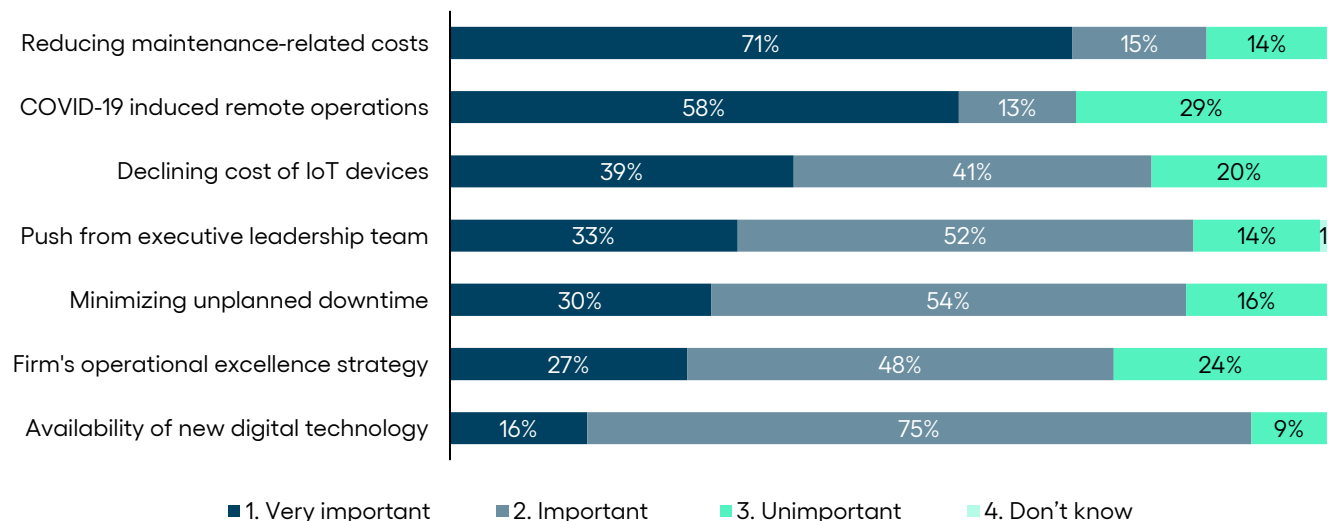Note: Data labels are rounded to zero decimal places; percentages less than 6% are written as numbers
Source: Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences

N=256

Figure 5

Adoption of Software

"To what extent do you use the following software applications at your firm?"

Software	1. Wide usage across operations	2. Usage at multiple facilities	3. Limited usage at a few facilities	4. Pilot projects only	5. Not using software	6. Don't know
Enterprise resource planning (ERP) software	31%	23%	21%	20%	3	2
Computerized maintenance management systems (CMMS)	13%	14%	22%	26%	23%	2
Enterprise asset management (EAM) software	11%	23%	21%	16%	26%	4
Predictive maintenance software	9%	19%	18%	20%	30%	4
Management of change software	7%	13%	18%	30%	32%	
Incident management software	7%	9%	28%	32%	23%	1
Process hazard analysis software	6	7%	21%	27%	37%	2
Process historian	4	9%	25%	22%	38%	2
Plant simulation software	4	9%	14%	31%	40%	2
Control of work software (includes modules for job hazard analysis, permit to work and isolation management)	4	11%	21%	32%	30%	1
Safety instrumented systems (SIS)	2	7%	17%	37%	36%	1
Maintenance strategy optimization software	2	7%	18%	29%	43%	2
Asset performance management (APM) software	2	11%	31%	38%	17%	2
Bow-tie risk management or barrier risk management software	1 4	13%	33%	48%		1
Asset investment planning software	1 3	10%	26%	59%		1

■ 1. Wide usage across operations   ■ 2. Usage at multiple facilities
■ 3. Limited usage at a few facilities   ■ 4. Pilot projects only
■ 5. Not using software   ■ 6. Don't know

Note: Data labels are rounded to zero decimal places; percentages less than 7% are written as numbers
Source: Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences   N=256
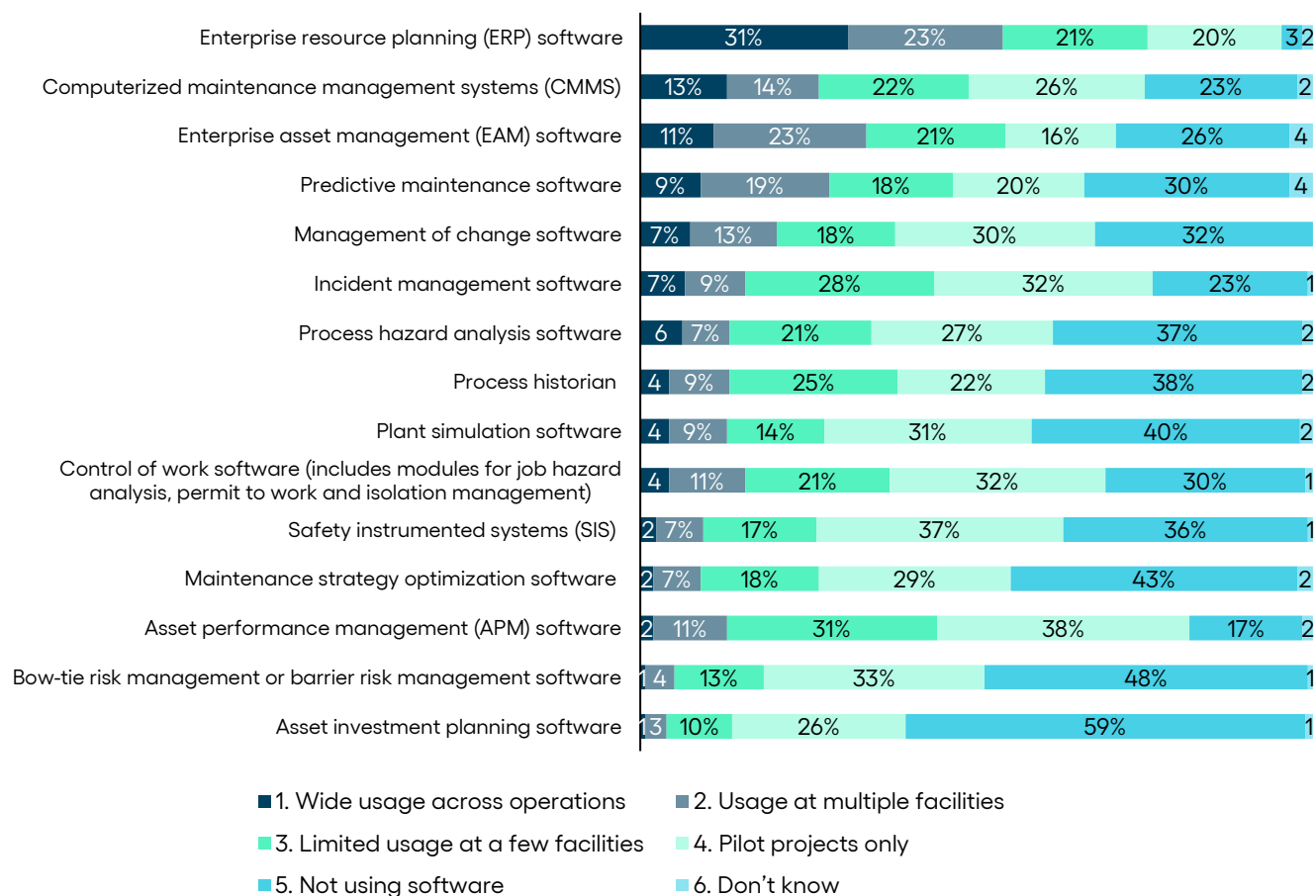
"The ideal APM solution will be able to predict all interventions needed across the asset life cycle, while keeping process safety and integrity at the forefront of decisions" - Asset Integrity Management Lead, Power Utilities

Growth In The APM Software Market Is Driven By Cost-Cutting Programmes And Improved Availability Of Data

With the priorities of asset-intensive industries no longer governed by minimizing asset downtime and maximizing production and quality, but extending to encompass sustainability, EHS and operational initiatives to support strategic objectives, the need for APM software to move from maintenance operations towards process optimization, lifecycle analysis and environmental performance has never been clearer. However, with a lack of understanding of the benefits of APM software, there is still significant opportunity to increase penetration as well as market share for vendors. Nevertheless, Verdantix has observed a rise in spend on APM software, due to (see **Figure 6**):

Figure 6

APM Software: Market Drivers

Cost-cutting programmes	• Increased pressure to prevent performance decline, boost profit margins and maximize production • APM software provides predictive maintenance capabilities to optimize performance	
Asset reliability and uptime	• Need to manage assets efficiently and sustainably while optimizing asset life • APM software analyses asset data to provide plant managers with asset health and failure prediction data, to support the decision-making process	
Digital transformation	• Increased investment in digital solutions to support automation and remote operations • APM software supports aging infrastructure and change management issues	
Data and systems centralization	• Firms traditionally have disconnected data sources • Challenges in extracting value from incumbent data infrastructure • APM software breaks down silos in data, increasing cross-practice collaboration	
Sustainability	• Climate change, ESG and government policy are changing business leadership priorities • Big drive to incorporate ESG and sustainability initiatives into business goals and strategies • APM software supports the monitoring of ESG metrics and reduction of carbon emissions	

Source: Verdantix analysis

- **Cost-cutting programmes to achieve financial KPIs.**
  With fears of an impending recession, and rising energy prices, plant managers and heads of maintenance are under pressure to identify methods to increase profit margins and maximize plant output, while preventing performance decline. Eighty-six per cent of the 256 respondents in our 2021 global survey described reducing maintenance-related costs as 'very important' or 'important' when investing in asset management software, while 84% mentioned minimizing unplanned downtime as 'very important' or 'important'. Firms are looking to adopt APM solutions to drive better economic return on assets. For example, a large diversified natural resource producer is using Hitachi Energy's Lumada APM solution at one of its African copper mines to provide a detailed breakdown of asset health and enable operators to make data-driven decisions that minimize maintenance costs and efforts, while maintaining equipment reliability and availability.

  "Mechanical downtime or process delays mean that our machines are working only at 52% of their capacity. We need to increase this percentage and therefore are shortlisting APM solutions to improve performance" – *VP Engineering, Food and Beverage*

- **Initiatives to improve asset uptime and availability.**
  APM software helps firms manage assets efficiently and sustainably, while ensuring reliable operations and decreasing unplanned downtime. SCG Chemicals, an integrated petrochemicals firm, implemented AVEVA's APM solution and achieved 100% plant reliability, as well as zero unplanned downtime, with real-time visibility of its plant's performance and analytics to predict asset failure.

  "We have a strong interest in improving asset integrity management while extending asset run time, improving reliability and optimizing performance with APM software." Asset Integrity Manager, Oil and Gas (Upstream)

- **Increased commitment to digital transformation strategies.**
  The transformative potential of digital solutions has long been spearheaded by large conglomerates across the asset-intensive industries, such as BASF, ENGIE, ExxonMobil, SABIC and Sinopec. C-Suite executives are now actively allocating budget towards APM solutions to support asset maintenance and performance activities, to proactively manage aging infrastructure and change management challenges. Since 2018, Société Algérienne de Production de l'Electricité (SPE), Algeria's national power generation utility, has been using GE Digital's APM solution to improve operational performance, plant reliability and asset maintenance. With GE Digital, SPE has reduced major incidents by up to 40%, saved over $20 million in performance and operations costs and increased availability by up to 6% (see Verdantix SPE Attains Reliable, Safe And Efficient Power Generation With GE Digital).

  "We are looking to transform our business using APM solutions to drive autonomous maintenance capabilities and support Industry 4.0 objectives. The CEO and board used a combination of studies, business cases and internal interviews to understand the gaps in our portfolio, to select the best APM tool." – Operations Executive, Pharmaceuticals

- **Data and systems centralization opportunities.**
  Firms have historically been held back by siloed data limiting the value that can be extracted from incumbent infrastructure and information. Siloed data create issues for maintenance, operations and reliability teams looking to make data-driven decisions. APM solutions support the creation of a holistic digital ecosystem, breaking down the barriers between segregated data systems and increasing cross-practice collaboration. Shell's QGC business, one of Australia's leading natural gas producers, has reduced time spent tagging data by 90%, as well as lost time from maintenance crews arriving on site without correct parts and tools, by using Bentley Systems's AssetWise ALIM software to manage its master tag registry of over 20 million data points (See Verdantix Bentley Systems Provides A Range Of Solutions To Create, Maintain And Operationalize Digital Twins For Process Industries).

  "In the past, we struggled with cumbersome and disjointed systems which made it hard to access data. We needed something that would seamlessly connect with SAP, MES [manufacturing execution system] and data historians, so that all data could be accessed from one place. This will enable us to effectively monitor asset health and understand when it is time to replace or maintain our assets" - Operations Executive, Pharmaceuticals

- **Need to achieve sustainability and environmental objectives.**
  Forty-eight per cent of the 256 interviewees in our 2021 global survey noted sustainable operations as a 'high priority' for improvement in 2022, as part of their operational excellence initiatives. APM software allows users to monitor, manage and optimize emissions production and asset leaks and seeps, supporting firms in incorporating ESG and sustainability initiatives into overall business goals and strategies. In 2022 Flutura and TechnipFMC launched E-Mission, a process optimization tool that combines TechnipFMC's oil and gas domain expertise with Flutura's Cerebra AI analytics capabilities. The tool can predict and optimize reid vapor pressure based on the changing conditions of wells and weather on upstream production facilities, to maximize oil production, reduce flaring and lower overall Scope 1 emissions. An initial pilot of the solution saw a production facility reduce flaring by 60%, while increasing overall production volume.

  "Sustainability is quickly becoming one of the most important decision-making criteria. Therefore, we are exploring how APM software can be used to monitor our carbon footprint, support future regulations and optimize energy consumption." – CIO, Oil and Gas (Upstream)

Spend On APM Software Is On The Rise

Growth in the APM software market is being driven by a combination of cost-cutting strategies, C-Suite-led digital transformation plans, stagnating productivity rates, the declining cost of industrial Internet of Things (IIoT) sensors and a rising emphasis on achieving sustainability objectives. Our analysis finds that:

- **Global APM software spend will reach $4.5 billion in 2026.**
  According to Verdantix analysis, the APM software market was worth $2.6 billion in 2021 (see Verdantix Market Size And Forecast: Industrial Asset Management Software 2021-2026 (Global)). The majority of spend on APM software remains concentrated in North America and Europe. The market outlook over the next five years is healthy, with spend set to reach $4.5 billion by 2026, rising at a CAGR of 11.6% (see **Figure 7**).

- **Opportunities exist for further APM software uptake.**
  Just two per cent of the respondents in the Verdantix 2021 operational excellence global corporate survey reported wide usage across their operations for APM software, with 11% reporting usage at multiple facilities and 31% noting limited usage at a few facilities. Additionally, 38% reported operating pilot projects only, while 17% had not invested in APM software at all. This lack of business-wide coverage highlights the significant white space that exists in the APM software market and the potential for growth.

- **Investment in software supporting core APM activities will thrive in 2022.**
  When asked about plans for investment in software for asset management activities, use cases centred around APM software were prominent among the responses in the Verdantix 2021 survey. Fifty-three per cent of respondents anticipated new spending on software for asset health monitoring, while 45% mentioned spending on software for asset failure prediction – with these the top two asset management solutions in terms of planned spend.

APM Software Vendors Hail From Five Distinct Backgrounds, Each With A Different Market Positioning And Approach

Growth in the APM software market is on the rise, with spend forecast to increase from $2.6 billion in 2021 to $4.5 billion in 2026. Varying use cases, drivers and awareness barriers have seen vendors catering to the APM software market emerge from diverse backgrounds (see **Figure 8**). The six core categories of providers in the APM solutions market are:

- **Large industrial automation technology providers.**
  Integrated industrial technology providers, such as AVEVA, Emerson, GE Digital and Siemens, have entered the APM market by leveraging decades of digitization and automation expertise. These firms traditionally expand their asset management software portfolios through aggressive acquisition strategies and in-house developments of a central platform to connect their multiple offerings. In 2022 Siemens acquired Brightly Software, an EAM software provider, and Senseye, an AI-driven predictive maintenance software provider, to gain software capabilities in the asset management space, while offering MindSphere, an IIoT platform, to unite the solutions.

- **EAM software suppliers expanding solution functionality to cover APM use cases.**
  Over the last five years, EAM software providers such as Accruent, IBM, IFS, SAP and UpKeep have been launching new modules for asset health monitoring, automated maintenance task prioritization based on asset criticality, asset failure predictions, lifecycle costings for repair or replace decisions, and spare parts forecasting. Hexagon, which acquired Infor's EAM business in 2021, integrates seamlessly with sensors and
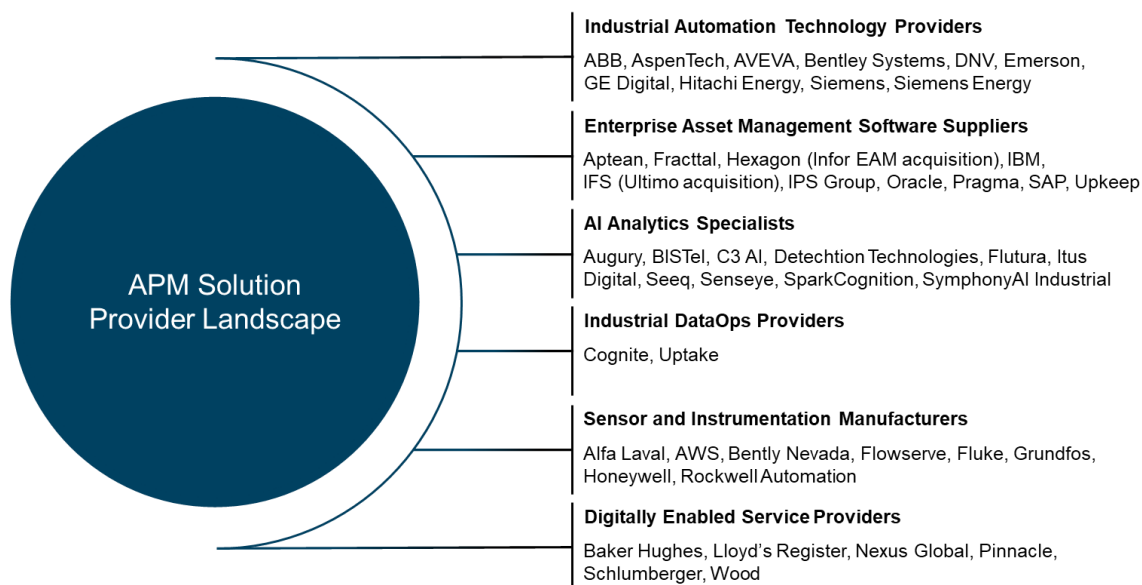
Figure 7

APM Software Market Forecast: 2021-2026
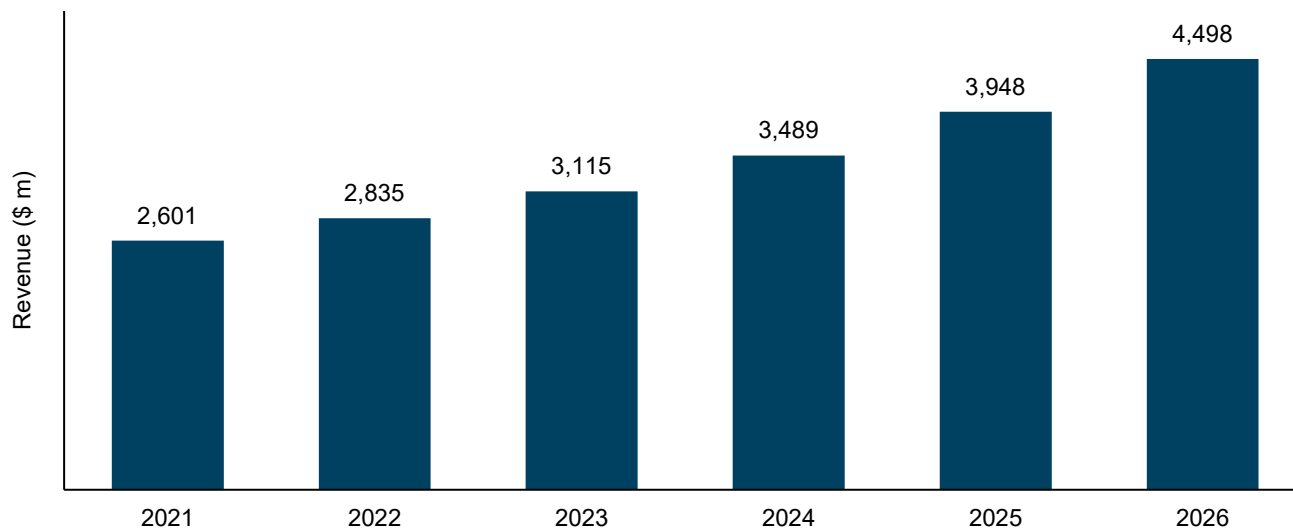
Source: Verdantix Market Size And Forecast: Industrial Asset Management Software 2021-2026

Figure 8

APM Software: Provider Landscape

Industrial Automation Technology Providers

ABB, AspenTech, AVEVA, Bentley Systems, DNV, Emerson, GE Digital, Hitachi Energy, Siemens, Siemens Energy

Enterprise Asset Management Software Suppliers

Aptean, Fracttal, Hexagon (Infor EAM acquisition), IBM, IFS (Ultimo acquisition), IPS Group, Oracle, Pragma, SAP, Upkeep

AI Analytics Specialists

Augury, BISTel, C3 AI, Detechtion Technologies, Flutura, Itus Digital, Seeq, Senseye, SparkCognition, SymphonyAI Industrial

Industrial DataOps Providers

Cognite, Uptake

Sensor and Instrumentation Manufacturers

Alfa Laval, AWS, Bently Nevada, Flowserve, Fluke, Grundfos, Honeywell, Rockwell Automation

Digitally Enabled Service Providers

Baker Hughes, Lloyd's Register, Nexus Global, Pinnacle, Schlumberger, Wood

Note: this list is not exhaustive
Source: Verdantix analysis

field inspection data, allowing firms to move from a preventative maintenance strategy to a predictive approach, while providing insights for long-term asset investment plans.

- **AI analytics specialists.**
  Providers such as Augury, C3 AI, Flutura, Itus Digital, Seeq and SymphonyAI Industrial specialize in offering machine learning (ML)-based solutions to help firms gain insights into the health and performance of assets, predict asset failures, forecast asset performance and optimize maintenance as well as plant operations. Itus Digital combines ML models with an extensive asset library covering over 180 equipment classes, 1,400 failure modes, 850 maintenance activities and 1,500 condition-based protections to determine failure modes with corrective actions or protections (see Verdantix Itus Digital Differentiates With An Innovative Approach To APM, Underpinned By Easy-To-Implement Digital Asset Twins).

- **Industrial DataOps Providers.**
  A strong data foundation is essential for the deployment of advanced analytical tools. Industrial data operations (DataOps) providers such as Cognite and Uptake focus on in operationalizing best practices for industrial data management by streamlining the data capture, management and contextualization process (see Verdantix Ten Industrial DataOps Platform Providers To Watch In 2022). With Uptake Fusion – Uptake's flagship DataOps platform – a Canadian energy producer centralized all data sources at an enterprise level, enabling its teams to view the same data at the same time, regardless of location. Data subjected to Uptake's predictive maintenance models allowed the firm to increase production through optimal gas lifts.

- **Sensor and instrumentation manufacturers.**
  Sensor and instrumentation manufacturers such as AWS, Fluke, Honeywell and Rockwell Automation capitalize on their extended engineering and process control expertise and capabilities to seamlessly integrate with instrumentation, in order to retrieve plant data and provide technology that optimizes asset performance. Honeywell provides out-of-the-box integrations between its sensors and its software products — Honeywell Forge (its APM software) and UniSim Design (its process simulation software) — to create a holistic solution that optimizes operational efficiency, process safety, risk and emissions.

- **Systems integrators and digital service providers.**
  Ninety-four per cent of the 256 respondents in our global 2021 survey stated that they would use a third-party consultant in the next 12 months to support the development of their vision and strategy for asset maintenance management digitization, while 56% said they would use consultants for predictive maintenance software implementation (see **Figure 9**). With the growing need for expertise to support asset management and strategic objectives, firms are turning to systems integrators and digital service providers such as Accenture, Arcadis, Stork and Wipro to provide assistance with adopting an APM solution. Such assistance can encompass training, data collection and mapping, implementation technical consultancy, product development and system deployment (see Verdantix Green Quadrant Operational Excellence Digital Services 2020).

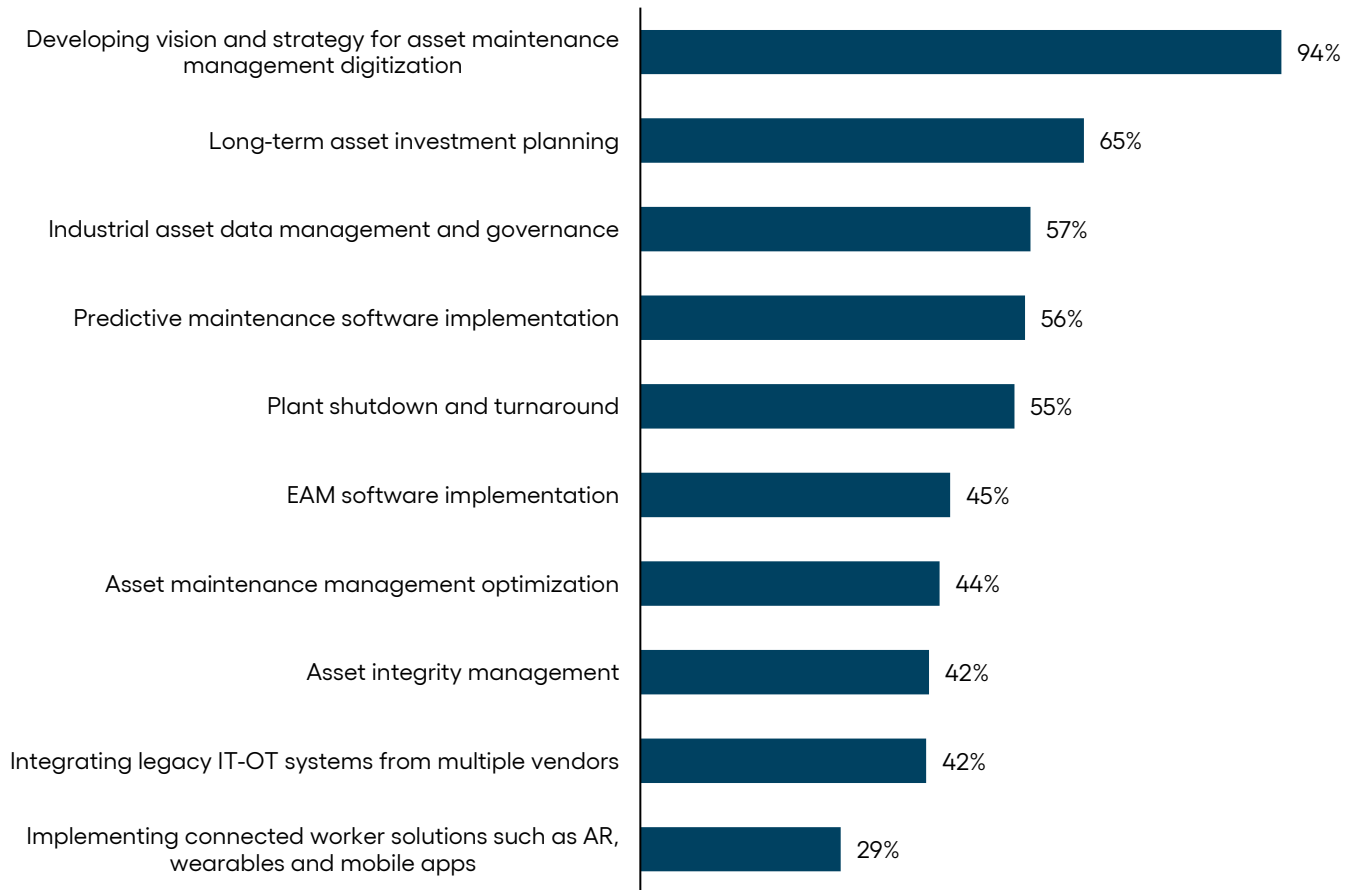## APM Vendors Support Plant-Wide Performance And Sustainability Strategies

APM solution providers originate from differing backgrounds, but converge on solving similar asset maintenance and performance optimization issues for their customers. To gain a competitive edge and capitalize on the growing market, APM solution providers are aiming to further accelerate the time to value of their products, increase autonomy and expand their portfolio functionality to support a firm's entire digital strategy. To achieve this, APM solution provider product strategies are focused on:

Operational Excellence Consulting Projects: Expected Use Of Service Providers In 2022

"For which of the following processes do you plan to use a third-party consultant in the next 12 months?"

Process	Percentage
Developing vision and strategy for asset maintenance management digitization	94%
Long-term asset investment planning	65%
Industrial asset data management and governance	57%
Predictive maintenance software implementation	56%
Plant shutdown and turnaround	55%
EAM software implementation	45%
Asset maintenance management optimization	44%
Asset integrity management	42%
Integrating legacy IT-OT systems from multiple vendors	42%
Implementing connected worker solutions such as AR, wearables and mobile apps	29%

Source: Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences   N=256

- **Developing IIoT and data management platforms as the foundation of an APM offering.**
  With the global consensus moving towards the cloud, and the emergence of industrial DataOps platform providers such as Cognite, HighByte, Hitachi Vantara and Uptake, who provide APM capabilities along with the ability to quickly ingest, contextualize and manage data, large industrial asset management software suppliers have started investing in data management and IIoT platforms to act as a single source of truth on which to build the rest of their portfolios. Data management platforms help firms streamline the data capture, handling and contextualization processes, while accelerating time to value, cloud deployment and scalability. In 2021 AVEVA launched its Data Hub platform, while in 2022 Hitachi inaugurated its Lumada Industrial DataOps software and GE Digital brought out its Industrial Data Diagnostics platforms.

- **Leveraging partnerships and acquisitions to accelerate product development and market share.**
  Over the last two years the APM market has been subjected to a flurry of mergers and acquisitions. Alongside industrial automation giants such as AVEVA, Emerson and Siemens – expanding their offerings for the APM market with their recent acquisitions of, respectively, OSIsoft, AspenTech and Senseye – mid-sized firms have

built out their capabilities and increased their market share since 2020 through a series of acquisitions and partnerships. Recent developments have seen Cenosco joining the Open AI Energy Initiative in March 2022 to provide asset integrity management capabilities to the energy industry; Augury acquiring Seebo in May 2022 to offer manufacturing firms an integrated solution combining asset and process health insights, to maximize performance; Baker Hughes acquiring ARMS Reliability in February 2021 to enhance industrial operational efficiencies, extend asset life cycles, and reduce non-productive downtime; and SymphonyAI Industrial acquiring connected frontline worker software provider Proceedix in December 2021 and IIoT software supplier Savigent in March 2021, to incorporate connected worker workflows within its APM offering (see **Figure 10**).

- **Expanding functionality to cover worker-focused solutions.**
  Following COVID-19, APM vendors are increasingly integrating their solutions with industrial wearables such as augmented reality (AR) solutions, to support remote working and training activities. In February 2021 IBM launched IBM Maximo Mobile, which offers AI-powered remote assistance, an offline mode and real-time access to operational technology (OT) and asset data. Following its acquisition of Proceedix, SymphonyAI Industrial incorporated its functionality for digitized workflows, instructions and standard operating procedures (SOPs), accessed on mobile/tablets within its asset management suite. Flutura, meanwhile, integrates directly with RealWear AR headsets, to support data capture and inspection routines.

- **Enhancing data visualization capabilities with 3D visualization software.**
  A variety of drivers, such as COVID-19, cloud computing and technology maturation, have made 3D visualization across the industrial asset management space possible and practical (see Verdantix Applications Of 3D Visualization Software And Its Benefits For Industrial Asset Management And Operations). In June 2022 GE Digital announced a partnership with Visionaize, a 3D digital twin solutions provider, to deliver highly accurate visualization capabilities for inspectors and planners, allowing them to complete integrity tasks more effectively and efficiently. Hitachi Vantara, meanwhile, has developed Lumada Inspection Insights, an AI-focused inspection, monitoring and automation software suite that leverages computer vision and satellite imagery, to allow users to automate inspection processes by analysing all visual inspection data and visualize the health and risk profiles of assets and infrastructure.

- **Increasing self-service analytics and configuration capabilities to ease adoption barriers.**
  One of the key barriers to APM software adoption is its complexity and the expertise required for deployment. Vendors in the market are focusing on simplifying asset management strategies, making it easier and clearer for firms to deploy tools to assess failure risk, emerging threats and corrective actions. They are doing so by expanding their asset libraries to cover a wide range of assets and by offering no-code or low-code environments for users in different roles to develop analytics for their specific use cases. In August 2022 Itus Digital launched Asset Risk Analyzer, a free and easy-to-use solution for assessing industrial risk and criticality. The solution automatically ingests and analyses large data sets to calculate operational risk due to equipment failure. The insights generated help asset managers prioritize and justify improvement efforts.

- **Making investments to develop ESG, energy transition and decarbonization capabilities.**
  ESG and sustainability issues are front of mind for executives, and APM vendors are expanding their software portfolios to support growing ESG priorities (see Verdantix Global Corporate Survey: ESG And Sustainability Governance, Strategies And Priorities). In 2021 Flutura released its net zero offering to help customers reduce GHG emissions. In January 2022 IBM acquired Envizi, an environmental performance management data and analytics software provider, which can integrate with the Maximo Application Suite to help organizations analyse, manage and report on environmental goals, identify efficiency opportunities and assess sustainability risk. IBM emerged as a Leader in the Verdantix Green Quadrant benchmark for carbon management software (see Verdantix Green Quadrant: Enterprise Carbon Management Software 2022).

Figure 10

Asset Management Software Market Transactions

Multi-Billion Dollar Deals	Targeted M&A	Funding	Partnerships
- Jun 2022 Siemens acquires Brightly Software for $1.6 billion - Oct 2021 Emerson acquires AspenTech in $11 billion deal - Jul 2021 Hexagon acquires Infor's EAM business for $2.8 billion - Mar 2021 Autodesk acquires Innovyze for $1 billion - Aug 2020 Clayton Dubilier & Rice (CD&R) acquires Epicor for $4.7 billion - Aug 2020 AVEVA acquires OSIsoft for $5 billion	- Jul 2022 IFS acquires EAM vendor Ultimo - June 2022 Siemens acquires predictive maintenance vendor Senseye - May 2022 Augury acquires AI vendor Seebo - Jan 2022 IBM acquires environmental performance management vendor Envizi - Dec & Mar 2021 SymphonyAI Industrial acquires connected frontline worker software provider Proceedix and IIoT software supplier Savigent - Feb 2021 Baker Hughes acquires APM solution provider ARMS Reliability	- Feb 2022 Saudi Aramco purchases 100% of Aker BP's shares in Cognite - Oct 2021 Augury raises $180 million, reaching a $1 billion valuation - Oct 2021 Copperleaf completes IPO - Jun 2021 MachineMetrics raises $20 million in Series B funding - May 2021 Cognite raises $150 million, reaching a $1.6 billion valuation - Apr 2021 Seeq raises $50 million in Series C funding	- Jun 2022 Saudi Aramco and Cognite launch CNTXT to deliver joint digital solutions - Jun & Mar 2022 AVEVA partners with Alizent and Limble CMMS - Mar 2022 Cenosco joins the Open AI Energy Initiative - Jan 2022 & Jun 2021 Uptake partners with Cognizant and Inductive Automation - Oct 2021 Cognite partners with HUVR - Sept 2021 C3 AI partners with Google Cloud

Note: this list is not exhaustive
Source: Verdantix analysis

- **Creating digital twin offerings to enhance plant operations.**
  Forty-seven per cent of the 117 respondents in our 2021 global operational excellence survey ranked the reduction of asset downtime through predictive analytics as their top value proposition for using industrial digital twins at their firm. APM solutions providers are at the forefront of digital twin strategies, offering immersive visualizations and asset-specific digital twin models and libraries by combining predictive analytics, first principle models and performance data. Bentley Systems has upgraded its iTwin platform for APM, providing enhanced visualization and analytics visibility through digital twin models. GE Digital offers customers over 300 different digital twin equipment classes in its analytics catalogue, allowing industrial firms to easily build, deploy and get value from their digital twin investments.

Green Quadrant For APM Software 2022

Buyers of APM software from both heavy and light industries seek comprehensive, configurable and scalable solutions that build strong foundations for asset information, asset health, failure prediction, reliability analysis, maintenance optimization and integrity management, alongside adjacent functionality such as risk management, asset lifecycle management and environmental performance management. For the purposes of this report, Verdantix defines APM software as:

"Industrial software applications and associated asset content that monitor asset performance, predict failures and synchronize with IT and OT systems to generate insights that help optimize production, reliability, maintenance and environmental KPIs."

This assessment includes both applications deployed on-premise and those that are cloud-hosted.

Green Quadrant Methodology

The Verdantix Green Quadrant methodology provides buyers of specific products or services with a structured assessment of comparable offerings at a certain point in time. The methodology supports purchase decisions by identifying potential vendors, structuring relevant purchase criteria through discussions with buyers and providing an evidence-based assessment of the products or services in the market. To ensure objectivity of the study results, the research process is guided by:

- **Transparent inclusion.**
  We aim to analyse all providers that qualify for inclusion in the research. For those providers that provide insufficient information or are unwilling to cooperate fully on the 206-point questionnaire and two-and-a-half-hour product demonstration, we include them in the report based on public information, where this would provide an accurate analysis of their market positioning.

- **Analysis from the market perspective.**
  We integrated findings from our latest global corporate operational excellence survey of 256 decision-makers, many of whom have bought or plan to buy software products such as those analysed in this Green Quadrant. The data-driven survey findings inform how we define the relevant software categories, sub-categories and weightings that propel the Green Quadrant graphic output.

- **Reliance on professional integrity.**
  As it is not feasible to check all data and claims made by vendors, we emphasize the need for professional integrity. Assertions made by software providers are put in the public domain via the Verdantix report and can be checked by competitors and existing customers. Verdantix also retains previous iterations of vendors' Green Quadrant questionnaire responses and makes comparisons and scoring adjustments as needed, to ensure accuracy.

- **Scores based on evidence, briefings and customer interviews.**
  To assess software vendors' expertise, resources, business results and strategies, we gather evidence from public sources and conduct interviews with multiple spokespeople and industry experts. When providers claim to be 'best in class,' we challenge them to present supporting evidence.

- **Scores founded on relative comparisons.**
  We construct measurement scales ranging from 'worst in class' to 'best in class' performance at a certain point in time. A provider's position in the market can change over time, depending on how its offering and success evolves relative to its competitors. As a result, a vendor's Quadrant positioning may not necessarily improve — even if it adds new applications, makes a strategic acquisition or receives investment — as the assessment is relative to what other vendors are offering or have been doing since the previous Green Quadrant study. The Green Quadrant analysis is typically repeated every one-and-a-half to two years.

Scope And Methodology For The 2022 Green Quadrant APM Software Study

Verdantix studies reflect the current state of customer requirements and product capabilities. As such, we have developed the assessment criteria to ensure alignment with the present state of the market. This iteration of the 2022 Green Quadrant APM software study is a update on the 2020 Green Quadrant APM software study (see Verdantix Green Quadrant: Asset Performance Management Solutions 2020). In this iteration of the study, Verdantix:

- **Developed APM scenarios from capability assessments.**
  We developed a set of the most important and relevant capability areas in which customers expect vendor functionality. Using the 2020 Green Quadrant APM software study, the 2021 Verdantix Buyer's Guide for APM Software, and feedback from vendors and customers, we developed a framework of 10 technical capabilities and 10 functional capability areas (see Verdantix Green Quadrant: Asset Performance Management Solutions 2020 and Verdantix Buyer's Guide: Asset Performance Management Software)

- **Weighted the questionnaire categories to reflect market priorities.**
  The Verdantix Green Quadrant evaluates the latest customer technology preferences, to ensure that the weightings of all high-level criteria reflect global buyers' current priorities across all APM software components. Following extensive interviews with 256 senior operational excellence decision-makers, we applied adjusted weightings for each high-level capability criterion to mimic its relative priority for improvement and to reflect APM software spending plans for 2021 amongst customers.

- **Included coverage of customer success and adoption.**
  A key, and oftentimes overlooked, criterion into which customers require insight relates to the customer success strategies that vendors implement in the market. To account for these, we included questions around total customer count, renewal rates and strategy. Furthermore, we undertook 10 customer interviews with users of the vendor solutions highlighted in the Green Quadrant.

Evaluated Providers: Selection Criteria

Verdantix defined vendor inclusion criteria to ensure that the Green Quadrant analysis only compared firms providing similar services. The 15 APM software providers included in this study were selected because they:

- **Have strong functionality to offer more than five out of the 10 APM capabilities assessed.**
  We scanned the market to identify those vendors that offer more comprehensive APM applications to manage the broad spectrum of asset management needs being assessed, alongside additional functionality in areas adjacent to asset performance.

- **Have a minimum of 50 employees, annual revenues in excess of $3 million from APM software and five named customers.**
  The Verdantix Green Quadrant APM software study is intended to assess the most prominent vendors offering APM platform solutions. All vendors disclosed at least five named customers who adopted and deployed their software for APM use cases in 2021.

- **Possess the resources to deliver a broad APM suite.**
  We focused the study on vendors with the human, financial and technological resources to meet the needs of diverse customers for the foreseeable future. This criterion reflects the desire of most customers to ultimately use a comprehensive and integrated platform to manage all asset management requirements globally.

Based on the inclusion criteria above, this report looks in depth at the APM software platforms available from 15 vendors. AspenTech, AVEVA, Baker Hughes, Bentley Systems, Cenosco, Cognite, Flutura, GE Digital, Hitachi Energy and SymphonyAI Industrial participated actively in the study, with complete responses to the questionnaire. Honeywell provided a live product demonstration and briefing, but did not complete the questionnaire. DNV, IBM, SAP and Uptake were invited to participate, but either declined or did not respond.

Evaluation Criteria For APM Software

Verdantix defined the evaluation criteria for the Green Quadrant APM software study using a combination of interviews with corporate practice managers and software executives, desk research, discussions with multiple customers and staff expertise. Analysis was also informed by responses to the Verdantix global corporate operational excellence surveys. In full, this year's Green Quadrant analysis compares offerings from 15 software vendors using a 206-point questionnaire covering 10 categories of technical capabilities, 10 categories of functional capabilities and 12 categories of market momentum. In our analysis:

- **Capabilities measure the breadth and depth of functionality.**
  The Capabilities dimension, plotted on the vertical axis of the Green Quadrant graphic, is a measure of the breadth and depth of each software provider's functionality. To assess this, we evaluated data for 10 technical capabilities and 10 functional capabilities. These technical capabilities were: data capture – sensors and industrial systems; data capture – imaging systems; data capture – mobile devices/apps; integration – business software; data management; platform – configurability; platform – development environment; cyber security; user interfaces; and system admin. The functional capabilities were: information management; asset health; failure prediction; reliability analysis; performance optimization; maintenance optimization; risk management; integrity management; asset lifecycle management; and environmental performance (see **Figure 11** and **Figure 12**).

- **Momentum measures strategic success factors.**
  The Momentum dimension, plotted on the horizontal axis of the Green Quadrant graphic, measures each software vendor on a range of strategic success factors. The criteria that make up the Momentum score are grouped into 12 high-level categories: organizational resources; services; partnerships; innovation and product strategy; vision and commercial strategy; certifications; acquisitions; customers; financial resources; customer success and adoption; industry penetration; and brand preference (see **Figure 13**).

We assessed the evidence provided by all the software vendors using a quantitative model that started with the sub-criteria scores. Each sub-criterion was equally weighted, to generate the overall score for each capability area. For example, failure prediction is one of the high-level criteria evaluated in the Capabilities section, but is also composed of three weighted sub-criteria that determine the overall failure prediction score.

We scored all sub-criteria between the values of zero ('no capability') and three ('best in class'). Subsequently, we allocated each high-level criterion a percentage weighting that determined its contribution to the overall score for the specific capability. We based the weightings on customer survey data regarding the APM software functionality that is most widely used, along with analyst perceptions of the broader APM software landscape. The combination of high-level criteria scores in the Capabilities and Momentum sections generated the Green Quadrant graphic (see **Figure 14**) and rankings (see **Figure 15** and **Figure 16**).

Figure 11-1

Technical Capabilities Criteria for APM Software

Capabilities	Questions
Data Capture - Sensors & Industrial Systems (5%)	What capabilities are available to capture txt and CSV data? What collectors do you have for supporting standard industrial communication protocols? What capabilities are available to capture data from staging tables? What capabilities are available to capture data from data historians? What capabilities are available to capture data from SISs and relief devices? What capabilities are available to capture data from IIoT platforms? What capabilities are available to capture data from IIoT devices? What functionality is there to help with large data sets?
Data Capture - Imaging Systems (1%)	What capabilities can capture data from cameras to monitor an asset's physical condition? What capabilities can capture data from laser scanners to monitor an asset's physical condition?
Data Capture - Mobile Devices/Apps (3%)	What capabilities are available to capture data from mobile inspection rounds? What capabilities are available to capture data from mobile incident reports? What capabilities are available to capture data from mobile safety observations? What capabilities are available to capture data from integrity certification inspections? What capabilities are available to capture data from mobile proof testing via process calibrators?
Integration - Business Software (6%)	How does your software integrate with CMMSs and what does that enable? How does your software integrate with EAM software and what does that enable? How does your software integrate with EHS software and what does that enable? How does your software integrate with AIM systems and what does that enable? How does your software integrate with AIP software and what does that enable? How does your software integrate with ERP software and what does that enable? How does your software integrate with LIMSs and what does that enable?
Data Management (7%)	What tools do you offer for continuous data integration? What tools do you offer for continuous data delivery? What tools do you offer for data privacy? What tools do you offer for data preparation and orchestration?
Platform - Configurability (4%)	How can forms be (re)configured? How can business rules be (re)configured? How can role-based user rights be (re)configured? How can terminology be (re)defined? How can the user interface be (re)configured? How can measurement metrics be (re)configured? How can the workflow be (re)configured?
Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.	

Source: Verdantix analysis

Figure 11-2

Technical Capabilities Criteria for APM Software

Capabilities	Questions
Platform - Development Environment (3%)	What development tools can clients use to develop/customize the applications? What development tools can clients use to develop/customize workflows? What development tools can clients use to develop/customize analytics models? What is your development environment?
Cyber Security (4%)	What vulnerability assessments do you perform and when? Do you use third-party vendors to perform vulnerability assessments? Who and how often? Are you (not just your data centre) SOC 2 or ISO 27001/27002 certified? Are you HIPAA-compliant? Are all data encrypted end to end? What is your security framework for enterprise and mobile applications? How does your software support customers in their need to be GDPR-compliant? Which web hosting provider(s) do you use? Please detail your state of compliance with the SLA over the last year. What is the application uptime and compliance with customer SLAs? What is the SLA for data recovery? RPO, RTO?
User Interfaces (6%)	What is the quality of the laptop/PC web user interface? With which browsers is the APM software compatible? What is the quality of the mobile app user interface? With which mobile operating systems are the APM apps compatible? What capabilities are available for a wide-screen control centre user interface? What capabilities are provided for a geo-spatial (2D) user interface? What capabilities are provided for a 3D user interface? What accessibility certifications does the user interface have? What languages are available out of the box? In what ways do you engage customers with regard to obtaining user feedback/strengthening user experience? What methodologies do you use to ensure that user experience is considered in your software design?
System Admin (1%)	What functionality is available to analyse and report usage patterns? What functionality is available for user administration?

Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.

Source: Verdantix analysis

Figure 12-1

Functional Capabilities Criteria for APM Software

Capabilities	Questions
Information Management (3%)	What capabilities are available to create and manage an asset database? What functionality is available to build an asset hierarchy and manage asset groups? What capabilities are available to change the original asset hierarchy? What functionality is available to manage asset information? What functionality is available to build and manage an asset risk matrix? How many out-of-the-box asset classes can you support?
Asset Health (6%)	What functionality is available to support building and maintaining an asset health database? What functionality is available to support a health overview of equipment and functional locations? What functionality is available to support failure diagnostics based on thresholds/rules? What alerts and notifications are available?
Failure Prediction (9%)	What predictive analytics methods and tools are available to forecast asset failure and time-to-action? What are the asset types available? What prescriptive analytics are available to support asset performance management? What functionality is available to identify false positives?
Reliability Analysis (9%)	What functionality do you offer to support reliability life data analysis and associated industry standards? What functionality do you offer to support accelerated life testing (ALT) analysis? What functionality do you offer to visualize and automate the building of failure models? What functionality do you offer for supporting asset criticality analysis? What functionality do you offer for FRACAS? What standards can you support?
Performance Optimization (6%)	What functionality is available to support availability analysis and throughput calculation? What functionality do you offer to support production loss analysis? What functionality is available to support production optimization? What functionality is available to support insights into operational performance?
Maintenance Optimization (9%)	What functionality is offered to support maintenance plan optimization? What functionality is available to analyse and predict maintainability? What standards do you support? What functionality is available to forecast and optimize spare parts? Which reliability-centred maintenance standards are supported?
Risk Management (3%)	What functionality is available to support a quantitative assessment of the risks of asset failure in terms of fatalities, injuries and environmental damage? What functionality is available to support hazard analysis? What functionality is available to support asset-related incidents?
Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.	

Source: Verdantix analysis

Figure 12-2

Functional Capabilities Criteria for APM Software

Capabilities	Questions
Integrity Management (9%)	What functionality is available to design and improve the scheduling of operator rounds, to streamline data collection, as well as to support shift handover? What functionality is available to manage device calibration activities? What functionality is available to improve the planning, efficiency and effectiveness of inspections? What functionality do you offer to support integrity operating windows (IOW) programmes?
Asset Lifecycle Management (3%)	What functionality is available to support lifecycle cost analysis? What functionality is available to support decisions on asset lifecycle optimization in the context of long-term asset purpose?
Environmental Performance (3%)	What functionality is available to support carbon emissions monitoring/reduction? What functionality do you offer for leaks and seeps management? What functionality is available to support energy efficiency? What functionality is available to support environmental programme goals and certifications?
Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.	

Source: Verdantix analysis

Figure 13-1

Momentum Capabilities Criteria for APM Software

Capabilities	Questions
Organizational Resources (10%)	How many employees does your firm have? What has been the percentage change in employee numbers between Jan 2020 and Jan 2022? What is the total number of employees dedicated to your APM software? In how many/which countries does your firm have an office? In how many locations does your firm host the application? Where are your global points of presence for data centres?
Services (10%)	What percentage of your firm's APM revenues are generated from APM services? What services do you offer to help customers implement your software? How many APM SMEs do you employ and what is their expertise? How is your technical support for APM software resourced? How is your customer success programme set up?
Partnerships (10%)	With which consulting firms do you have a formal partnership for APM? With which software vendors does your firm have a formal relationship? With which IIoT firms do you have a formal partnership for APM? With which APM-related industry groups does your firm work?
Innovation & Product Strategy (11%)	What is your firm's product strategy for the next 18 months? How do you undertake innovation for your APM software? What is your firm's strategy when it comes to R&D investment allocations to support long-term viability and maintain competitive advantage(s)? What percentage of your revenue is invested into R&D for new product development for 2022? How often do you release new functionality? What are your firm's initiatives that support clients' digital twin strategies?
Vision & Commercial Strategy (5%)	What is your firm's vision for how the APM software market will evolve? What percentage of your firm's revenues come from the APM software market? What is your firm's vision for the target customers/addressable market opportunity you seek to target over the next 5 years? How will your firm's go-to-market strategy help you win in the APM market?
Certifications (3%)	Which standards bodies is your firm a member of? What accreditations does your firm hold?
Acquisitions (3%)	How many acquisitions have you made in the last 3 years to enhance your APM offering? How many employees joined your firm through APM acquisitions in the last 3 years?

Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.

Source: Verdantix analysis

Figure 13-2

Momentum Capabilities Criteria for APM Software

Capabilities	Questions
Customers (15%)	How many firms (logos) have deployed your software? How many firms (logos) have deployed your APM software? How many facilities/plants have deployed your APM software? On a monthly basis (2021 average), how many active users are there of your APM software? In 2021, how many new APM customers (logos) did you win? What % of your APM customers renewed their contracts in 2021 compared with 2020? What was the renewal rate (%) of your APM customers by value in 2021?
Financial Resources (10%)	What was your firms annual revenue in 2021? What percentage of one year overall revenue growth was organic? What percentage of one year overall revenue growth was inorganic by acquisition? What percentage of total revenue related to APM use cases? What percentage of one year revenue growth related to APM use cases was organic? What percentage of one year revenue growth related to APM use cases was inorganic by acquisition?
Customer Success & Adoption (15%)	How many FTE employees are dedicated to customer success and account management? How many client accounts, on average, are each responsible for? Detail how you have supported operations executives in pre-sale scenarios such as business case analysis. Detail the availability and location of customer care/support and the differing levels of support offered. What types of support services are typically requested? What is the average response time? What is your net promoter score (NPS) for customer satisfaction? Please detail the APM vendor services that exist to support ongoing user adoption/engagement and active use of your software solutions. Among customers that deployed your APM software from 2018 onwards, please detail the average number of active users at the 3-month mark versus the 24-month mark. What is your customer retention rate?
Industry Penetration (3%)	How many customers do you have in each of the following industries; aerospace & defence, automotive, chemicals, construction & infrastructure, electronic & electrical, F&B and FMCG, forestry, pulp & paper, industrial equipment, maritime, mining & metals, oil and gas downstream, oil and gas midstream, oil and gas upstream - offshore, oil and gas upstream - onshore, pharma & life sciences, power generation, power transmission & distribution, public sector (government, cities), telecoms, transport & warehouse, and water & wastewater?
Brand Preference (5%)	Based on survey data collected from the Verdantix Global Corporate Survey 2021: Operational Excellence Budgets, Priorities & Tech Preferences, which comprised interviews with 256 executives.
Figures in brackets represent the weighting given to each criterion in the flexible multi-criteria model that generates the Green Quadrant graphical analysis.	

Source: Verdantix analysis

Figure 14

Green Quadrant: Asset Performance Management Solutions 2022
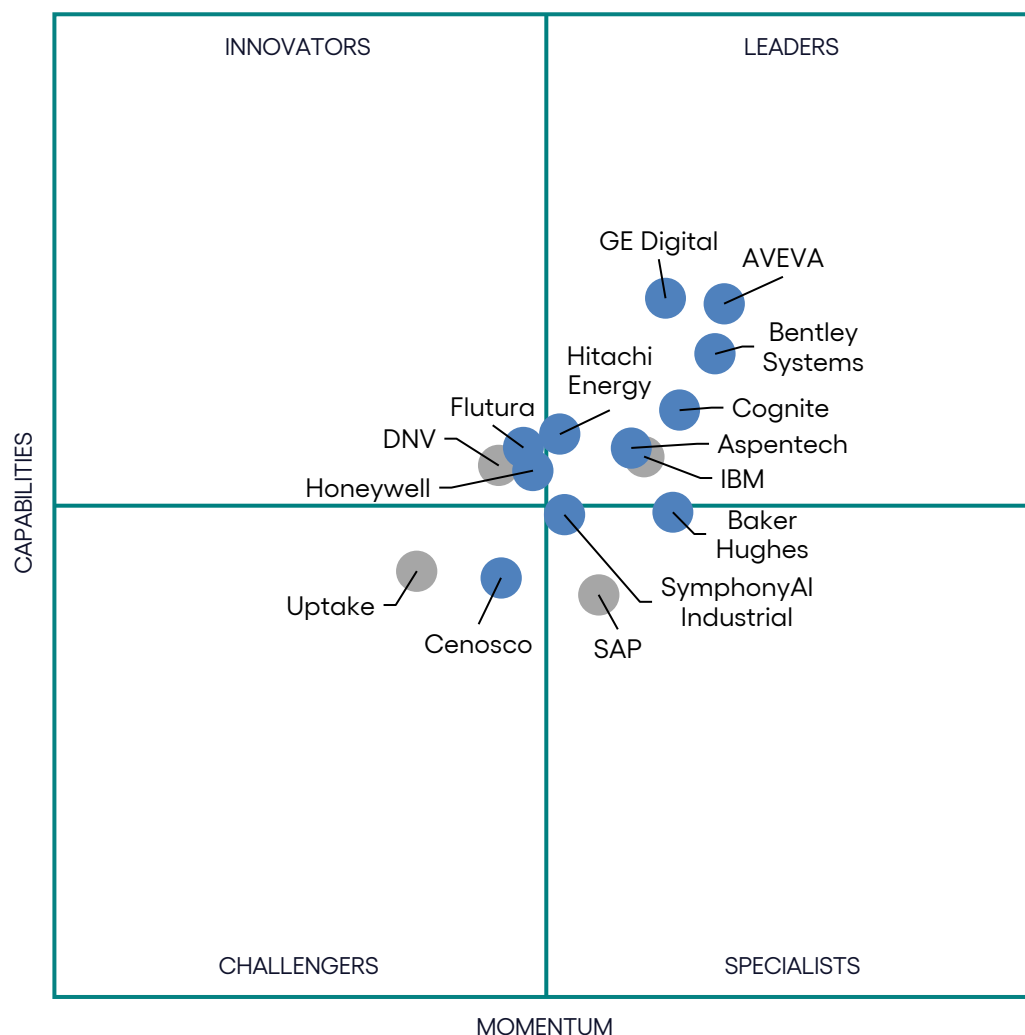
Capabilities	This dimension measures each software supplier on the breadth and depth of its software functionality across 20 capability areas, as outlined in Figure 11 and Figure 12.

Momentum	This dimension measures each software supplier on 12 strategic success factors, as outlined in Figure 13.

Note: a grey plot indicates a non-participating vendor

Source: Verdantix analysis

Figure 15-1

APM Vendor Capability Scores

	AspenTech	AVEVA	Baker Hughes	Bentley Systems	Cenosco	Cognite	DNV	Flutura
Data Capture - Sensors & Industrial Systems	1.7	2.2	2.0	1.6	1.6	2.2	1.1	2.6
Data Capture - Imaging Systems	0.0	2.0	0.0	2.4	1.4	2.0	0.7	2.3
Data Capture - Mobile Devices/Apps	0.5	2.2	1.3	1.6	1.4	2.0	1.4	0.7
Integration - Business Software	1.4	2.3	1.0	2.2	0.6	1.2	1.7	1.4
Data Management	1.5	2.3	0.8	2.0	1.3	2.8	1.3	2.0
Platform - Configurability	1.4	1.5	1.0	2.4	1.0	2.0	1.1	1.9
Platform - Development Environment	2.8	1.6	1.4	1.7	0.1	1.5	1.0	2.1
Cyber Security	1.3	1.3	1.7	2.7	1.9	1.8	1.5	2.0
User Interfaces	1.3	2.3	1.4	2.1	1.1	2.4	1.3	2.0
System Admin	1.5	2.5	1.0	2.5	1.5	2.0	1.5	1.5
Information Management	1.1	2.8	1.7	2.8	1.6	1.7	1.4	1.6
Asset Health	2.5	2.3	2.3	2.0	1.5	2.8	2.0	2.0
Failure Prediction	2.6	2.4	2.2	2.4	1.0	1.8	1.4	2.0
Reliability Analysis	1.5	2.5	2.2	1.8	1.7	1.5	2.7	1.8
Performance Optimization	2.5	2.0	1.3	1.8	0.0	1.8	1.5	1.3
Maintenance Optimization	1.5	2.3	2.3	1.2	1.7	1.4	1.8	0.9
Risk Management	1.2	1.0	0.7	2.0	2.3	0.4	2.4	1.1
Integrity Management	1.2	2.3	0.5	2.1	1.9	1.9	1.9	1.5
Asset Lifecycle Management	3.0	1.5	1.0	2.0	2.0	0.0	1.5	0.5
Environmental Performance	1.6	1.6	1.3	1.3	0.0	2.2	1.7	2.9

Scoring Framework

3   Vendor provides evidence of market-leading functionality, supported by a broad set of references to customer examples

2   Vendor provides evidence of strong functionality, supported by a broad set of references to customer examples

1   Vendor provides evidence of moderate functionality, with limited references to customer examples

0   No response provided or available publicly, or supplier has a weak offering

Source: Verdantix analysis

Figure 15-2

APM Vendor Capability Scores

	GE Digital	Hitachi Energy	Honeywell	IBM	SAP	Symphony AI Industrial	Uptake
Data Capture - Sensors & Industrial Systems	2.0	1.5	1.6	1.9	1.3	1.9	1.9
Data Capture - Imaging Systems	1.0	3.0	2.0	3.0	1.4	0.7	0.0
Data Capture - Mobile Devices/Apps	1.8	2.2	2.0	2.1	1.2	2.0	1.0
Integration - Business Software	1.9	1.9	2.2	1.9	1.8	1.0	1.2
Data Management	1.5	2.3	1.3	2.0	1.3	1.3	2.5
Platform - Configurability	2.0	1.4	1.0	1.6	1.9	1.9	1.4
Platform - Development Environment	1.5	0.8	1.0	0.7	1.0	1.8	1.4
Cyber Security	2.0	1.4	1.6	1.5	1.5	1.2	1.5
User Interfaces	2.0	2.0	1.1	1.5	1.4	1.3	0.8
System Admin	2.0	1.5	1.0	2.0	2.0	1.5	1.0
Information Management	2.1	2.2	1.7	2.0	1.7	1.8	1.6
Asset Health	2.0	1.8	2.0	2.0	2.0	2.0	1.8
Failure Prediction	2.4	2.0	1.8	2.0	1.2	2.4	1.4
Reliability Analysis	2.7	2.5	2.0	1.5	0.5	1.3	1.7
Performance Optimization	2.0	1.0	2.0	1.0	0.5	2.0	1.3
Maintenance Optimization	2.5	1.5	1.3	2.0	2.2	1.1	1.4
Risk Management	2.0	1.6	1.0	1.0	1.3	0.8	0.7
Integrity Management	2.7	1.2	1.6	1.3	0.3	1.6	0.8
Asset Lifecycle Management	2.0	2.0	1.5	1.5	1.0	0.0	0.0
Environmental Performance	2.2	1.0	1.9	1.3	0.4	0.1	0.1

Scoring Framework

3   Vendor provides evidence of market-leading functionality, supported by a broad set of references to customer examples

2   Vendor provides evidence of strong functionality, supported by a broad set of references to customer examples

1   Vendor provides evidence of moderate functionality, with limited references to customer examples

0   No response provided or available publicly, or supplier has a weak offering

Source: Verdantix analysis

Figure 16-1

APM Vendor Momentum Scores

	AspenTech	AVEVA	Baker Hughes	Bentley Systems	Cenosco	Cognite	DNV	Flutura
Organizational Resources	1.9	1.8	1.8	1.6	1.7	1.6	1.6	1.3
Services	2.3	2.8	2.5	2.3	1.5	1.8	1.5	1.5
Partnerships	1.8	2.1	1.7	2.5	1.2	2.0	1.1	2.9
Innovation & Product Strategy	1.8	2.4	1.7	2.3	1.5	2.3	1.3	1.6
Vision & Commercial Strategy	2.0	2.0	2.0	2.2	2.0	2.6	1.0	1.6
Certifications	0.0	1.0	1.0	2.0	0.5	1.5	2.5	1.5
Acquisitions	1.0	3.0	2.0	2.5	0.0	1.0	0.0	0.0
Customers	1.5	1.9	2.3	1.8	1.5	2.2	1.6	1.0
Financial Resources	2.5	2.2	2.0	1.8	1.7	1.9	1.2	1.0
Customer Success & Adoption	1.7	1.6	1.8	2.0	1.2	2.2	1.4	1.6
Industry Penetration	1.0	2.0	1.0	1.0	1.0	1.0	2.0	2.0
Brand Preference	2.0	2.0	1.4	2.4	1.0	1.2	1.2	1.2

Scoring Framework

3   Vendor provides evidence of market-leading functionality, supported by a broad set of references to customer examples

2   Vendor provides evidence of strong functionality, supported by a broad set of references to customer examples

1   Vendor provides evidence of moderate functionality, with limited references to customer examples

0   No response provided or available publicly, or supplier has a weak offering

Source: Verdantix analysis

Figure 16-2

APM Vendor Momentum Scores

	GE Digital	Hitachi Energy	Honeywell	IBM	SAP	Symphony AI Industrial	Uptake
Organizational Resources	1.7	1.6	1.8	1.9	1.9	1.8	0.8
Services	2.3	2.0	2.0	2.3	1.8	1.3	1.0
Partnerships	2.4	1.2	1.8	2.9	2.3	1.2	1.3
Innovation & Product Strategy	2.0	1.7	1.5	1.9	1.8	2.4	1.0
Vision & Commercial Strategy	1.8	1.4	1.0	2.0	1.4	1.8	1.6
Certifications	1.5	1.5	1.0	1.5	1.5	1.0	0.5
Acquisitions	1.0	2.5	1.0	0.0	0.0	3.0	2.0
Customers	2.4	1.2	1.2	1.4	1.2	1.5	1.1
Financial Resources	1.1	1.6	1.3	1.3	1.5	1.9	1.2
Customer Success & Adoption	1.4	1.3	1.0	1.4	1.7	1.2	0.7
Industry Penetration	2.0	1.0	1.0	2.0	1.0	1.0	2.0
Brand Preference	2.4	2.8	3.0	3.0	3.0	1.0	1.8

Scoring Framework

3   Vendor provides evidence of market-leading functionality, supported by a broad set of references to customer examples

2   Vendor provides evidence of strong functionality, supported by a broad set of references to customer examples

1   Vendor provides evidence of moderate functionality, with limited references to customer examples

0   No response provided or available publicly, or supplier has a weak offering

Source: Verdantix analysis

AspenTech Provides Best-In-Class Failure Prediction And Investment Planning Capabilities To Optimize Asset Performance For The Process Industries

Founded in 1981 and headquartered in Bedford, Massachusetts, Aspen Technology, known as AspenTech, is a provider of enterprise asset performance management, monitoring and optimization solutions. The firm has a global footprint, with 62 offices around the world and reported APM revenues of $709 million in 2021. Through its 2016 acquisitions of Mtelligence Corporation (known as Mtell) for asset health monitoring and predictive analytics, and Fidelis Group for asset lifecycle optimization, AspenTech significantly enhanced the capabilities of its APM portfolio. This was further cemented by its 2020 acquisition of Camo Analytics, an industrial analytics software provider. In July 2022 AspenTech announced that it had entered into a definitive agreement to acquire Micromine, a design and operational management solutions provider for the mining industry, with the aim of expanding its software portfolio and industry expertise to this sector. AspenTech's APM offerings consist of a suite of products for the integration of industrial data across existing data historians and cloud-ready solutions; Aspen Mtell and Aspen ProMV for asset health monitoring and prescriptive maintenance; and Aspen Fidelis for asset lifecycle analysis. AspenTech's APM solution is used by over 120 customers, predominantly across the chemicals, petrochemicals, oil and gas and pharmaceuticals industries. Key customers include Borealis, Braskem, LUKOIL, MOL Group and SABIC.

Strengths And Differentiators
Based on the Green Quadrant analysis, Verdantix finds that AspenTech has strengths in:

- **Asset health monitoring and failure prediction.**
  AspenTech garnered the highest and second–highest scores of 2.6/3.0 and 2.5/3.0 for asset failure prediction and health monitoring capabilities in this Green Quadrant. Users of AspenTech's APM portfolio can seamlessly import asset hierarchies, equipment taxonomies and failure mode and effects analysis (FMEA) libraries from third-party systems. Through in-house machine learning (ML) capabilities, Mtell can measure the actual behaviour of an asset under normal or abnormal operating conditions, and in degradation or failure conditions. Through its intrinsically developed platform, users can understand the percentage contribution of relevant sensors to failure alerts, see the health of an asset in terms of its probability to fail at that time, detect precise degradation or failure patterns, dispatch warnings months or weeks before an impending failure, declare the time-to-failure and accurately identify false positives. OCP Ecuador, a midstream oil and gas firm that transports, stores and ships crude oil, reduced unplanned downtime and carbon emissions, and improved its decision-making ability, by using Mtell to build a 20-day forecast to detect impending asset failures, such as combustion problems and valve and injector calibration issues.

- **Performance optimization.**
  AspenTech was the highest-scoring vendor for its performance optimization capabilities in the Green Quadrant. Performance optimization forms a core part of the Fidelis offering, with users able to calculate asset availability, potential risks and corresponding costs. Aspen ProMV can assess parameter patterns that indicate potential losses due to off-spec product, excess flaring, increased fouling or energy consumption. It then relates these back to the operating parameters contributing most to the alert, so that actions can be taken before impact occurs. By learning from available historical process data, ProMV can predict and diagnose asset performance and health, providing advice to correct failing process conditions and guidance to improve asset performance. Customers can use Fidelis to design and re-design production systems to increase performance KPIs such as production throughput.

- **Asset lifecycle management.**
  AspenTech achieved the top score of 3.0/3.0 for asset lifecycle management in the Green Quadrant analysis, excelling in the ability to offer lifecycle cost analysis and strategy optimization. Aspen Fidelis enables users to

execute multiple lifecycle simulations to predict how an asset will perform in the future, identify bottlenecks and perform what-if analysis to evaluate options to improve operations and maintenance activities. The solution is further able to provide comprehensive analysis of the cost and risk of all maintenance and operations decisions over a multi-year time period (from less than one year to over 20 years).

Improvement Opportunities

Based on the Green Quadrant analysis, Verdantix finds that AspenTech could improve by:

- **Developing reliability analysis functionality.**
  AspenTech received a score of 1.5/3.0 for reliability analysis, against the Green Quadrant average of 1.8/3.0. While it scored strongly (2.0/3.0) for reliability life data analysis and asset criticality analysis, AspenTech should consider partnering with a provider such as Itus Digital to enhance its capabilities to create failure models and to support failure reporting, analysis and corrective action systems (FRACAS) (see [Verdantix Itus Digital Differentiates With An Innovative Approach To APM, Underpinned By Easy-To-Implement Digital Asset Twins](#)).

- **Enhancing capabilities to support operator rounds, inspection rounds and IOW programmes.**
  AspenTech received 1.2/3.0 for integrity management, which is below the Green Quadrant average of 1.5/3.0. AspenTech can provide alerts to identify sensor drift, supporting calibration management, but lacks the sophistication to incorporate risk-based inspection (RBI) scheduling, shift handover support and the creation of integrity operating windows (IOW) programmes. AspenTech should consider partnering with asset integrity software suppliers such as Metegrity and OneBridge Solutions to rapidly supplement its integrity management capabilities.

Selection Advice For Buyers

Considering all supplier offerings assessed in the Green Quadrant analysis, we believe that AspenTech should be shortlisted by:

- **North American and European firms in the process industries at any stage of their APM journey.**
  Over 80% of AspenTech's customers belong to the chemical and oil and gas industries and are based in North America and Europe. With market-leading capabilities in asset health monitoring and failure prediction, firms across the process industry can expect to use the AspenTech APM suite to effectively identify and pre-empt asset failures. With the capability to deploy sensors and a complete APM solution, AspenTech can support firms just embarking on their digital journey – while those with existing investments in digital solutions can look to supplement their capabilities by licensing specific AspenTech modules and capitalizing on the extensive services on offer. The Hungarian multinational oil and gas firm MOL Group used Aspen Mtell to detect faults in its pumps, thereby improving efficiencies and the sustainability of its plant operations. Through continued use, Mtell has now become part of MOL's strategic digitization plan, which includes initiatives to extract increased value from its assets and boost overall plant availability to 96%.

- **Firms looking past minimizing asset downtime towards maximizing efficiency and performance.**
  Firms in industries such as chemicals and oil and gas, where even the smallest improvements in production efficiency can lead to significant monetary benefits, and where there are aggressive environmental performance initiatives, should consider using AspenTech. With the highest Green Quadrant scores for performance optimization and asset lifecycle management, firms can be assured that not only will AspenTech support them in condition monitoring and failure prediction activities, but also in the optimization of daily production activities and future investment decisions, taking into consideration operational performance, EHS, ESG and sustainability metrics. Firms working with AspenTech can expect to run their assets efficiently while reducing risk and safety implications.

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