

F R O S T & S U L L I V A N

FROST & SULLIVAN BEST PRACTICES AWARD

INTEGRATED PERFORMANCE MANAGEMENT
GLOBAL

Customer Value Leadership Award
2019

YOKOGAWA 

FROST & SULLIVAN

2019

BEST
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Background and Company Performance

Industry Challenges

The industrial market is undergoing significant shifts, driven by the technology forces of digital. Technology convergences of algorithms, sensors, cloud, and edge are driving an expansion of traditional business models (such as break-fix maintenance models). Customers are evaluating existing solutions, including process simulation models, and challenging solution providers to innovate and provide cutting-edge applications, such as advanced process optimization solutions that will help them achieve outcomes smarter, faster, and simpler. Digital transformation is a continuous journey, but it is not purely about technology implementation. It is the application of technology in unique ways to help transform business approaches and achieve differentiated outcomes. There are many challenges in navigating the journey of digital transformation.

One of the prominent underlying challenges of digital transformation for global customers is data quality. Process industries have collected sensor data for over 30 years, but they are now at a critical juncture to drive value creation from data extracted. Today, the challenge resides in the ability to combine big and small data and translate both into meaningful insights that impact operational performance. Another issue is the siloed view of plant management objectives between C-suite, engineering, and operations. The increasing siloes within the plant hierarchy have continued to restrain customers from achieving a single version of truth from a single screen. Furthermore, every plant is unique; thus, key performance indicators (KPIs) cannot be a one-size-fits-all approach. KPIs will need to be customized for each customer, based on their needs and requirements.

Until recently, there were no viable solutions that helped customers better manage operational performance in a collaborative and scalable manner. Yokogawa's OpreX™ Profit-driven Operation (PDO) is unique in its ability to allow customers to design customized performance indicators and help them achieve cutting-edge best-practices.

Customer and Business Impact

Yokogawa is a 104-year-old pure-play automation and process control solutions company. Its technology prowess and the reliability of its offerings are well known across global markets. It continues to make bold market moves such as its recent acquisition of KBC Technologies, vaulting Yokogawa to achieve differentiated market positioning. The organization's domain knowledge and application expertise has enabled it to become one of the preferred suppliers in the process industry space. One of its new solutions is PDO. A winning strategy for Yokogawa has always been its capability to develop innovative solution offerings that help overcome customer challenges. In a market with several solutions that help customers make more sense of Big Data, Yokogawa chose to take an uncharted path and create a market category of its own. This market category is Integrated Performance Management (IPM). The IPM solution pulls in real-time data from distributed control systems (DCS) versus plant information management systems (PIMS) to structure a KPI dashboard that outlines the performance of plant management

objectives. DCS has the highest quality and fidelity of real-time data available within a plant. Frost & Sullivan research shows that Yokogawa's ingenuity in leveraging this data differentiates it from its peers. This stewardship in driving the industry and its ecosystem to think differently truly sets the company apart. At a time when customers are challenging present-day solutions, Yokogawa's PDO provides a new experience with dynamic capabilities.

Translating next-generation technology to achieve differentiated market positioning

IPM requires a judicious evaluation of a plant's data and providing the right balance of plant KPIs to the right functional personnel at the right time. Especially, IPM facilitates Operators and Engineers in a plant-floor to collaboratively solve performance issues in the same day before it is reflected in weekly or monthly performance report for the management.

Today, several solutions either help in optimizing specific KPIs such as production plan achievement, energy saving, and safety, but none comprehensively extend across all critical KPIs required for plant operations management. Most current solutions are based upon first-principles approaches, which have their own set of disadvantages. The main issue is that these software solutions use pre-built models to drive process optimization, but not profit optimization. Several ICT companies perform a top-down approach (integrating plant-floor systems with business systems) to provide visibility on business indicators. The key disadvantages of this are that the visibility is siloed and provides one set of customer needs versus prescriptive analytics that are profit focused. Customers are facing two main critical issues, which drive the need for such solution offerings:

- There is a growing divide between increasing system complexity and decreasing skilled workforce.
- Global competition and trade-off of plant management objectives create a mandate for customers to be acutely focused on profit improvements. Monitoring every change (big and small) in process/plant operations will be required to better optimize the outcomes.

Yokogawa, along with its subsidiary KBC, brings forth key capabilities to achieve a differentiated market positioning. The PDO solution leverages Yokogawa's operational technology experience and KBC's industry best practices to visualize the balance of management objectives as role-based performance indicators in real-time on a DCS-like dashboard. KBC consultants are able to offer prescriptive guidance to customers on improving the plant performance. KBC's best practices cover hierarchical and role-based performance metrics that extend from C-level to plant-floor, thus motivating all employees to focus on profitable operation for each role. KBC also has best practices around management objective-based performance metrics such as production achievement, profitability, energy conservation, asset reliability, and safety. Present-generation solutions look at performance metrics in silos, but Yokogawa's next-generation

solution of PDO is superior due to its ability to help customers understand the connected synergies between KPIs. It also helps customers evaluate the impact of change on one KPI over the associated KPIs. Further, these KPIs are aggregated into a composite score that accurately reflects the operational performance.

The organization's PDO is one of the unique solutions and service offerings in the company's integrated performance management solutions portfolio. It is achieved by integrating OT, IT, and business and domain knowledge. The solution is focused on driving clarity amidst KPI conflict management and optimizing plant profit performance.

Aligning customer needs to empower them with differentiated solutions and service offerings

Integration and alignment across a plant's leadership hierarchy is crucially important from an integrated performance management perspective. Often times, there are disconnects between KPIs used by C-level, engineering, and operations. This results in a lack of synchronization that restrains operational performance. The top five critical issues that will need to be overcome by customers in order to realize reduced performance variability in plant operations are discussed below.

- **C-level KPIs differ significantly from those of factory floor:** Boardroom KPIs are focused on profitability, return on capital employed (ROCE), shareholder returns, etc., while the factory floor KPIs are centered around safety, availability, reliability, security, etc. Disconnects between the two lead to a failure to inspire and motivate factory floor personnel to consistently perform with a focus toward profitable operation.
- **Lack of clear co-relation between KPIs:** With the solutions currently available in the market, customers are unable to analyze the impact between KPIs. For instance, if the focus on plant uptime KPI is high, customers are unable to predict and analyze the impact of the same on sustainability and energy management KPIs. On a similar note, plants were previously very focused on safety and production plan achievement, but new objectives such as energy conservation and carbon footprint reduction have been added. This causes conflict between the KPIs, resulting in profit loss.
- **Decline in skilled workforce availability:** The most knowledgeable workforce is eligible for retirement. The retirement rates vary by industry, but, in oil and gas, about 50% of the workforce will be eligible for retirement by 2022 (per a 2015 statistic presented by American Petroleum Institute). The onset of this retirement, followed by the entry of millennial is causing further disconnects in plant operations. The new workforce requires intuitive interfaces and is not very familiar with traditional plant control systems. Operational aspects that were managed by experience based upon trial and error will now need to be replaced by system interfaces that are built upon intuitive user experiences. Essentially, what cannot be measured cannot be managed. In line with the same, customers will need smart

dashboards that go beyond just showcasing of data. The next-gen KPI dashboards will need to showcase a cause-and-effect analysis to the operator. For example, operators should be aware of implications on associated KPIs when changing the dial on one of the KPIs. This will create unchallenged visibility and comprehensive awareness on plant operational metrics.

- **Lack of leverage of a plant's big and small data:** As with any process industry, the distributed control system (DCS) is akin to the central nervous system of the plant. The DCS interfaces with multiple field devices and collects data to compute. The computation compares with set operational values and subsequently takes action on them. While there is high-quality data within this system, customers have not taken full advantage of the big and small data resident within this system. Astute analysis of this data will result in more profitable operations.
- **Dependence on linear dynamic models:** Customers have relied on process simulator models, linear program vectors, APC models, PID parameters, and set point process values to manage plant operations. However, these values are as good as the latest update. These updates are usually not managed well, causing the plant to operate in sub-optimal conditions. Moreover, the complexity involved in such systems has increased operators reliance on manual interventions.

Due to these endemic process issues across industries, Yokogawa created a customer-centric solution to help solve them. The organization's ability to bring forth domain expertise, application knowledge, and consultative services helps customers achieve profitable outcomes. Yokogawa has over 1,200 application experts and industry consultants who have an advanced knowledge on applications, making the company a trusted partner for process industry customers worldwide.

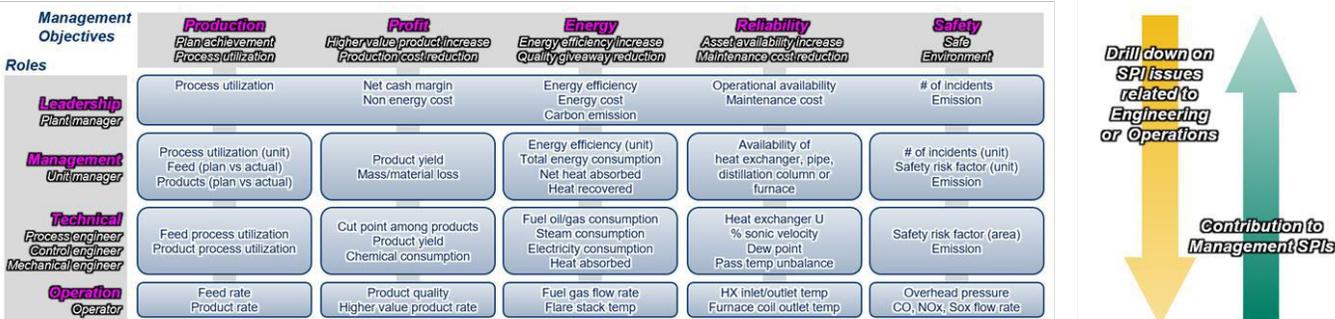
Large customers in chemicals, refining and power generation space have expressed concerns over mis-alignment of operational KPI's with business objectives. A top tier chemicals manufacturer stated that, "We have enough process parameters and fair amount of information. The critical thing is, if you look at our plants in general, it is difficult when something is more critical than others. We are seeking to achieve a proper method of providing dashboards for each individual base on its level, based on the complexity of information. Essentially, we are looking at structuring a smart dashboard."

On a similar note, another oil and gas major from Middle East stated that, "We have facilities which are widely distributed geographically. A case in point: 200 oil wells are scattered across the field located in different remote locations. The adoption of automation and digitalisation helps in obtaining the remote data into remote terminal unit and onwards into the DCS. Our operators subsequently just look at the data and control from one central location instead of sending manpower to various locations. We have all the data at one location (i.e. Control room) and control the field elements remotely from the main control room. If we have to control all these with manpower it will delay the job so automation and timely/relevant information helps in increasing the efficiency and safety."

Yokogawa’s PDO solution leverages real-time big and small data from DCS and blends with intrinsic domain knowledge to create a new benchmark indicator called Synaptic Performance Indicators (SPIs). The company’s customer-centricity and KBC’s application expertise has been combined to create hundreds of SPIs across functions such as engineering (yield/KPI, optimizer performance, energy consumption, asset availability, ESD triggers), operations (feed rate, unit performance, furnace efficiency, critical alarm), and management (gross revenue, margin, energy costs, maintenance cost, incident). The SPIs are traced back to performance attributes such as production achievement, reliability, and safety. The other benefits of the PDO solution include:

- PDO is operation assistance for profitable operation which shows the SPIs on real time to operators and engineers to improve performance.
- PDO is a cutting-edge business innovation that helps customers shift from process control to performance control in order to realize real time management.
- PDO helps in realization of operations having common management perspective across management level to operator level. This helps customers in driving real time performance improvement.
- Without PDO as a solution until now, the management reports have been designed for daily/weekly/monthly views. The latency in these reports often drives a slow level of operational responsiveness.
- PDO could also be deployed as a training tool for operators and engineers to execute operations by having both the perspectives of the management perspective and operational profitability.

The beauty of SPIs lies in their ability to address the diversity between various functions, but also maintain a synergistic alignment between them to minimize conflicts and waste. Today, Yokogawa has structured more than 2800 SPIs for refinery operations and over 800 for ethylene operations. The ability of the organization to draw correlations between macro-level plant-level management objectives and micro-level SPIs exemplifies the organization’s focus on creating lasting value. Shown below is a visual outlook on how SPIs (micro indicators) trace back to plant management objectives (macro indicators).



Synaptic Performance Indicators (SPIs)

Driving sustained customer value and structuring a platform approach to help achieve operational performance optimization

Similar to vital signs being a reflection of a human being's health, SPIs are poised to become the vital sign standard for operational health. Yokogawa has structured the following SPIs to help customers measure, monitor, and manage.

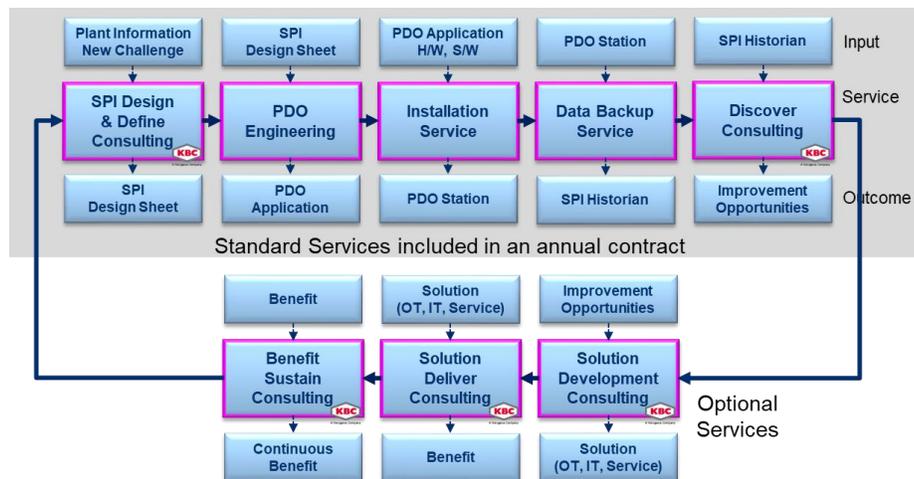
- **Production SPIs:** This set of metrics identifies the process utilization, the gaps in production achievement, yield, and product quality.
- **Energy SPIs:** Assesses energy cost and energy consumption across areas such as hydrogen, steam, electricity, water, and fuel.
- **Reliability SPIs:** Measures aspects around asset performance management. These include metrics such as reliability, availability, and maintainability such as mean time to failure (MTTF), running time, mean time between failures (MTBF), mean time to repair (MTTR), and asset efficiency.
- **Safety SPIs:** This is a critical measurement point for plant operations, covering aspects such as number of incidents, safety risk factors, and alarm management.
- **Profit SPIs:** Intelligent by design, Yokogawa played its master card by creating this indicator as a composite measure of all aforementioned SPIs. It evaluates measures such as increase of higher value product, reduction of production cost, and net cash margin.

Sustained customer value is achieved through the following:

- **Smart use of live big and small data from DCS:** High-frequency data that has the highest quality, integrity, and fidelity is captured by DCS. Traditionally, DCS has been used for process monitoring, control, and production management, but seldom used for profit optimization. The challenge is tying all of these data points together and tracing them back to plant management KPIs such as production, profitability, energy, reliability, and safety. Knowing what to measure, when to measure, and why to measure are key questions that Yokogawa and KBC help a customer evaluate to achieve profit-centric outcomes. The SPI dashboard pulls in data from DCS and the remaining data from plant information management systems (PIMS) and computes a score. This score helps model good operational behavior across operational, engineering, and management personnel.
- **Creation of expert systems:** Yokogawa has leveraged KBC's domain knowledge to infuse its consulting capability with the PDO solution pack. Its expertise in process variables and ideal operating conditions is being combined with DCS trend data, enabling the company to create a higher baseline and a lower baseline threshold for customers to be within. These indicators can be customized based on plant conditions and maturity levels. Once the value exceeds threshold parameters,

alarms can be channeled to KBC experts who can offer prescriptive recommendations to customers in bringing the operations state back to compliant levels. The ability to remotely support operations with expert advice is a unique offering from Yokogawa. It is called as Co-pilot.

- **Profit Improvement Program (PIP):** Yokogawa and KBC have continued to pioneer the market and challenge the status quo. What was seemingly impossible earlier has been made possible by the differentiated capabilities brought forth by both of these organizations. For example, Indian refineries work with Yokogawa and KBC in an outcomes-based service model to drive operational performance. KBC's domain expertise and process knowledge allows Yokogawa to deliver top notch services around design of SPIs and consultative services. The foresight possessed by the organization consultants facilitates solution development, delivery and lifecycle sustainment of benefits for customers. This in-depth process consulting value-proposition is hardly matched by any peers in the market, today. Due to the depth and rigor of analysis through the use of proprietary and reliable process models (from KBC), a typical PIP program could result in measurable benefits in the range of \$10 - \$100M/Y (this is calculated for a 200 bpd refinery).

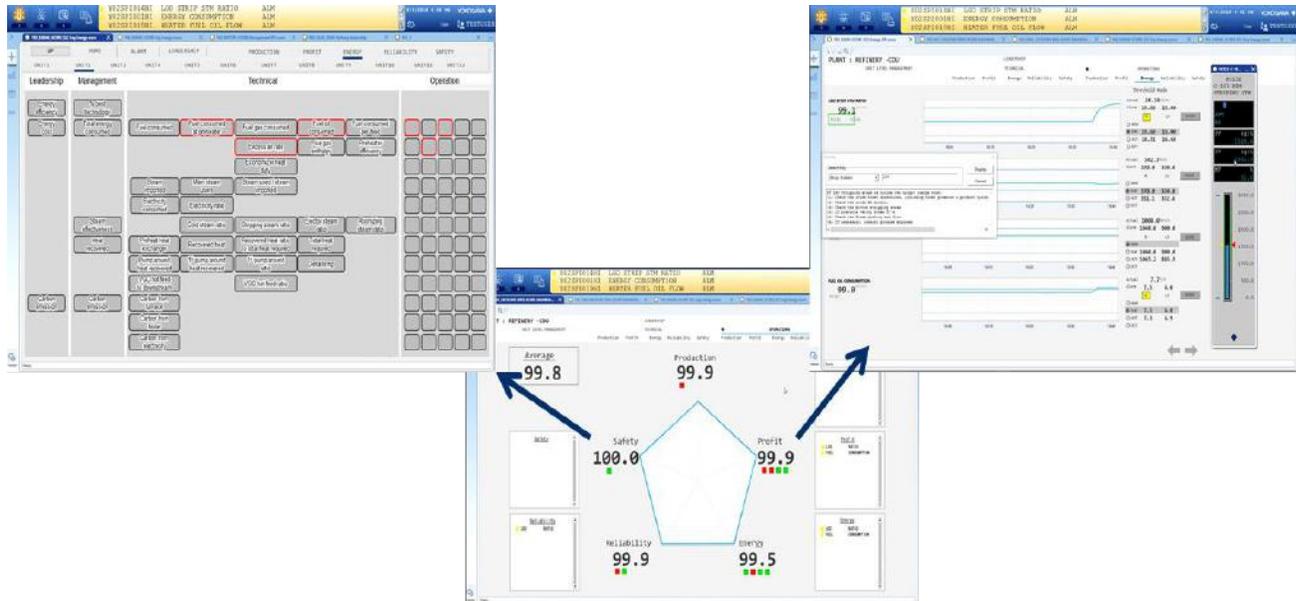


In essence, working with Yokogawa helps customers shift from ad-hoc/event-driven operations to an operation that balances the trade-offs between KPIs such as production, energy, reliability, safety, and profitability.

From a market differentiation standpoint, Yokogawa is pioneering the IPM space. As shown in the exhibit below, there are many classes of solution providers available today. They can be classified in the following ways:

- **Business visibility:** These are broad and wide solution providers who utilize a top-down approach and apply general purpose analytical algorithms on plant data. The outcomes are less meaningful for plant-specific operations, but acceptable to monitor business performance indicators.

- **Functional visibility:** Solution providers that play in this space leverage plant data, and historical data, but offer a siloed view on specific areas such as energy management, alarm management, and cybersecurity. The lack of comprehensiveness in this approach creates a challenging situation for customers because they will need to work with multiple solution providers to achieve the single version of the truth.

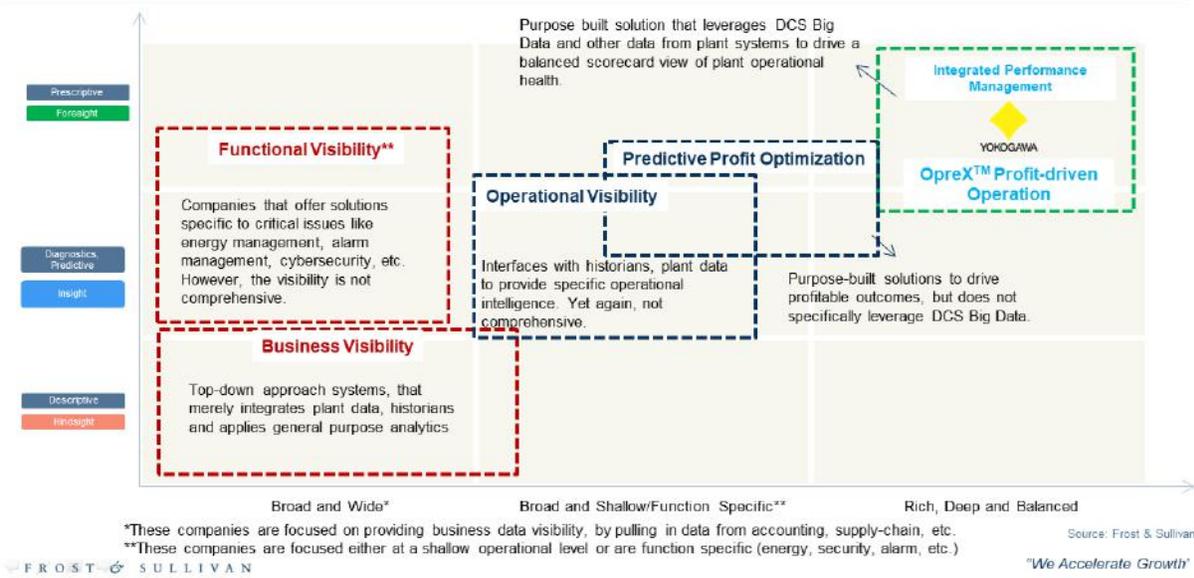


- **Operational visibility:** There are a number of automation solution providers in this space. They also leverage asset data and plant historical data, blending them with application knowledge. However, the lack of domain expertise and advanced knowledge on KPI management restrains them from making a meaningful impact on a plant's profitability.
- **Predictive profit optimization:** This is the closest that a customer can get to achieving profitable operations today. Even here, the challenges are around the use of process models and the complexities in using the same. The process models are critical, but not often updated. This results in sub-optimal performance.

Yokogawa has wisely positioned itself in the IPM space by ensuring that the PDO solution overcomes the challenges of the aforementioned solution and service offerings. It blends in high-quality data from DCS with expert services from KBC to deliver profit-impacting solutions.

Shown below is the exhibit outlining Yokogawa’s differentiated market positioning:

Culture Transformation and Change Management Starts by Bringing Together People and Process on the Foundation of Clarity and Context (w/o Logos)
 Yokogawa’s Unique Competitive Market Positioning in Integrated Performance Management Market



Conclusion

In today’s digital-focused market, customers prefer solutions that make them smarter, faster, leaner, and more profitable. While the market contains multiple solution offerings that pull in data from PIMS and plant systems to present visual data, Yokogawa continues to excel with differentiated solution offerings such as PDO. This solution is expected to become the standard for global plant operations because it balances the trade-offs between KPIs and provides one solid operational health score. The ability of the score to model good behavior allows extensive stickiness of the solution with customers. For the solution’s strength, differentiation, and lasting customer value, Frost & Sullivan presents Yokogawa Electric Corporation with the 2019 Global Customer Value Leadership.

Significance of Customer Value Leadership

Ultimately, growth in any organization depends upon customers purchasing from a company and then making the decision to return time and again. Delighting customers is, therefore, the cornerstone of any successful growth strategy. To achieve these dual goals (growth and customer delight), an organization must be best-in-class in three key areas: understanding demand, nurturing the brand, and differentiating from the competition.



Understanding Customer Value Leadership

Customer Value Leadership is defined and measured by two macro-level categories: Customer Impact and Business Impact. These two sides work together to make customers feel valued and confident in their products' quality and long shelf life. This dual satisfaction translates into repeat purchases and a high lifetime of customer value.

Key Benchmarking Criteria

For the Customer Value Leadership Award, Frost & Sullivan analysts independently evaluated two key factors—Customer Impact and Business Impact—according to the criteria identified below.

Customer Impact

Criterion 1: Price/Performance Value

Requirement: Products or services offer the best value for the price, compared to similar offerings in the market.

Criterion 2: Customer Purchase Experience

Requirement: Customers feel they are buying the optimal solution that addresses both their unique needs and their unique constraints.

Criterion 3: Customer Ownership Experience

Requirement: Customers are proud to own the company's product or service and have a positive experience throughout the life of the product or service.

Criterion 4: Customer Service Experience

Requirement: Customer service is accessible, fast, stress-free, and of high quality.

Criterion 5: Brand Equity

Requirement: Customers have a positive view of the brand and exhibit high brand loyalty.

Business Impact

Criterion 1: Financial Performance

Requirement: Overall financial performance is strong in terms of revenue, revenue growth, operating margin, and other key financial metrics.

Criterion 2: Customer Acquisition

Requirement: Customer-facing processes support the efficient and consistent acquisition of new customers, even as it enhances retention of current customers.

Criterion 3: Operational Efficiency

Requirement: Staff is able to perform assigned tasks productively, quickly, and to a high quality standard.

Criterion 4: Growth Potential

Requirements: Customer focus strengthens brand, reinforces customer loyalty, and enhances growth potential.

Criterion 5: Human Capital

Requirement: Company culture is characterized by a strong commitment to quality and customers, which in turn enhances employee morale and retention.

Best Practices Recognition: 10 Steps to Researching, Identifying, and Recognizing Best Practices

Frost & Sullivan analysts follow a 10-step process to evaluate Award candidates and assess their fit with select best practice criteria. The reputation and integrity of the Awards are based on close adherence to this process.

STEP	OBJECTIVE	KEY ACTIVITIES	OUTPUT
1 Monitor, target, and screen	Identify Award recipient candidates from around the globe	<ul style="list-style-type: none"> • Conduct in-depth industry research • Identify emerging sectors • Scan multiple geographies 	Pipeline of candidates who potentially meet all best-practice criteria
2 Perform 360-degree research	Perform comprehensive, 360-degree research on all candidates in the pipeline	<ul style="list-style-type: none"> • Interview thought leaders and industry practitioners • Assess candidates' fit with best-practice criteria • Rank all candidates 	Matrix positioning of all candidates' performance relative to one another
3 Invite thought leadership in best practices	Perform in-depth examination of all candidates	<ul style="list-style-type: none"> • Confirm best-practice criteria • Examine eligibility of all candidates • Identify any information gaps 	Detailed profiles of all ranked candidates
4 Initiate research director review	Conduct an unbiased evaluation of all candidate profiles	<ul style="list-style-type: none"> • Brainstorm ranking options • Invite multiple perspectives on candidates' performance • Update candidate profiles 	Final prioritization of all eligible candidates and companion best-practice positioning paper
5 Assemble panel of industry experts	Present findings to an expert panel of industry thought leaders	<ul style="list-style-type: none"> • Share findings • Strengthen cases for candidate eligibility • Prioritize candidates 	Refined list of prioritized Award candidates
6 Conduct global industry review	Build consensus on Award candidates' eligibility	<ul style="list-style-type: none"> • Hold global team meeting to review all candidates • Pressure-test fit with criteria • Confirm inclusion of all eligible candidates 	Final list of eligible Award candidates, representing success stories worldwide
7 Perform quality check	Develop official Award consideration materials	<ul style="list-style-type: none"> • Perform final performance benchmarking activities • Write nominations • Perform quality review 	High-quality, accurate, and creative presentation of nominees' successes
8 Reconnect with panel of industry experts	Finalize the selection of the best-practice Award recipient	<ul style="list-style-type: none"> • Review analysis with panel • Build consensus • Select recipient 	Decision on which company performs best against all best-practice criteria
9 Communicate recognition	Inform Award recipient of Award recognition	<ul style="list-style-type: none"> • Present Award to the CEO • Inspire the organization for continued success • Celebrate the recipient's performance 	Announcement of Award and plan for how recipient can use the Award to enhance the brand
10 Take strategic action	Upon licensing, company is able to share Award news with stakeholders and customers	<ul style="list-style-type: none"> • Coordinate media outreach • Design a marketing plan • Assess Award's role in future strategic planning 	Widespread awareness of recipient's Award status among investors, media personnel, and employees

The Intersection between 360-Degree Research and Best Practices Awards

Research Methodology

Frost & Sullivan's 360-degree research methodology represents the analytical rigor of our research process. It offers a 360-degree-view of industry challenges, trends, and issues by integrating all 7 of Frost & Sullivan's research methodologies. Too often companies make important growth decisions based on a narrow understanding of their environment, leading to errors of both omission and commission. Successful growth strategies are founded on a thorough understanding of market, technical, economic, financial, customer, best practices, and demographic analyses. The integration of these research disciplines into the 360-degree research methodology provides an evaluation platform for benchmarking industry participants and for identifying those performing at best-in-class levels.

360-DEGREE RESEARCH: SEEING ORDER IN THE CHAOS



About Frost & Sullivan

Frost & Sullivan, the Growth Partnership Company, enables clients to accelerate growth and achieve best-in-class positions in growth, innovation and leadership. The company's Growth Partnership Service provides the CEO and the CEO's Growth Team with disciplined research and best practice models to drive the generation, evaluation and implementation of powerful growth strategies. Frost & Sullivan leverages more than 50 years of experience in partnering with Global 1000 companies, emerging businesses, and the investment community from 45 offices on six continents. To join our Growth Partnership, please visit <http://www.frost.com>.