FROST & SULLIVAN

BEST PRACTICES AWARDS

PHILIPS

2019 GLOBAL ARTIFICIAL INTELLIGENCE FOR ENHANCED RADIOLOGY INTERPRETATION COMPANY OF THE YEAR AWARD

Contents

Background and Company Performance

Industry Challenges

Medical imaging jumped on to the digital bandwagon in the early 1990s with the first-generation of radiology and cardiology picture archiving and communication systems (PACS). Over the last two decades, imaging informatics expanded to almost every clinical area following technological developments and value-added bundled services, such as vendor neutrality, web-based viewing, and mobility. From radiology and cardiology to pathology, diagnostic imaging utilization increased along with the rise in departmental-based imaging information technology (IT) tools, yielding huge datasets with massive storage requirements. Frost & Sullivan estimates the imaging storage volumes needed in the US alone at over 1 exabyte in 2017.[1]

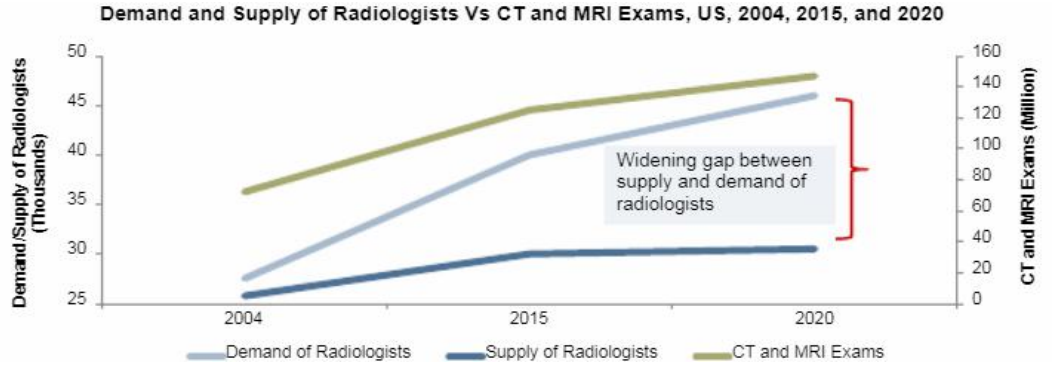
With meaningful use standards in full effect, more and more providers and healthcare facilities in the United States (US) combine the imaging IT infrastructure and traditional PACS to improve overall image management services and radiology workflow efficiencies and reliability. However, digital image archives remain hard to use and share within and across the healthcare enterprise despite today's third-generation imaging platforms extending connectivity and interoperability beyond radiology. Most offerings involve solutions with siloed data providing limited content and context and separate analysis and reporting processes, producing inadequate information for an evidence-based decision-making framework.

Radiology is becoming a cost center instead of a revenue source, compelling healthcare systems to restructure to meet the evolving value-driven landscape. Still, providers are struggling to achieve the ultimate goal of increasing access to high-quality healthcare at lower overall costs—after decades of supporting fee-for-service processes, i.e., rewarding volume, not quality, of rendered services. Radiologist shortages combined with several billion medical images generated each year globally also strain already inefficient radiology workflows. Notably, the Royal College of Radiologists' 2017 workforce census reports annual increases of 3 in the workforce paired with a 10% to 12% complex imaging, which thwarts meeting all diagnostic reporting requirements and, hence, delays patients' imaging results by at least 1 month in the United Kingdom.[2]

The workload demand/ workforce resource imbalance also results in high imaging utilization costs too often, e.g., overuse, underuse, and inefficient resource allocation. More importantly, radiologist burnout, a growing concern, may negatively affect interpretation, leading to life-altering and life-threatening diagnostic inaccuracies and delays. A recent survey with about 600 respondents reports about 45% of radiologists feeling burned out.[3]

[1] *Big Data Opportunities in the US Medical Imaging Market* (Frost & Sullivan, April 2015)
[2] https://www.rcr.ac.uk/system/files/publication/field_publication_files/bfcr185_cr_census_2017.pdf
[3] https://www.healthimaging.com/topics/practice-management/report-45-radiologists-are-burned-out (Accessed August 2019)

Acute Radiologist Shortages



Source: Frost & Sullivan

Frost & Sullivan believes that next-generation medical imaging informatics must truly support the shift to value-based care, with its ultimate success hinging on delivering the right care to the right patient at the right time.[4] Original equipment manufacturers, imaging IT providers, and PACS vendors are preparing for a significant industry realignment around outcomes-focused, sustainable healthcare, and, with higher costs to bear, help drive a cost-conscious, quality-demanding volume-to-value-transformation.

Developments in imaging technologies and image analysis software over the last few years are propelling opportunities for more cost-effective radiology practices, with more advanced capabilities leading to cost savings throughout clinical pathways. PACS solutions already provide faster access to images, and image analysis tools bring out standardization, eliminating variability from one radiologist to another. The limiting factor now is access to the right curated patient information at the right stage of the care continuum.

Big Data tools along with digital enablers like cloud technologies and artificial intelligence (AI), including machine learning (ML), deep learning, and natural language processing, promise capturing, managing, viewing, and analyzing digital image information at a grander scale, potentially improving workflow efficiencies, productivity, and care quality. However, AI companies fall short from the overarching goal, connecting the dots along the care continuum. Embedded in PACS, most AI-based tools deliver single-point solutions — i.e., basic radiology workflows, e.g., image analysis; specific functions and tasks, such as patient synopsis; or target a small number of use cases, like pulmonary nodules.

Vendors must integrate AI-enabled tools seamlessly in the radiologist's entire workflow to realize its value and enhance the radiologist experience. Frost & Sullivan estimates the global medical imaging AI market will reach $1.4 billion in 2022, with a compound annual growth rate of about 74% from 2018 to 2022.[5] Image analysis constitutes the predominant segment during the forecast period.

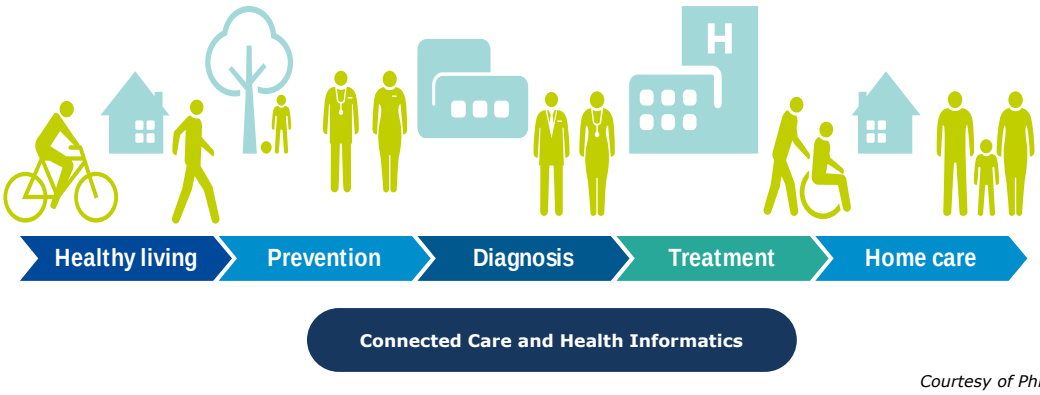
[4] https://www.pcori.org/events/2019/alliance-health-policy-briefing-right-care-right-patient-right-time-role-comparative (Accessed August 2019)
[5] *Growth Opportunities in the Global Medical Imaging Artificial Intelligence Market, Forecast to 2022*, (Frost & Sullivan, Oct 2018).

Visionary Innovation & Performance and Customer Impact

Headquartered in Amsterdam, the Netherlands, Philips Healthcare (Philips) is a health technology leader in diagnostic imaging, image-guided therapy, patient monitoring, and health informatics. Over the past decade, the Dutch company transitioned from a century-old conglomerate titan into a dedicated health technology firm.

Philips provides integrated solutions and services spanning across the health continuum, care levels, and settings. It capitalizes on core competencies and value-based healthcare trends to enable innovative delivery models for sustainable, high-quality, and affordable care.

Philips Healthcare Solutions



Courtesy of Philips

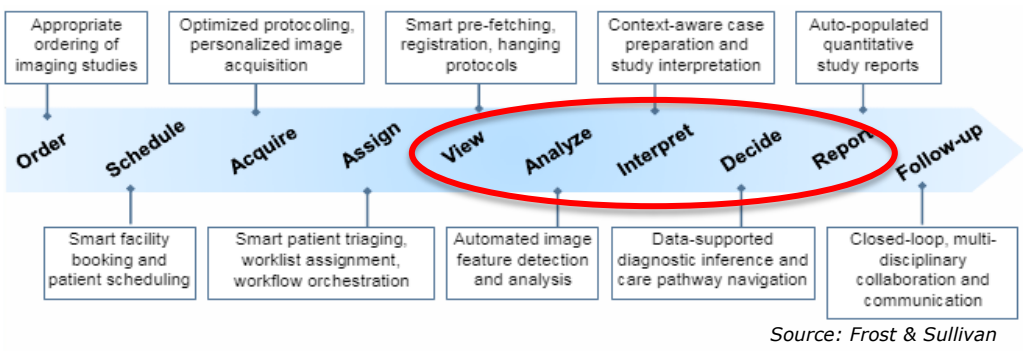
The company's vision centers on sustainable health with the stated purpose of *improving the lives of 3 billion people a year by 2030*.

Mission-driven: A Connected Whole

AI's perception in imaging informatics is transitioning from 'substituting radiologists' to an 'efficient tool enhancing radiology' across the diagnostic imaging workflow spectrum, from image ordering, scan scheduling, and image acquisition and processing to image analysis, interpreting, reporting and patient follow-up.

Any solution catering to radiologists' primary reading must adapt to their customized workflows, providing easy access to the studies and, if necessary, advanced tools for analysis, interpretation, and communication. Nonetheless, traditional PACS players and AI companies mostly focus on narrowly-defined AI applications.

AI Use Cases across the Radiology Value



Source: Frost & Sullivan

Over the last decade, Frost & Sullivan observed how Philips properly harnessed technology assets across various industries and business units with a clear end-goal in mind: facilitate holistic, patient-specific insights and smart clinical decision-making at the point-of-care. Next-generation precision diagnostics solutions provide a substantial opportunity for the company, extending radiology's value by delivering on the Quadruple Aim—reduce the capital cost of care, improve the patient and provider experience, and enhance health outcomes.

"The underlying premise for healthcare has always been the earlier you diagnose and treat a patient, the better the outcomes and the lower the costs. As diseases become more treatable and more chronic, AI can help identify triggers and address them well before they fully manifest."

—Homer Pien, Chief Scientific Officer, Precision Diagnosis, Philips

Philips aims to empower care teams to deliver precision medicine (PM) by taking a systems approach to patient care. Thus, system components must transfer patient information seamlessly across the care continuum to drive PM effectively. The company's Enterprise Diagnostic Imaging Platform is a configurable suite of informatics tools granting care teams access to vital information through systems of record, leveraging the information therein to cultivate the insights needed for precision diagnosis via systems of engagement. Philips employs technologies within the AI space to enable an optimized synapse between these two systems, which drive precision diagnosis.

"We [Philips] also team up with application providers and care providers to build the proof points for AI integration in the workflow. Integration in workflow means that it eliminates steps, rather than add to them, and helps optimize those workflows. If we get solid data governance and workflow integration approaches in place, AI and ML will go mainstream. When that happens, there will come a time when we forget there is AI in use, as it is securely embedded in the solutions we use every day."

—Jeroen Tas, Chief Innovation & Strategy Officer, Philips

Philips combines clinical domain and operational knowledge to channel the right components of its two interlocking systems into solutions that propel its clinical and diagnostic service lines within the hospital. With a legacy of healthcare leadership, the company built one of the industry's broadest portfolios, fueled by deep research collaborations with clinical partners and outreach for enhancing third party informatics solutions.

Philips leverages state-of-the-art technologies to optimize its broad suite of tools, providing timely insights to enhance the radiologists' work—borne from an understanding of the patient and user context and AI deeply embedded within their workflows. Its informatics offerings integrate such technologies at every step of the patient care continuum, often at interlinking building blocks within its platform, potentially sparking precision diagnosis not only at particular points of care but helping to drive patients along care pathways by:

- Presenting the right information where most needed facilitates higher quality care and greater operational efficiency

- Informing the clinician enables more informed decision-making for improving patient outcomes
- Enhancing automated workflows allow for higher patient throughputs
- Employing intelligent tools and smart workflows provide operational insights that drive lower costs to the hospital.

For instance, Philips' Illumeo, with adaptive intelligence, is an imaging informatics technology developed alongside radiologists to enhance the primary reading experience. Its benefits span the entire radiologist workflow, from acquisition to PACS to reports, throughout the patient care journey. The system integrates the most relevant case-related information from EHRs/EMRs and various hospital IT systems for a holistic, 360-degree, context-aware patient view, and facilitates care collaboration between radiologists and referring physicians.

"Adaptive intelligence expressed seamlessly in the primary reading workflow automates the process, optimizes radiology workflows and provides more clinical depth and insight into a patient at a drastically reduced time."

—Kevin Lev, Marketing Lead, Philips Healthcare - ICAP

Illumeo optimizes care delivery across the radiology value chain with a scalable integrated approach. At the same time, intelligent tools and smart workflows result in dynamic, insight-rich outputs, empowering radiologists to deliver on the Quadruple Aim. Aligned with the company's mission and strategic focus, Philips' AI paradigm to primary reading redefines the way radiologists see, seek, and share clinical information to better patients' lives.

An Insightful, Adaptive, and Intuitive Primary Reading Experience

"The degree of intuition and seamless integration that all of these advanced tools bring will help optimize and automate what radiologists need to do, providing meaningful insights at reduced times—presenting the right data at the right time within the workflow."

—Lev

The adaptive intelligence concept combines a host of advanced tools with a deep understanding of clinical imaging acquisition and workflows, driving smart radiology workflows and using data presentation states to offer added insights and extend radiologists' capabilities. The technology adapts to the radiologists—almost like a personal assistant trained to augment their skills and preferences, helping to make the best use of their time.

Philips embeds its sophisticated algorithms deep into the radiology workflow. Seamless clinical data integration with the day-to-day radiology practice presents holistic patient insights for enhanced diagnostic confidence and patient-centered care.

Illumeo with adaptive intelligence is a new paradigm of clinically intelligent software. Its differentiating features stand over four critical supporting pillars: contextual relevance, adaptive intelligence, reduced variability, and extensible.

This AI paradigm applied to primary reading serves a single goal—to empower the radiologist, enabling them to improve patient care. It utilizes advanced algorithms to adapt to the patient context and to that of the caregiver so that physicians achieve a holistic patient view early in the diagnostic pathway. Illumeo provides standardized tooling and easy comparison modes to help normalize workflows across radiologists while tailoring to the radiologist's needs and preferences. The system streamlines workflows and enables intuitive, robust, and reliable hanging protocols backed by an intelligent image processing engine, i.e., image reading, tagging, and analysis, and an image recognition system. Also, the adaptive interface and advanced interactive reporting promote efficiencies, furthering a state-of-the-art experience.

Adaptive Intelligence in Radiology PACS

Courtesy of Philips

The technology's scalability supports an active, agile, integrated, enterprise-wide strategy, a truly unique proposition in today's value-driven landscape.

Applying this AI paradigm to the primary reading environment is still in early implementation phases, coalescing key proof points around product usage. However, early adopters report more efficient and effective case preparations, witnessing significant time savings—about 60%—and productivity benefits in turnaround time, same-day readings, and context-driven tool selection.[6] Philips employs agile development models, with quick product iterations based on customer feedback.

[6] University of Utah Health Radiologists. Results from specific user experience are not predictive of results in other cases.

Shaping Radiology's Future

"Customers are associating Philips as a leader within the AI space. As we continue deploying solutions within our informatics platforms backed by the Illumeo paradigm and adding algorithms to the workflow, we expect continuous partnering with customers to provide AI-driven context-based insights throughout the care pathway will become the cornerstone for how Philips approaches the world of primary reading in Radiology."

—Kevin Lev

As it integrates with its existing systems, Philips's near-term market strategy for applying this AI paradigm to the primary reading environment focuses on existing IntelliSpace PACS customers and targets the English- and French-speaking markets. The system is available worldwide to all customers—even without working with Philips PACS prior.

However, more broadly, the company is working toward leadership positions in integrating AI algorithms in its precision diagnostics platform and imaging modalities, whether developed internally, through deep customer partnerships, or integrated via third-party collaborations directly within radiologist-caregiver workflows.

Typically, PACS systems purchasing and implementation cycles are lengthy. Philips anticipates that transitioning customers to a new paradigm will take some time. However, it has a growing pipeline of orders and interest, indicating substantial expansion, particularly, as late 2018 was the first installation. In July 2019, the company announced its latest deal, a 10-year agreement with the Centre Hospitalier Régional Universitaire de Nancy, France, a new customer, for its IntelliSpace PACS solution with Illumeo.

…Beyond Illumeo

Philips sells Illumeo as part of a growing solution set within the Enterprise Diagnostic Imaging Solutions Platform, keeping the system in optimal operating conditions, including innovations coming down the pipe. As it moves forward, the company plans on the AI paradigm to the primary reading environment, i.e., offering contextual insights directly within the workflow, becoming the guiding principle for incorporating AI throughout its solutions in informatics and beyond. In time, Philips will incorporate proprietary and third-party algorithms and create deeper integrations with its advanced visualization platform for a unique enterprise diagnostic imaging experience. At this time, the company will also explore pursuing a marketplace model to grant customers more convenient access to innovation they can select to include in their practice both at research and operational levels.

Philips is uniquely positioned to reshape the radiology value chain as it actively capitalizes on an end-to-end strategic innovation powered by the vision of deep AI incorporation across the care pathway and fueled by a deep partnership with its customers. Its brand strength, global medical imaging footprint, expertise across clinical segments, and extensive informatics portfolio, coupled with its ability to establish partnerships with third-party AI imaging vendors set the company apart from its competitors—offering broader, seamless workflows across integrative medical imaging informatics.

Conclusion

With evidence-based medicine now more entrenched in the medical community, medical imaging data is exponentially growing driven by an aging population, rising chronic disease prevalence, and widening applications. At the same time, radiologists' demand is evolving faster than supply capability and exacerbated by global workforce shortages. Radiology departments are becoming cost-centers rather than revenue-generators, placing additional pressures on healthcare organizations to do more with less. Artificial intelligence (AI)-based technologies can help radiologists respond to increasing demands to interpret studies more quickly.

Frost & Sullivan recognizes the Philips' approach to AI as represented by the Illumeo paradigm, with adaptive intelligence, as a disruptive imaging informatics strategy. It exemplifies how the company intends to employ the clinically intelligent software to adapt to radiologists' skills and preferences to extend their capabilities. With solutions like Illumeo, Philips embeds advanced algorithms across multiple touch points in the radiologist workflow and the patient care pathway, offering insights each step of the way. This new paradigm generates dynamic, meaningful, insight-rich findings delivered in a tailored, context-aware view, empowering radiologists to transition from volume-to-value-based care—taking radiology to the next level.

Philips is taking the lead in terms of thought leadership by viewing AI not as a point solution enabler, but as an embedded facilitator in the entire workflow, providing an enhanced, seamless experience for the radiologist compared to the competition which still addresses specific areas, like image analysis, or steps in the workflow in a siloed fashion. With this new AI paradigm applied to the primary reading environment, Philips walks the talk.

With its thought and technological leadership and customer-driven, patient-centered innovation, Philips Healthcare earns the 2019 Frost & Sullivan Global Company of the Year Award.

Significance of Company of the Year

To receive the Global Company of the Year Award (i.e., to be recognized as a leader not only in your industry, but among non-industry peers) requires a company to demonstrate excellence in growth, innovation, and leadership. This excellence typically translates into superior performance in three key areas—demand generation, brand development, and competitive positioning—that serve as the foundation of a company's future success and prepare it to deliver on the 2 factors that define the Company of the Year Award: Visionary Innovation and Performance, and Customer Impact).

Understanding Company of the Year

Driving demand, brand strength, and competitive differentiation all play critical roles in delivering unique value to customers. This three-fold focus, however, must ideally be complemented by an equally rigorous focus on Visionary Innovation and Performance to enhance Customer Impact.

Key Benchmarking Criteria

For the Global Company of the Year Award, Frost & Sullivan analysts independently evaluated each factor according to the criteria identified below.

Visionary Innovation & Performance

Criterion 1: Addressing Unmet Needs
Criterion 2: Visionary Scenarios through Mega Trends
Criterion 3: Implementation Best Practices
Criterion 4: Blue Ocean Strategy
Criterion 5: Financial Performance

Customer Impact

Criterion 1: Price/Performance Value
Criterion 2: Customer Purchase Experience
Criterion 3: Customer Ownership Experience
Criterion 4: Customer Service Experience
Criterion 5: Brand Equity

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	• 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	• 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	• 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	• 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	• 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	• 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	• 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	• Review analysis with panel • Build consensus • Select winner	Decision on which company performs best against all best-practice criteria
9	**Communicate recognition**	Inform Award recipient of Award recognition	• 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 able to share Award news with stakeholders and customers	• 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.