Market Outlook

Market Outlook: Product Lifecycle Management (PLM), 2019-2024, Worldwide

December 2019

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Quadrant Knowledge Solutions

Executive Overview

The global PLM market outlook research includes a detailed analysis of the global market regarding short-term and long-term growth opportunities, emerging technology trends, market trends, and future market outlook. The study provides a comprehensive market forecast analysis of the global PLM market in various geographical regions, revenue type, and industry segmentation. This research provides strategic information for technology vendors to better understand the market supporting their growth strategies and for users to evaluate different vendors capabilities, competitive differentiation, and its market position.

Key Research Findings

Followings are the key research findings:

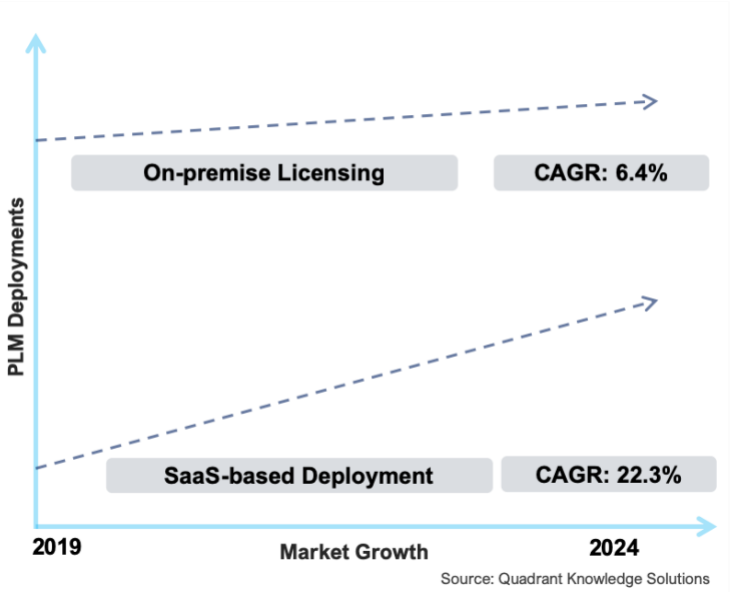
Deployment Trend:

PLM market is expected to grow at a CAGR of 7.4% from 2019-2024

Global PLM market has grown by 7.6% in 2019, exceeding the growth estimates from PLM analysis conducted in the year 2018 by Quadrant's PLM market outlook report. The global PLM market is expected to grow at a CAGR of 7.4% from 2019-2024 from a market size of $19.97 billion in 2019 to over $28.58 billion by 2024.

Cloud-based PLM application is finding increasing market traction amongst mid-market and SMB market segment. The cloud-based PLM solution is expected to grow at a CAGR of 22.3% compared to a CAGR of 6.4% for an on-premise licensing. By 2024, cloud-based PLM to contribute approx. 30% of the total PLM market at a market size of $4.16 billion in 2024.

Figure: PLM Market Growth by Deployment Type
On-premise vs SaaS-based Deployments



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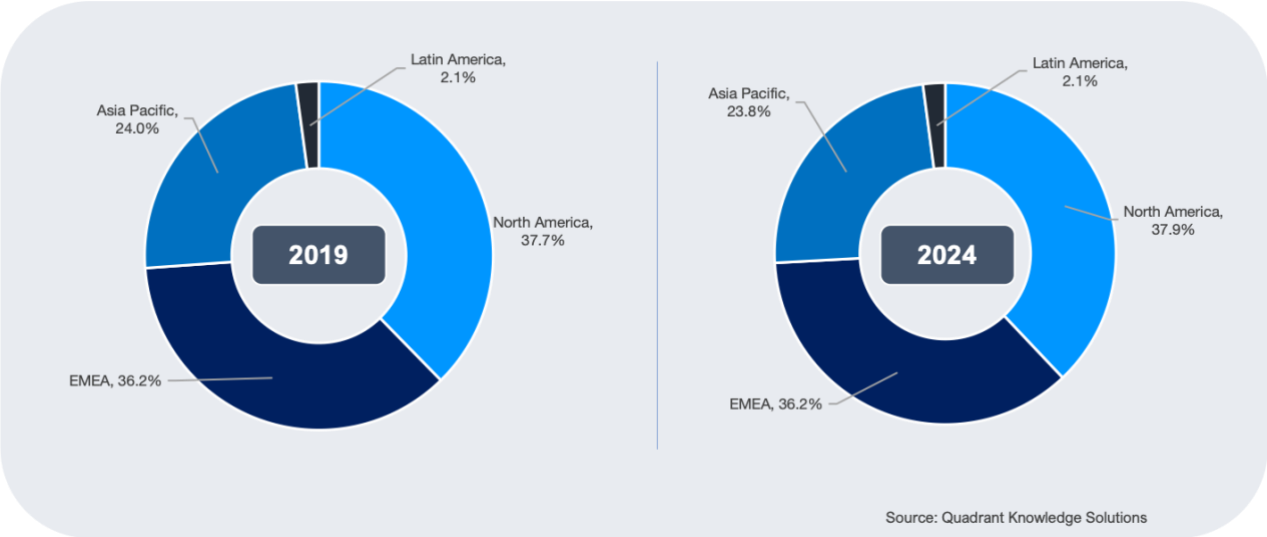
Regional Trends:

North America region continues to dominate the global PLM market as well as market growth throughout 2019-2024

**Figure: Revenue Share by Geographical Regions
2019 vs 2024**



North America and European market continue to lead the market growth with steady growth throughout the forecasted years of 2019-2024. The market in NA and Western European region is driven by industrial companies focusing on optimizing their design & development processes to drive the next generation of operational excellence as part of their digital transformation roadmap. PLM market is expected to grow at a CAGR of 7.6% and 7.4% respectively in the NA and EMEA region during 2019-2024.

Industry Vertical Trend:

PLM Software is increasingly making inroads into non-traditional industries from the process, batch, and energy industries

Industrial companies across industry sectors are struggling in designing and developing the next generation of complex products with built-in intelligence and connectivity requiring a complex process of specification, design, and validation. Organizations need an integrated design approach with enhanced collaboration between multiple disciplines, including mechanical, electrical, and software to develop the next generation of smart connected products and factories. This trend is expected to play a major role in the adoption of advanced PLM functionalities across industry verticals to support the vision of connected industries and enterprise.

Automotive, aerospace & defense, industrial equipment, and high technology industries are primary users of PLM solution in the global market and contribute over 77.6% of the total market in the year 2019. PLM vendors in recent years are

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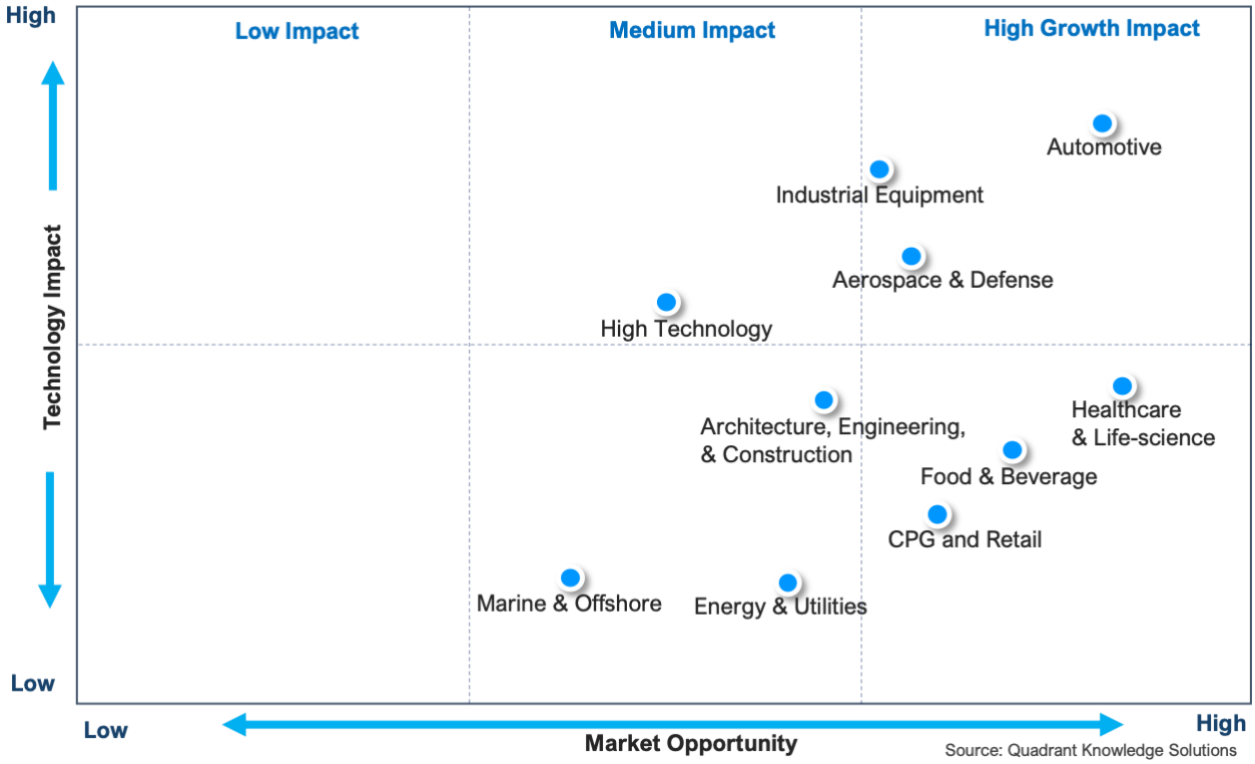
increasingly targeting non-traditional industries from process and batch manufacturing sectors with industry-specific functionalities and tailored solutions. The non-traditional sectors, such as consumer packaged goods, life sciences, food & beverage, shipbuilding, energy & utilities, chemicals, medical devices, retail, and others are increasingly embracing advanced PLM solutions.

Figure: Market Opportunities and Technology Impact Analysis by Industry Verticals



Competition Dynamics & Trends:

The sophistication of technology platforms and integrations & interoperability are amongst the top competitive differentiators

PTC, Dassault Systemes, and Siemens are the top performers and top three technology leaders in the 2019 SPARK Matrix of the global product PLM market. These companies provide a sophisticated and comprehensive technology platform to address a variety of PLM use cases across discrete, process, batch, and energy & utility industries. SAP is also positioned in the leader section owning to their comprehensive PLM solution tightly integrated with business systems, collaborative innovation, and analytics capabilities.

Oracle, Autodesk, and Aras are positioned amongst the major challengers in the 2019 PLM SPARK Matrix. These companies provide comprehensive technology capabilities and continue to gain significant market traction in the global PLM market.

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Market Background, Key Trends, and Market Drivers

Product Lifecycle Management (PLM) consists of a set of software solutions to support organizations throughout the stages of the product lifecycles from its conceptualization to its design, build, market, support, maintain, and retirement. A holistic PLM solution supports enterprise-wide requirements for engineering designs and development, manufacturing workflows, and managing consistent product information. The solution enables collaboration amongst various stakeholders, both internal and external, responsible for specific product lifecycle processes.

PLM is a mature and well-established technology strategy in managing product lifecycle from its early concept generation through its retirement. However, driven by a major industry-wide transformation, due to the emergence of industrial digitalization, industry 4.0, and connected value chain initiatives, PLM vendors are adding advanced capabilities incorporating emerging technology trends.

Large manufacturing organizations are often associated with the large distributed ecosystem of stakeholders and thereby face challenges in fostering effective collaborations amongst various distributed teams for managing product design and development processes. An inefficient system of managing product development data with multiple disparate systems often results in extended time to market, development errors, and poor product quality. While the majority of the large industrial companies have adopted PLM technologies in managing design and development processes, the majority of these traditional solutions lack capabilities in handling present complex market dynamics. Additionally, traditional PLM solutions were associated with long implementation, substantial upfront investment, difficult to use, complex upgrade, and challenging to integrate with enterprise business systems.

Large industrial companies are either amid digital transformation initiatives or planning their roadmap towards digitalization. Advanced PLM solution is considered as a core technology platform for managing smart, connected, and complex product development processes in the digital age. Industrial companies are looking at PLM solution with key capabilities including integrated data management, distributed collaboration, and seamless integration with enterprise systems like manufacturing execution systems (MES), enterprise resource planning (ERP), supply chain management (SCM) and internet of things (IoT) platforms for a holistic strategy towards building a connected enterprise.

Followings are the major components of a PLM solution:

- **Multi-CAD Solution**: Multi-CAD solution includes multiple applications for design, analysis, and simulation of a product and production environment. It includes tools, such as computer-aided design (CAD), mechanical CAD (MCAD), electrical CAD (ECAD), computer-aided engineering (CAE), computer-aided manufacturing (CAM), electronic design automation (EDA), simulation & analysis, and others.

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- **Product Data Management (PDM)**: PDM platform includes a centralized and secure product data repository that provides a single version of the truth and updated product information to all the product stakeholders. Product information may consist of multi-CAD data, models, requirements, process information, documentation, and such others. Advanced PDM platform includes role-based access control to enable various product stakeholders to access only the relevant information to review, modify, comment, and share specific product information and features. Integrated PDM platform provides a foundation for a collaborative PLM environment to foster innovation and knowledge capture across organizational domains.

- **Digital Manufacturing**: Digital manufacturing solution includes integrated application suites to support the transition of product design into manufacturing processes. It enables organizations to perform advanced modelling, simulation and analysis of the manufacturing processes and plant environments including layout, equipment, resources, assembly lines, material flow, and such others. It helps manufacturing planning engineers to validate process design and optimize operational performance.

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Market Adoption and Deployment Trends

The global PLM market has grown by 7.6% in 2019, exceeding the forecasted market growth of 6.9% by Quadrant's analyst in the PLM analysis concluded in 2018. PLM vendors are making significant investments in adding advanced functionalities to help users in achieving the next generation of connectivity performance improvements. Industrial companies are increasingly upgrading their traditional PLM solutions to support customer-centric product design and development approach. The growing popularity of 3d visualization, augmented reality, and digital twin of product and production processes are gaining significant momentum from discrete manufacturing industries to transform their end-to-end value chain processes.

Figure: Primary Market Drivers, 2019-2024

Primary Market Drivers
Growing industrial digitalization, driven by the widespread adoption of IoT devices and Industry 4.0 strategies
Continued disruption in the industrial manufacturing technology landscape
Increasing complexities of smart products, intelligent factories, and operational processes
PLM functionalities to support emerging technologies of the digital twin, additive manufacturing, virtual reality, and augmented reality
Realizing the vision of Digital Twin and Digital Thread strategies
The growing popularity of cloud-based PLM application
Market expansion in mid-market and SMB sectors
Global growth opportunities from process and batch manufacturing industries

PLM value proposition in accelerating innovation, facilitating cross-functional global collaboration, improving product quality, and reducing time to market in the present dynamic and competitive environment is well understood by organizations across industry sectors. Thereby, PLM solutions are increasingly being seen as a core technology solution in designing and developing the next generation of smart connected products and intelligent factories. The growing popularity of PLM functionalities to support advanced visualization, predictive analytics, additive manufacturing, and model-based engineering and manufacturing are accelerating the adoption of advanced PLM solution across industry sectors. Additionally, the majority of the PLM vendors are making a significant investment in providing advanced PLM functionalities in realizing the vision of integrated and connected digital thread

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strategy. PLM vendors continue to focus on improving their technical capabilities and improving their overall value proposition in supporting organizations vision in realizing digital enterprise strategy.

The global PLM market which has grown by 7.6% in 2019 is expected to grow at a CAGR of 7.4% from 2019-2024. Global PLM market is expected to grow from an estimated market size of $19.97 billion in 2019 to reach over $28.58 billion by 2024. In addition to the large companies from the traditional discrete manufacturing sectors, Global PLM vendors are gaining significant greenfield market opportunities in the mid-market segments as well as emerging industries from process and batch manufacturing sectors.

Key Predictions:

Driven by the growing adoption by mid-market and SMB segment and increasing confidence of cloud application security, cloud-based PLM deployments are gaining significant momentum and are expected to grow at a CAGR of 22.3% compared to an anticipated CAGR of 6.4% for an on-premise deployment from 2019-2024.

By 2024, cloud-based PLM is expected to capture around 30% of the total market.

On deployment type, the PLM market is primarily dominated by on-premise deployments capturing 82.4% of the global market compared to 17.6% of the SaaS-based deployments in 2019. However, by 2024, Cloud-based PLM solution is expected to contribute to approximately 30% of the global PLM market. On overall revenue type, professional services capture 56.6% of the total PLM market in 2019. Regarding market trends, on-premise deployment is expected to remain a preferred choice, especially by large organizations from conventional industries.

Almost all major PLM vendors are focusing on improving their cloud PLM value proposition with subscription-based pricing. This trend is expected to play a crucial role in improving the penetration rate in the small and mid-sized businesses (SMBs) and overall market growth of PLM solution during the forecasted years of 2019-2024. Cloud PLM solution promises to reduce/eliminate the users' primary challenges related to implementation, customization, software upgrades, and higher licensing costs.

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Figure: Market Adoption Trends

PLM market is expected to grow at a CAGR of 7.4% from a forecasted period of 2019-2024.

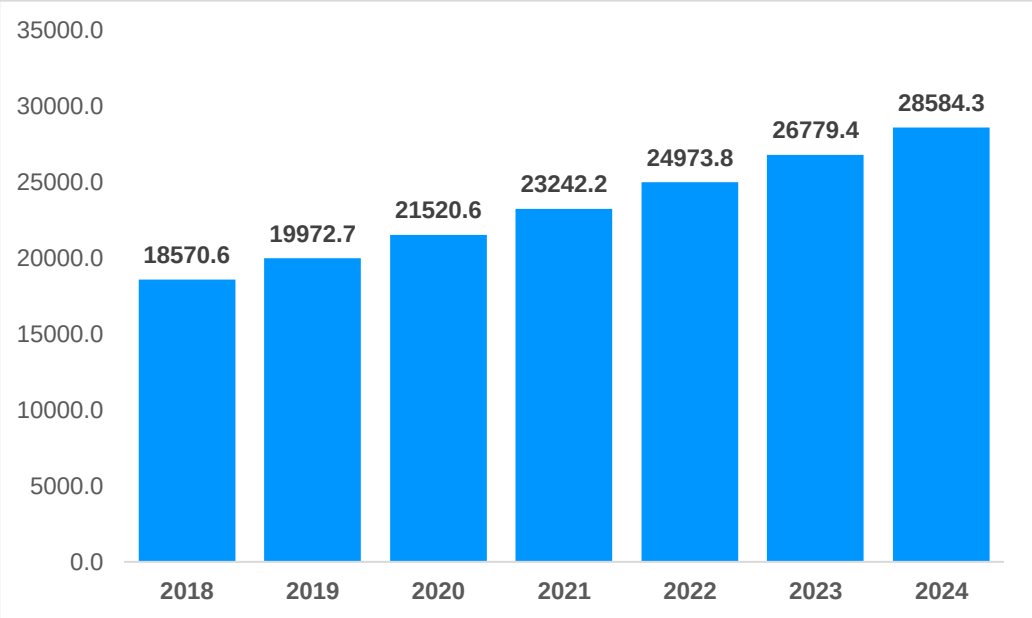

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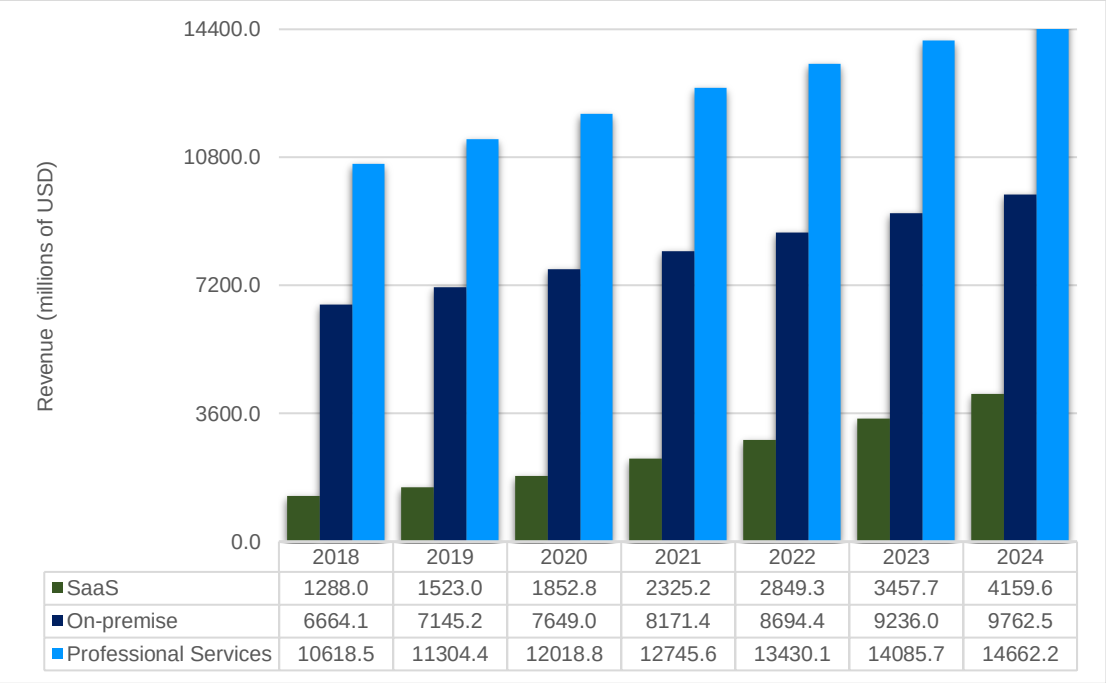
Figure: Revenue and Deployment Trends

By 2024, cloud-based PLM is expected to capture around 30% of the total market.



	2018	2019	2020	2021	2022	2023	2024
SaaS	1288.0	1523.0	1852.8	2325.2	2849.3	3457.7	4159.6
On-premise	6664.1	7145.2	7649.0	8171.4	8694.4	9236.0	9762.5
Professional Services	10618.5	11304.4	12018.8	12745.6	13430.1	14085.7	14662.2

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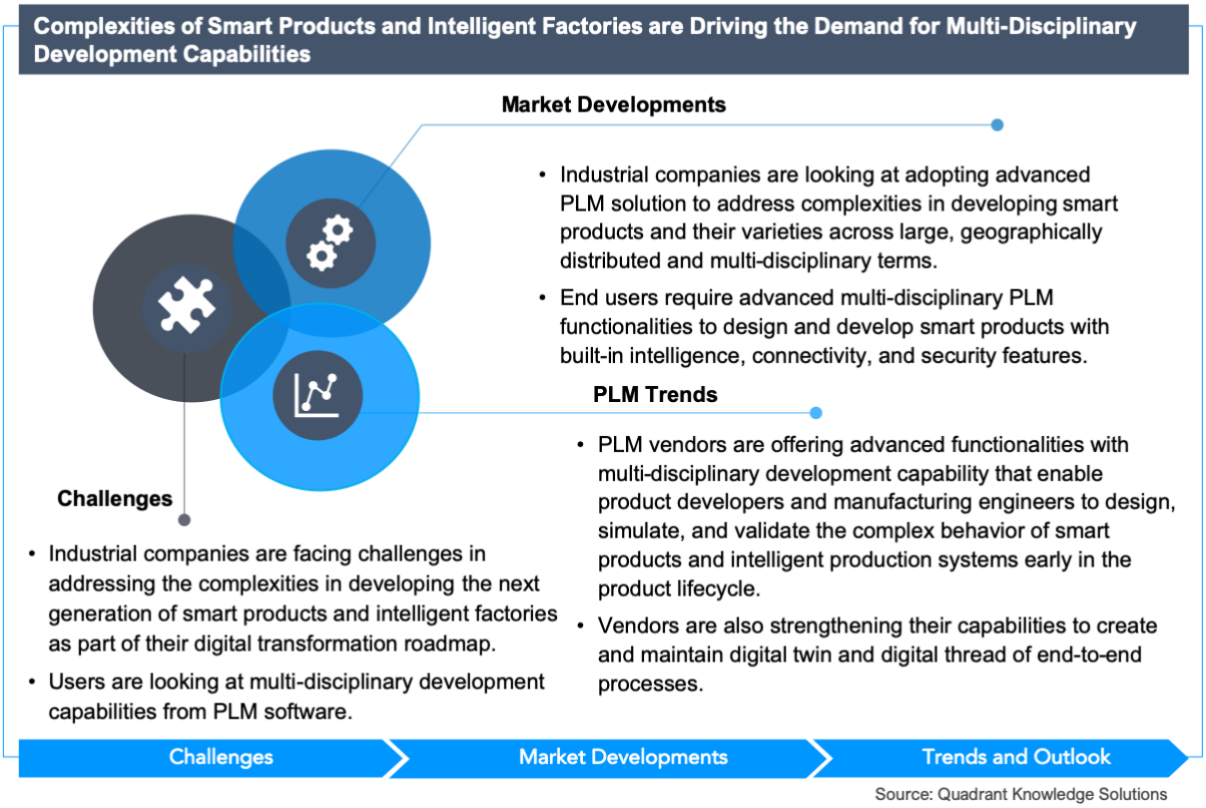
Key Market Drivers and Trends

The followings are the dominant technology and market development influencing the overall global PLM solution and market growth:

Complexities of Smart Products and Intelligent Factories are Driving the Demand for Multi-Disciplinary Development Capabilities



Source: Quadrant Knowledge Solutions

Digital transformation trends are influencing industrial companies across verticals to focus on building the next generation of smart products and intelligent factories. However, these smart connected products are highly complex in terms of built-in intelligence, connectivity, security, compliance requirements, and need to offer advanced functionalities. Organizations face challenges in developing the complex product and their varieties across large, geographically distributed and multi-disciplinary teams. Organizations require an integrated design approach with enhanced collaboration between multiple disciplines, including mechanical, electrical, and software to develop the next generation of smart connected products. PLM vendors are offering advanced functionalities with multi-disciplinary development capability that enable product developers and manufacturing engineers to design, simulate, and validate the complex behavior of smart products and intelligent production systems early in the product lifecycle. This significantly reduces the time and costs of design, specification, and validation of complex products, processes, and

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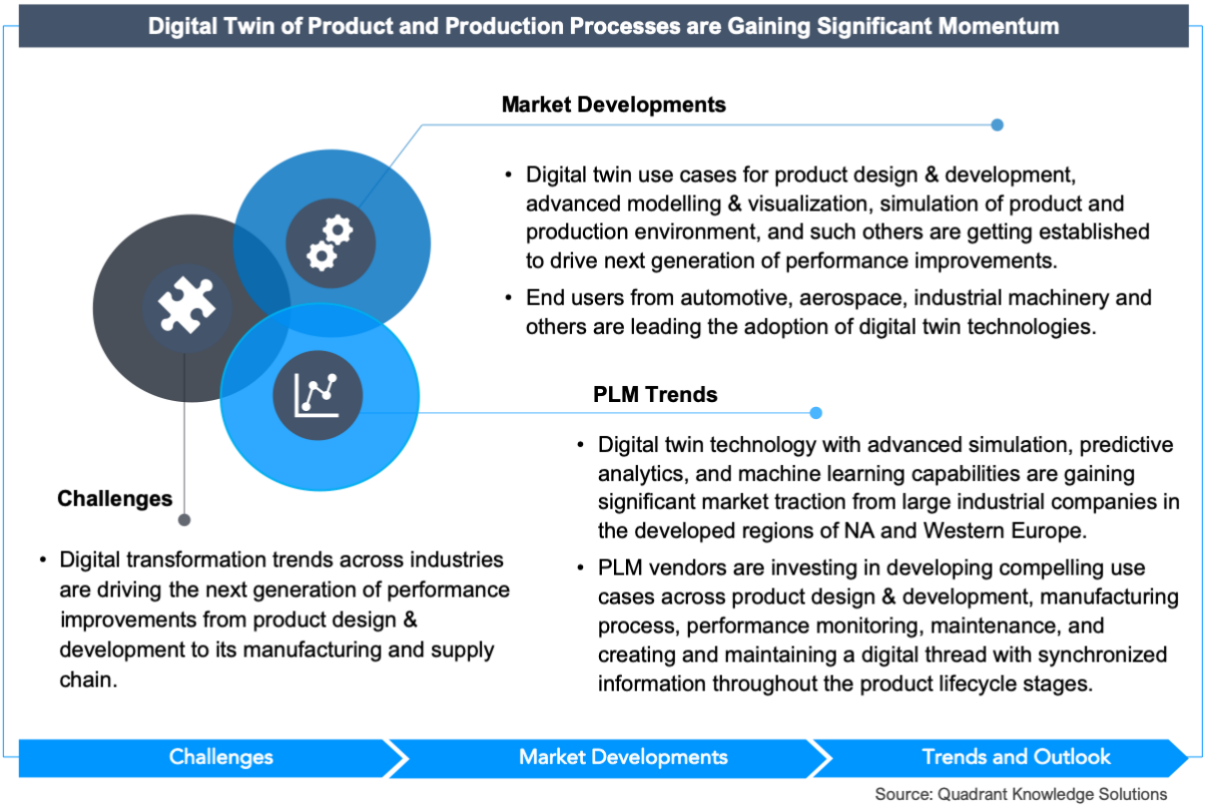
systems. Additionally, it is creating additional revenue for PLM vendors in addressing complexities of smart product and processes across industry segments.

Digital Twin of Product and Production Processes are Gaining Significant Momentum

A digital twin is a comprehensive digital representation of the physical products, processes, and systems in a virtual 3D environment. Digital twins are used as an information and behavioral model to understand, simulate, predict, and optimize the performance of a product and production system. Digital twin captures all the changes occurs throughout the product lifecycle stages from concept generation through development, manufacturing, and service, creating a consistent digital thread. Leveraging an integrated PDM platform, PLM vendors enable creating and maintaining a digital thread with up to date and synchronized information throughout the product lifecycle.



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PLM Vendors are Increasingly Adding Functionalities to Support Additive Manufacturing, VR, and AR Technologies

PLM vendors have made significant strides in including capabilities to support emerging technologies that may influence product development processes. PLM vendors are actively adopting mergers, acquisitions, and partnership strategy to support users in providing functionalities to support emerging technologies such as additive manufacturing, virtual reality (VR), and augmented reality (AR).

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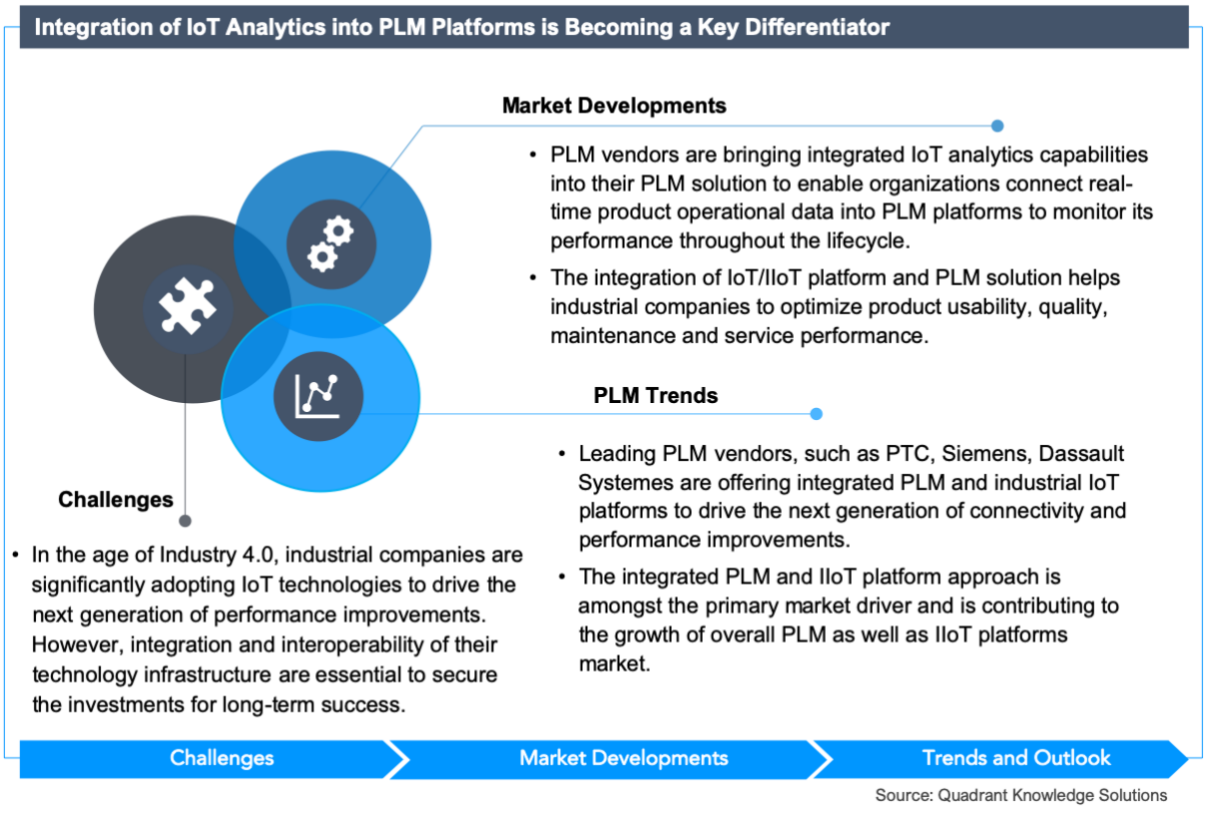
- PLM vendors are integrating additive engineering and manufacturing capabilities in their offerings to support the organization's smart manufacturing initiatives. Several industries, including aerospace & defense, industrial equipment, automotive, and others are increasingly adopting additive manufacturing technologies to print complex component parts that otherwise require complex machining. This helps in eliminating tooling costs for obsolete service parts.

- PLM vendors continue to improve the capabilities of offering virtual and augmented reality devices and applications to provide their customers with an edge over competitors in bringing innovative products faster in the market. VR/AR technologies are increasingly being used by organizations to accelerate the processes of the entire product lifecycles. Virtual reality enables users to perform computer-generated simulation of product definitions, process design, inspection, and training. Whereas augmented reality technologies are predominantly being used in simulating assembly, production line, and service area to improve the clarity of the process understanding, predict product behavior, improve product quality, and overall efficiency of the manufacturing operations. AR/VR technologies provide a competitive advantage as it enables the creation of digital twin and digital threads in an immersive virtual environment to significantly improve operational efficiency and reduce time to market.

Integration of IoT Analytics into PLM Platforms is Becoming a Key Differentiator



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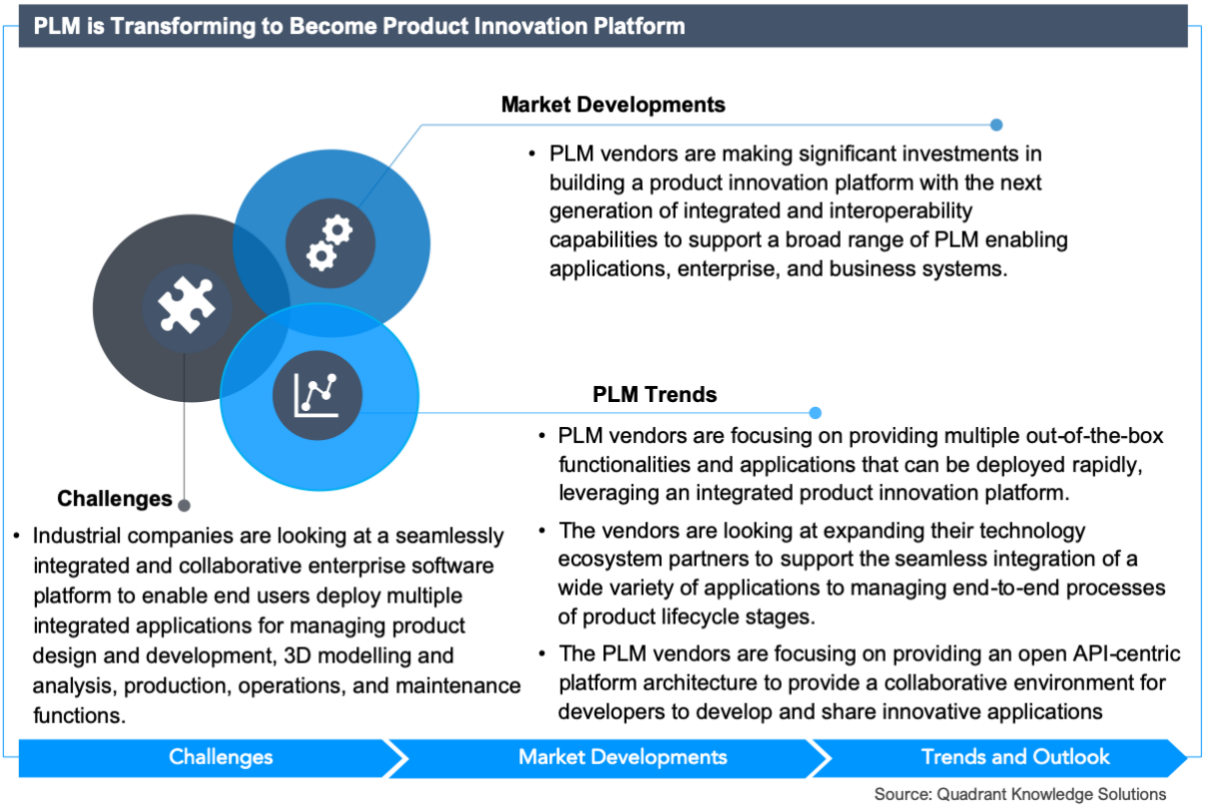
As IoT technologies are widely being accepted amongst industrial manufacturing, energy & utilities, healthcare, retail, and transportation industries, PLM vendors are bringing product analytics capabilities of IoT technology into their PLM solutions. PLM vendors are increasingly integrating their PLM solutions with IoT platforms. This enables organizations to connect real-time product's operational data into PLM platforms to gain insights into how products are performing in the field, and thereby optimizing its usability, quality, maintenance, and service performance. PLM solution with integrated IoT platform capability provides an end of end perspectives of the product lifecycle. IoT capability is becoming an important differentiator for PLM selection in the age of smart manufacturing and Industry 4.0. PTC, by integrating its industry-leading ThingWorx capability into its Creo CAD software and Windchill PLM application suite has taken an early lead and is gaining significant market traction. Siemens PLM is also integrating its MindSphere IoT platform and other application suites to drive the next generation of connectivity and performance improvements. Dassault Systemes continue to improve its 3DEXPERIENCE platform capabilities to support the internet of experience for digitally connected products, nature, and life in the physical world.

PLM is Transforming to Become Product Innovation Platform



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PLM vendors are making a significant investment in building a product innovation platform with the next generation of integration and interoperability capabilities to support a broad range of PLM-enabling applications, enterprise and business

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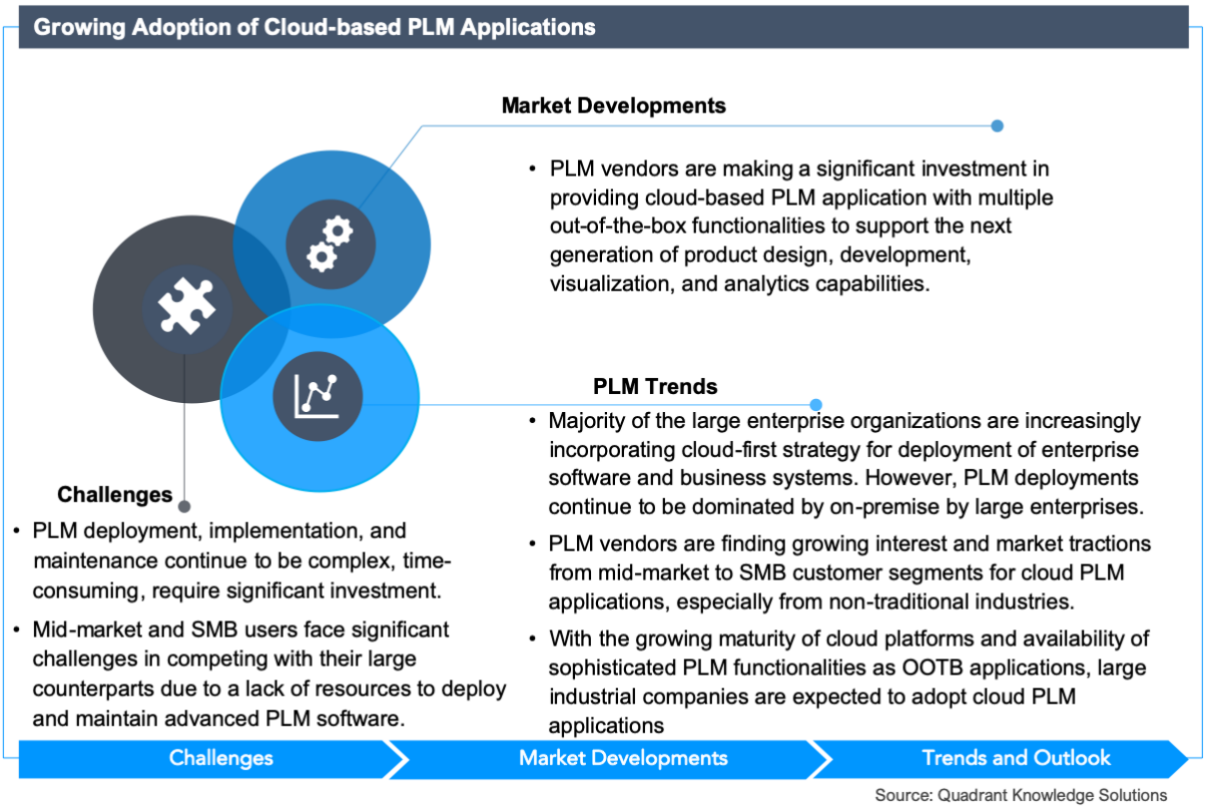
systems. PLM vendors are focusing on building several out-of-the-box functionalities and application that can be deployed rapidly, leveraging an integrated product innovation platform. PLM vendors may require creating a robust ecosystem of technology partners to support instant integration of a wide variety of application. Additionally, PLM vendors may also develop an open API-based technology architecture to bring an increasing number of developers and service providers to improve the effectiveness of their platform.

Growing Adoption of Cloud-based PLM Applications



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Majority of the large enterprise companies are moving towards a cloud-first strategy for deployment of enterprise software and business systems. However, cloud-based PLM solution is still in the emerging stage with most of the vendors still prefer on-premise deployment. Driven by the advancements in security technologies and growing confidence of cloud platforms, the scenario is gradually shifting. As part of the digital transformation trends, several global industrial organizations across industry verticals are increasingly adopting cloud-based business applications. Cloud-based deployment offers a significant advantage in terms of scalability and cost-effectiveness.

Additionally, vendors ensure that organizations always have access to the latest version of the solution with regular updates, maintenance, and support services. Further, mid-market and SMB organizations often lack resources in deploying cutting-

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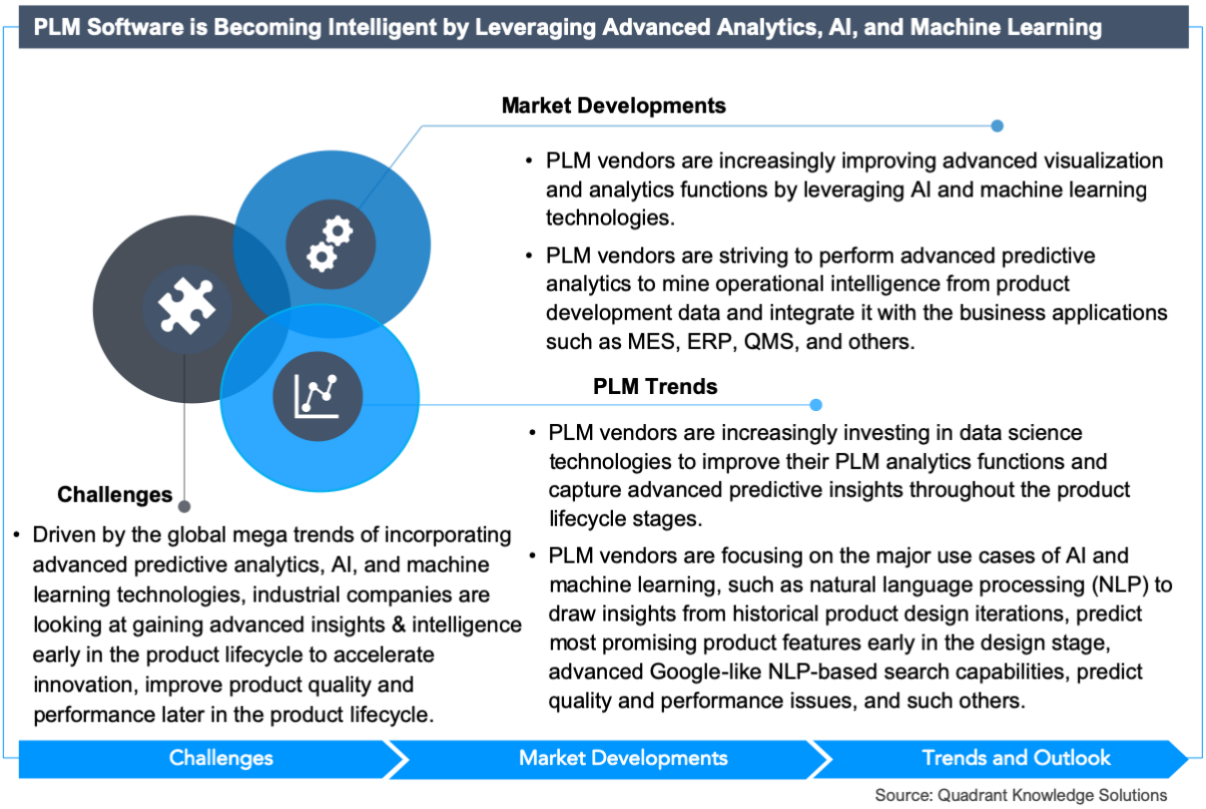
edge technologies and are associated with the same sets of operational challenges as large organizations. Thereby, mid-market and SMB organizations usually prefer cloud-based deployments to cut down their operational costs and fulfil all their unmet needs with a low monthly/yearly charge.

Presently, the PLM deployments continue to be dominated by on-premise, which constitutes over 82.4% of the total market in terms of product deployments, excluding professional services. With the growing maturity of cloud platforms and availability of sophisticated PLM functionalities as out-of-the-box applications, large industrial companies are expected to adopt cloud PLM applications during the forecasted years of 2019-2024. The cloud-based PLM solution is expected to grow at a CAGR of 22.3% compared to a CAGR of 6.4% for an on-premise licensing. By 2024, cloud-based PLM to contribute approx. 30% of the total PLM market at a market size of $4.16 billion in 2024.

PLM Software is Becoming Intelligent by Leveraging Advanced Analytics, Artificial Intelligence, and Machine Learning



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Driven by the global megatrends of leveraging advanced predictive analytics, artificial intelligence and machine learning technologies, industrial companies are looking at gaining advanced operational insights early in the product lifecycle to accelerate innovations, improve product quality, and overall performance later in the product lifecycle. As part of the product roadmap, PLM vendors are significantly investing in strengthening the capabilities to provide advanced visualizations and predictive

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analytics functions by building advanced algorithm powered by AI and machine learning expanding their data science resources. Majority of the PLM vendors are also expanding their in-house data science teams and striving to provide a collaborative community platform for developers and partners to develop and share advanced machine learning models. PLM vendors are striving to perform advanced predictive analytics to mine operational intelligence from product development data and integrate it with the enterprise and business applications, including ERP, MES, QMS, and others. PLM vendors are focusing on the major use cases of AI and machine learning, such as natural language processing (NLP) to draw insights from historical product iterations, predict most promising product features early in the design stage, advanced Google-like NLP-based search capabilities, predict product quality and performance issues, and such others.

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Regional Trends and Forecasts

Digital Transformation Strategy with Industry 4.0 and industrial internet initiatives is driving market adoption across geographical regions.

North America and European market continue to lead the market growth with steady growth throughout the forecasted years of 2019-2024. The market in NA and Western European region is driven by industrial companies focusing on optimizing their design & development processes to drive the next generation of operational excellence as part of their digital transformation roadmap. The large industrial companies are showing significant interest in emerging use cases of the digital twin, additive manufacturing, and industrial AR in their industrial environment requiring advanced PLM functionalities. End users, mainly from discrete manufacturing sectors, are increasingly adopting and upgrading their PLM solution to accommodate long-term technology trends into their enterprise to support customer-centric product development, intelligent factory, operations & maintenance, and support. EMEA market growth is primarily driven by increasing adoption in markets, including Germany, UK, France, Middle East countries, South Africa and others. Driven by industrial digitalization due to Industry 4.0 and widespread adoption of smart IoT devices across industry sectors, PLM is increasingly viewed as the key enabler for the successful execution of digital transformation roadmap.

Figure: Growth Prospects in Geographical Regions
2018-2019, vs CAGR during 2019-2024

Region	Growth (2018-2019, vs CAGR)	Market Analysis
North America	8.0% / 7.6%	• Strong market traction for emerging technologies of digital twin, additive manufacturing, industrial AR, and advanced analytics are driving the demand for advanced PLM functionalities • Industrial digitalization and growing adoption of smart IoT devices for a range of industrial use cases is creating a huge demand for advanced PLM platform and associated software infrastructure
Europe, Middle East and Africa	7.5% / 7.4%	• Industrial digitalization driven by Industry 4.0 initiatives is causing widespread deployments of smart IoT devices across industry sectors. PLM is increasingly being accepted as a key enabler for a successful execution of digital transformation roadmap • Strong market traction and growth of PLM software in markets including Germany, UK, and France.
Asia Pacific	6.9% / 7.2%	• The market growth is primarily driven by increasing industrial and infrastructure expansion activities in China, India, and South East Asia. • PLM vendors are finding increasing market traction in Australia and New Zealand. • The market in APAC region is expected to accelerate rapidly from 2021 onwards.
Latin America	6.5% / 7.1%	• PLM market is Latin America remain on the lower side and constitute just 2.2% in 2019 and is expected to grow at a below average CAGR of 7.1% during the forecasted years of 2019-2024. • PLM vendors continues to focus on key markets in Brazil and Mexico with region specific market growth strategies.

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Majority of the PLM software market revenue is coming from North America and EMEA regions. Together, they constitute 73.9% of the total market revenue, with an individual share of 37.7% and 36.2% respectively. PLM market is expected to grow at a CAGR of 7.6% and 7.4% respectively in the NA and EMEA region during 2019-2024. The long-term trend for the PLM market indicates that the developed regions of North America and Western Europe market continue to provide the highest business opportunities for vendors.

The market growth in the Asia Pacific region is primarily driven by increasing industrial and infrastructure expansion activities in China, India, and South-East Asia region. The "Made in China 2025" initiatives of the Chinese government focuses on various initiatives in the likes of industrial internet and industry 4.0 and are looking at significant investments in technology, innovation, and IT. Similarly, "Make in India" initiatives in India is gaining increasing traction. Industrial companies from automotive, consumer goods, electronics, and other industries are increasingly adopting PLM technologies for accelerating product design and product development. While the PLM market in Japan is almost flat, PLM vendors are finding market growth in Australia and New Zealand regions. Industrial companies from APAC regions continue to focus on transforming their product development and process engineering functions and are looking at advanced PLM tools to support their global growth strategies. Asia Pacific region currently holds 24.0% of the total PLM market and is expected to grow at a CAGR of 7.1% during 2019-2024.

PLM market in Latin America remains on the lower side and constitute just 2.2% in 2019 and is expected to grow at a below-average CAGR of 7.1% during the forecasted years of 2019-2024. PLM vendors continue to focus on key markets in Brazil and Mexico, with region-specific market growth strategies.

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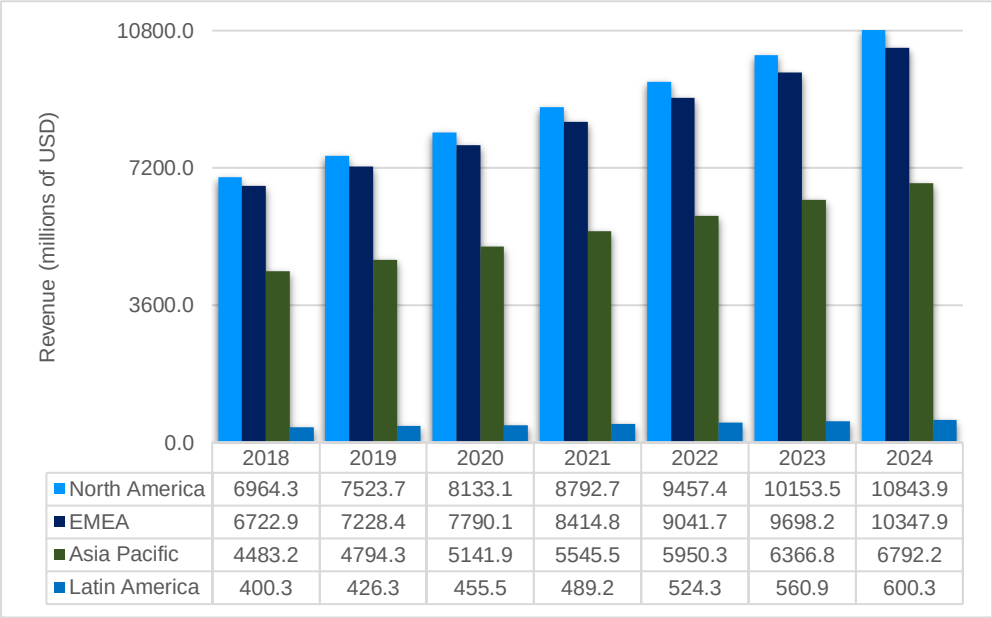
Figure: Market Forecast by Geographical Regions

Digital Transformation strategy with Industry 4.0 and industrial internet initiatives is driving market adoption across geographical regions.



	2018	2019	2020	2021	2022	2023	2024
North America	6964.3	7523.7	8133.1	8792.7	9457.4	10153.5	10843.9
EMEA	6722.9	7228.4	7790.1	8414.8	9041.7	9698.2	10347.9
Asia Pacific	4483.2	4794.3	5141.9	5545.5	5950.3	6366.8	6792.2
Latin America	400.3	426.3	455.5	489.2	524.3	560.9	600.3

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Industry Forecasts and Trends

Digital transformation trends are leading to widespread adoption of smart products, intelligent factories, and connected value chain solutions. Besides, growing production complexities, regulations, and dynamic competition are forcing process, batch, and energy industries to transform the way products are designed, manufactured, and maintained for optimized performance and efficiencies. Industrial companies across industry sectors are struggling in designing and developing the next generation of complex products with built-in intelligence and connectivity requiring the complex process of specification, design, and validation. Organizations need an integrated design approach with enhanced collaboration between multiple disciplines, including mechanical, electrical, and software to develop the next generation of smart connected products and factories. This trend is expected to play a major role in the adoption of advanced PLM functionalities across industry verticals to support the vision of connected industries and enterprise.

Key Predictions:

Automotive, aerospace & defense, high technology, and industrial equipment industry are expected to remain the largest contributor of the global PLM market throughout 2019-2024. On this, only automotive industry to post above-average growth rate with an anticipated CAGR of 7.7% during 2019-2024.

The emerging industries of healthcare & medical devices, food & beverage, and CPG & retail are expected to grow at an above-average CAGR of 7.9%, 7.9%, and 7.7% respectively. PLM vendors are increasingly offering industry-specific functionalities and solutions to drive the revenue growth from these industries.

Automotive, aerospace & defense, industrial equipment, and high technology industries are primary users of PLM solution in the global market and contribute over 77.6% of the total market in the year 2019. PLM vendors in recent years are increasingly targeting non-traditional industries from process and batch manufacturing sectors with industry-specific functionalities and tailored solutions. The non-traditional industries, such as consumer packaged goods, life sciences, food & beverage, shipbuilding, energy & utilities, chemicals, medical devices, retail, and others are increasingly embracing advanced PLM solutions.

Automotive, rail, and mobility offers the maximum opportunities for PLM vendors both in terms of market growth as well as revenue impact. The industry is amid major disruption and revolution with the growing popularity of autonomous vehicles, shared mobility, and electric vehicles. Electric vehicles and autonomous transportation are significantly driving the industry transformation and adoption of advanced PLM

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functionalities. Organizations require the next generation of design and development technologies with model-based engineering, advanced simulation, and integrated data management capabilities to accelerate product innovation and succeed in the dynamic market environment. Additionally, automotive organizations are increasingly leveraging integrated digital twin and digital thread technologies in addressing challenges in developing these complex product and product families. These technologies help automotive organizations in reducing development time, simulate the production environment, validate product behavior throughout its lifecycle, accelerate time to market, and improve overall product quality. The automotive industry is amongst the front runner in adopting advanced technologies including additive manufacturing, advanced robotics and factory automation solutions in realizing the vision of industry 4.0. The automotive industry is the primary user of the PLM solution and currently holds a market share of 23.9% in 2019 and is expected to hold 24.2% of the total market by 2024. The automotive sector is projected to grow at an above-average CAGR of 7.7% from 2019-2024.

The emerging industries, including healthcare & life-science, food & beverage, and CPG & retail sectors are expected to outperform growth prospects compared to traditional discrete industries. While these industries together constitute just 7.6% of the total PLM market in 2019, it is expected to grow at an above-average CAGR during the forecasted years of 2019-2024.

Aerospace & defense is also amongst the high growth impact industry for the global PLM market. The global A&D industry is growing with rising demands for commercial aviation, space systems, and increasing defense spending across global regions. A&D organizations are increasingly adopting an integrated PLM solution with integrated program planning & execution capabilities to overcome challenges related to increasing program complexities, cost escalation, complex regulations and certification requirements, and such others. Aerospace organizations are also looking at adopting an integrated solution to ensure smooth certification of aircraft, improve trust with aviation authorities, and enhance passenger safety. A&D sector currently holds a market share of 17.0% in 2019 and is expected to grow at a CAGR of 7.4% from 2019-2024.

Industrial equipment manufacturers are adopting advanced PLM solution to focus on improving machine engineering and design processes to drive performance improvements, reduce lead time, and optimize the cost of ownership to offer differentiated product offerings in the age of mass customization. PLM vendors are finding increasing traction for their simulation and testing solution to predict equipment performance and identify possible issues in component and assembly design early in the product lifecycle. Industrial equipment sector currently holds a market share of 20.2% in 2019 and is expected to grow at a CAGR of 7.3% from 2019-2024.

High technology and electronics sectors are increasingly adopting IoT technologies to incorporate connectivity and intelligence into their product offerings and provide unmatched customer experience. Organizations are adopting innovative business

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models to incorporate a strategy that goes beyond offering just physical products to include embedded software, networking, analytics, and personalized user experiences. The high technology industry is often associated with fast-paced innovation, global competition, and complex network of global supply chain ecosystem. To stay relevant and competitive, high tech organizations are embracing advanced PLM functionalities to improve collaboration between global suppliers, accelerate time to market, rapid response to dynamic market conditions, and redefine the customer experience. The high-tech sector currently holds a market share of 16.6% in 2019 and is expected to grow at a CAGR of 7.2% from 2019-2024.

PLM vendors have invested in formulating and implementing industry-specific solutions and domain expertise to support functionalities as per user-specific requirements. To drive revenue growth, vendors have added a diverse range of capabilities to support new industrial markets from the process, batch, energy, AEC, shipbuilding, retail, and consumer goods industries. Some niche vendors are also emerging to provide tailored PLM solution specific to targeted industry requirements. According to the market analysis, PLM vendors continue to find market traction and adoption growth from these emerging industries.

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Figure: Revenue Share by Industry Verticals

PLM Software is increasingly making inroads into non-traditional industries from the process, batch, and energy industries

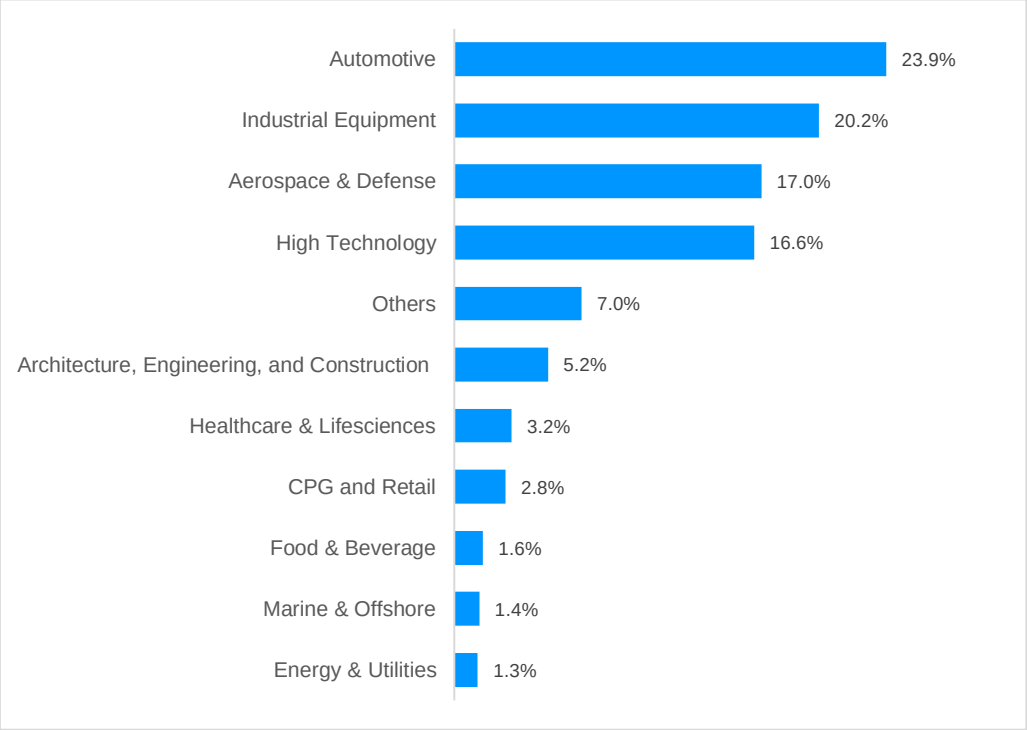

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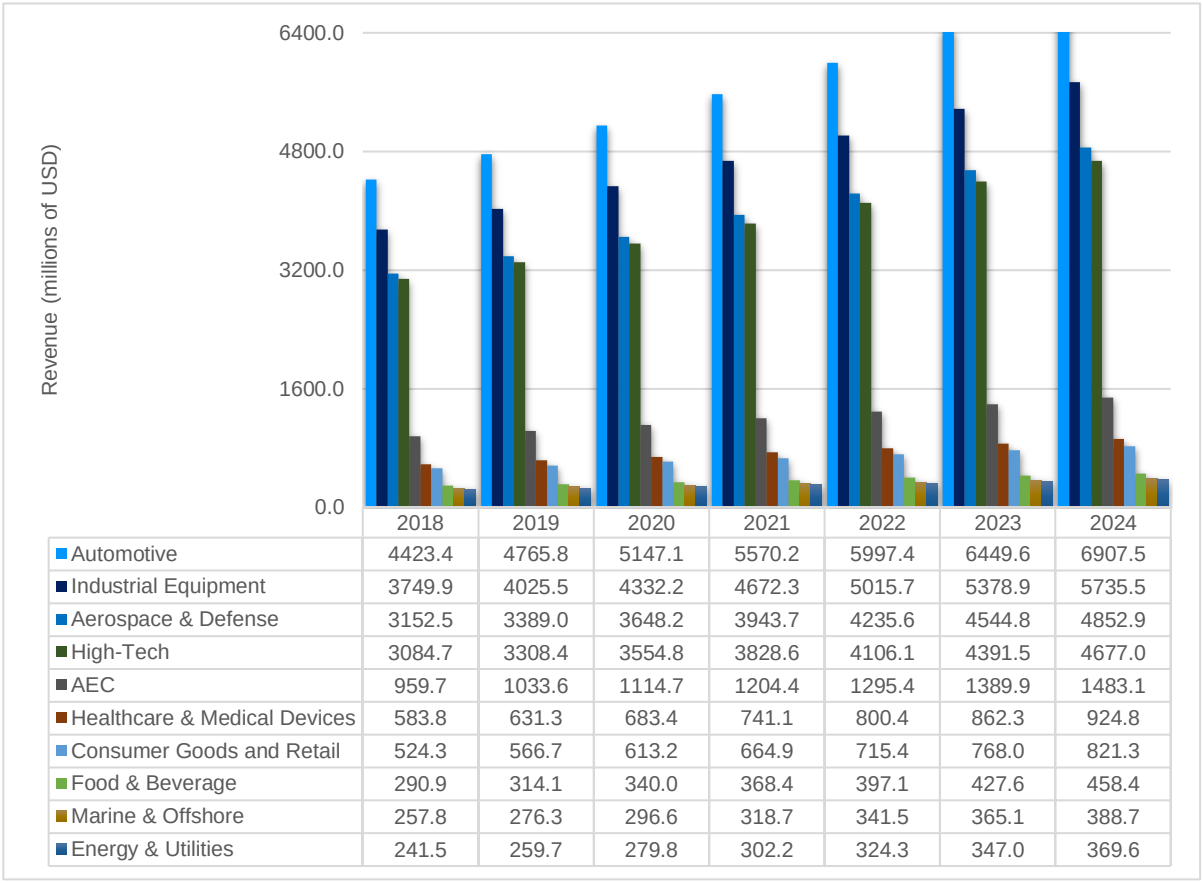
Figure: Market Forecast by Industry Verticals

Automotive, aerospace & defense, high technology, and industrial equipment industry are expected to remain the largest contributor of the global PLM market throughout 2019-2024.



	2018	2019	2020	2021	2022	2023	2024
Automotive	4423.4	4765.8	5147.1	5570.2	5997.4	6449.6	6907.5
Industrial Equipment	3749.9	4025.5	4332.2	4672.3	5015.7	5378.9	5735.5
Aerospace & Defense	3152.5	3389.0	3648.2	3943.7	4235.6	4544.8	4852.9
High-Tech	3084.7	3308.4	3554.8	3828.6	4106.1	4391.5	4677.0
AEC	959.7	1033.6	1114.7	1204.4	1295.4	1389.9	1483.1
Healthcare & Medical Devices	583.8	631.3	683.4	741.1	800.4	862.3	924.8
Consumer Goods and Retail	524.3	566.7	613.2	664.9	715.4	768.0	821.3
Food & Beverage	290.9	314.1	340.0	368.4	397.1	427.6	458.4
Marine & Offshore	257.8	276.3	296.6	318.7	341.5	365.1	388.7
Energy & Utilities	241.5	259.7	279.8	302.2	324.3	347.0	369.6

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Competitive Landscape and Analysis

Quadrant Knowledge Solutions conducted an in-depth analysis of major product lifecycle management vendors by evaluating their products, market presence, and value proposition. The evaluation is based on the primary research with expert interviews, analysis of use cases, and Quadrant's internal analysis of the overall PLM market. This study includes analysis of key vendors, including Aras, Autodesk, Dassault Systemes, Oracle, PTC, SAP, and Siemens.

PTC, Dassault Systemes, and Siemens are the top performers and top three technology leaders in the global product lifecycle management market. These vendors provide a comprehensive technology portfolio with breadth and depth of design, simulation, product data management, innovation, and digital manufacturing solution sets. These vendors are also frontrunners in integrating advanced analytics, 3D visualization, advanced analytics powered by artificial intelligence and machine learning, IoT analytics, additive manufacturing, augmented reality (AR), and other innovative technologies in their PLM solution portfolio. SAP is also positioned in the leader section owning to their comprehensive PLM solution tightly integrated with business systems, collaborative innovation, and analytics capabilities.

PTC Windchill PLM platform integrated with ThingWorx, an industry-leading industrial IoT platform, provides the foundation for the smart, connected enterprise enabling organizations to manage end-to-end processes of the product lifecycle and monitor its operational performance to optimize product quality and performance. PTC offers robust functionalities to support emerging technologies, such as providing virtual reality and augmented reality for multiple industrial use cases, the digital twin of product and production processes, creating and maintaining a digital thread, additive manufacturing, and such others. PTC, with strong overall performance across the parameters of technology excellence and the customer impact, has been positioned as the clear technology leader in the global PLM market.

Dassault Systemes offers deep domain expertise and industry experience with its market-leading PLM solutions. The company is the global market leader with the largest number of PLM software installation. Driven by the comprehensive PLM capabilities and support for advanced PLM functionalities, Dassault Systemes has received strong ratings for technology excellence and the customer impact and has been positioned as the top three technology leaders. Dassault Systemes offers industry-specific solutions for a wide variety of industry verticals to address industry-specific challenges with functional domain expertise.

Siemens Teamcenter PLM platform offers sophisticated PLM functionalities to help industrial companies accelerate product innovation working in a collaborative environment. Siemens is making significant investments in its Digital Innovation Platform strategy, with an open framework to provide multiple integrated applications and solutions supporting the entire lifecycle of the product development and digital enterprise strategy. The company offers the advanced capability for creating a digital

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twin for product, production and performance, and facilitates the integration between them to create a comprehensive digital thread.

SAP continues to gain market traction driven by its substantial presence in providing several fully integrated enterprise business applications, including ERP, CRM, SRM, SCM, and HCM. SAP PLM provides organizations with an ability to perform essential business processes with modular software designed to work with other SAP and non-SAP software. SAP continues to focus on improving advanced PLM capabilities and integrating functionalities to support integrated IoT platform, model-based engineering with integrated digital twin and digital thread strategy, advanced visualization, and such others. With strong overall performance, SAP has received above-average ratings and is positioned amongst the technology leaders in the global PLM market.

The PLM SPARK Matrix also recognizes Oracle, Autodesk, and Aras amongst the major PLM vendors with comprehensive PLM functionalities. These companies provide comprehensive technology capabilities and continue to gain significant market traction in the global PLM market. Autodesk provides a comprehensive application suite for product design, engineering and simulation solution widely accepted by a large number of users from large, mid-sized, and SMB users. The company is recognized for its easy to use and affordable solution for its software applications and PLM platform. With its cloud-first deployment strategy, Autodesk provides enhanced customer ownership experience with increased usability, easy implementation, automatic updates, and flexible to suit growing customer requirements.

Oracle Agile PLM offers enterprise-grade PLM functionalities to help its large enterprise customers centralize product data, streamline processes, and enable faster time to market for introducing new products. Oracle also offers cloud-native and digitally connected Oracle PLM Cloud, a separate solution that provides a digital thread across the entire product lifecycle to improve quality, optimize costs, and accelerate time to market. Oracle continues to invest in strengthening its cloud strategy and is aggressively promoting its cloud-based PLM solutions for both mid-market and large enterprise clients.

Aras is comparatively smaller and the emerging vendor with innovative PLM offerings. The Aras Innovator PLM platform offers strong customer ownership experience with ease of deployment and use. The platform is based on an open architecture that easily connects to authoring tools and enterprise systems and enables manufacturers to upgrade or deploy new features without many customizations. The innovative approach of offering no upfront software licensing fees, with an option to purchase enterprise subscription to utilize Aras support services, is well recognized to provide lower TCO.

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Key Competitive Factors and Technology Differentiators

Followings are the key competitive factors and differentiators for the evaluation of PLM solutions and vendors. While the majority of the PLM vendors may provide all the core functionalities, the breadth and depth of the capabilities may differ by different vendors offerings. Some of the key differentiators include ease of deployment and ownership experience, the sophistication of integrated BOM management, model-based enterprise strategy with digital twin and digital thread technologies, out-of-the-box applications, technology integration & interoperability, advanced analytics, and such others.

- **Deployment and Ownership Experience**: Traditional on-premise PLM solutions are associated with lengthy implementation, complex licensing and upgrades, and large upfront investment. PLM vendors are aggressively investing in building a robust cloud PLM capability to address implementation challenges and target new markets. User organizations are increasingly evaluating the value proposition and vendor's capability in providing single-tenant or multi-tenant SaaS as well as hybrid PLM deployment. However, the PLM deployments continue to be primarily dominated by on-premise deployment by large industrial companies. The prime target for cloud-based deployment remains the emerging market, non-traditional industries, and SMB organizations. As the industrial companies continue to move towards their connected enterprise vision, cloud-based deployment is expected to find significant adoption by organizations across industry verticals. Additionally, PLM vendors continue to improve capabilities to support advanced visualization, analytics, personalization, ease of use, social, and mobile to enhance the overall technology ownership experience.

- **The sophistication of Integrated BOM Management**: Organizations are facing challenges in maintaining consistent product data throughout its product lifecycle. Traditionally, engineering BOM is often modified by the manufacturing planning personnel with manufacturing-specific information to create a new record as manufacturing BOM. This has resulted in increased complexities of BOM management. Additionally, growing product varieties and multiple content authoring by various teams across departments and geographical locations are further adding to the complexities. Organizations are looking at building a unified BOM by synchronizing and integrating engineering BOM to manufacturing BOM to ensure a consistent product definition through design, development, manufacturing, and service. Major PLM solution provides capabilities of integrated BOM management with a single centralized source for all product information across the organization departments and external stakeholders. PLM solutions are also integrated with enterprise systems, including MES and ERP, to manage consistent BOM information across systems and enable efficient execution of product lifecycle processes. This helps organizations in maintaining a consistent product definition with closed-loop lifecycle management from early concept

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development through actual product release and after-sales services. The sophistication of integrated BOM management is amongst the most essential value proposition and technology differentiator.

- **Model-based Enterprise Strategy with Digital Twin and Digital Thread Technologies:** PLM vendors capabilities in providing a robust tool for creating a digital twin of product and production processes are essential to help industrial companies in realizing their digital transformation roadmap. Digital twins are used as an information and behavioral model to understand, simulate, predict, and optimize the performance of a product and production system. Digital twin captures all the changes occurs throughout the product lifecycle stages from concept generation through development, manufacturing, and service, creating a consistent digital thread. Leveraging an integrated PDM platform, PLM vendors enable creating and maintaining a digital thread with up to date and synchronized information throughout the product lifecycle. Digital thread facilitates collaboration between product engineering with manufacturing engineering for creating a consistent 3D model integrated with a digital twin of products and production processes. While leading PLM vendors support model-based engineering with digital twin and digital thread strategies, the effectiveness of the solution capabilities may differ between vendors solution.

- **Out-of-the-Box Applications and Functionalities**: While PLM is considered a mature solution, it still requires significant customization resulting in long implementation cycle, increased costs, and reduced agility to cope up with the future business transformation. The configurable and out-of-the-box application promises to significantly reduce/eliminate customization while enabling configuration to meet organization-specific needs. Majority of the PLM vendors are focusing on offering several out-of-the-box functionalities incorporating customers best practices and with industry collaborations to significantly reduce implementation cost and improve time to market. However, the PLM industry is still striving to achieve a balance between customization versus out-of-the-box functionalities. Quadrant Knowledge Solutions believes that the next generation of PLM evolution with comprehensive and proven out-of-the-box solution is expected to drive the significant technology adoption and market growth. Industrial companies should evaluate PLM vendors with comprehensive, proven, and industry-specific out-of-the-box functionalities to accelerate the deployment process and overall technology ownership experience.

- **Technology Integration and Interoperability**: The scope of PLM solution has expanded from the traditional focus on just design and build processes to include integrated data management and execution of product development processes from concept generation to its retirement within a distributed collaboration framework. PLM capability in providing seamless integration of xCAD with PLM solutions and to the enterprise applications including MES,

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ERP, CRM, SCM, HCM, and others is an important differentiator to support organizations in unifying product and process data across domains and locations. PLM vendors capability may differ in terms of providing system integration and interoperability with upstream business systems as well as downstream technologies.

- **PLM Analytics:** Enterprise organizations are increasingly evaluating PLM capabilities in providing intelligent reporting, rich dashboard, and advanced analytics to monitor development performance and end-to-end program management from product design to change management, traceability, cost, and quality management. PLM analytics capability significantly differs between PLM vendors. Customers may use built-in analytics capability of PLM solution or may use external tools to generate and run reports. PLM vendors continue to focus on improving capability to improve data access, reporting, and analytics to drive enhanced business value through utilizing comprehensive product information generated and available in the PLM/PDM platforms. Additionally, PLM vendors are making significant investments in incorporating advanced analytics, AI, and machine learning technologies to provide advanced predictive insights based on the analysis of the structured datasets from the product design & development, manufacturing, and its operations stages of the product lifecycle.

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SPARK Matrix: Strategic Performance Assessment and Ranking

Quadrant Knowledge Solutions' SPARK Matrix provides a snapshot of the market positioning of the key market participants. SPARK Matrix provides a visual representation of market participants and provides strategic insights on how each supplier ranks related to their competitors, concerning various performance parameters based on the category of technology excellence and customer impact. Quadrant's Competitive Landscape Analysis is a useful planning guide for strategic decision makings, such as finding M&A prospects, partnership, geographical expansion, portfolio expansion, and similar others.

Each market participants are analyzed against several parameters of Technology Excellence and Customer Impact. In each of the parameters (see charts), an index is assigned to each supplier from 1 (lowest) to 10 (highest). These ratings are designated to each market participant based on the research findings. Based on the individual participant ratings, X and Y coordinate values are calculated. These coordinates are finally used to make SPARK Matrix.

Technology Excellence	Weightage
Sophistication of Technology	20%
Competitive Differentiation Strategy	20%
Application Diversity	15%
Scalability	15%
Integration & Interoperability	15%
Vision & Roadmap	15%

Customer Impact	Weightage
Product Strategy & Performance	20%
Market Presence	20%
Proven Record	15%
Ease of Deployment & Use	15%
Customer Service Excellence	15%
Unique Value Proposition	15%

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SPARK Matrix: Product Lifecycle Management (PLM)

Strategic Performance Assessment and Ranking

Figure: 2019 SPARK Matrix
(Strategic Performance Assessment and Ranking)
Product Lifecycle Management (PLM) Market

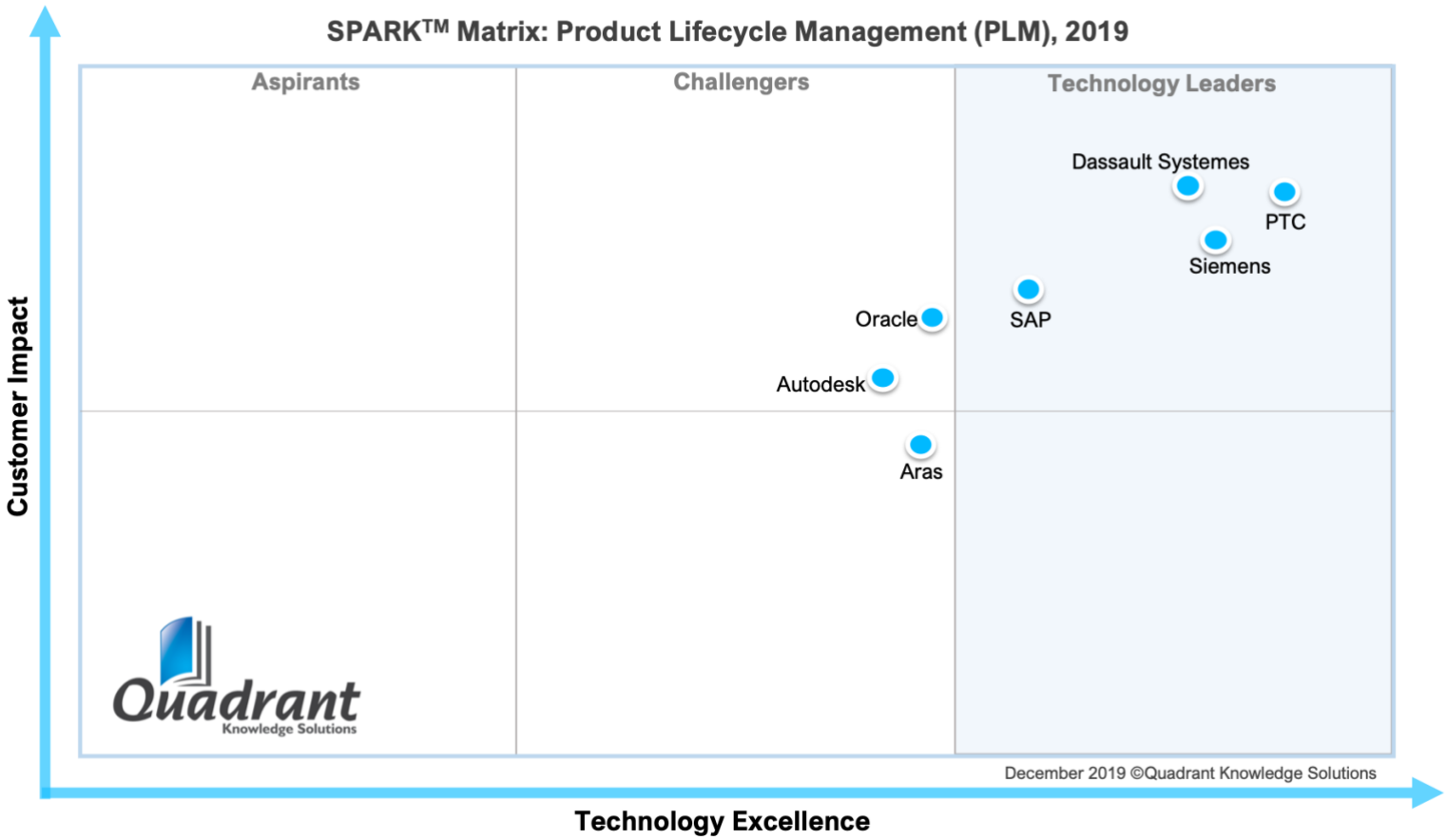

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Figure: 2019 SPARK Matrix Analysis
Technology Excellence: PLM Vendors Performance against Average Rating

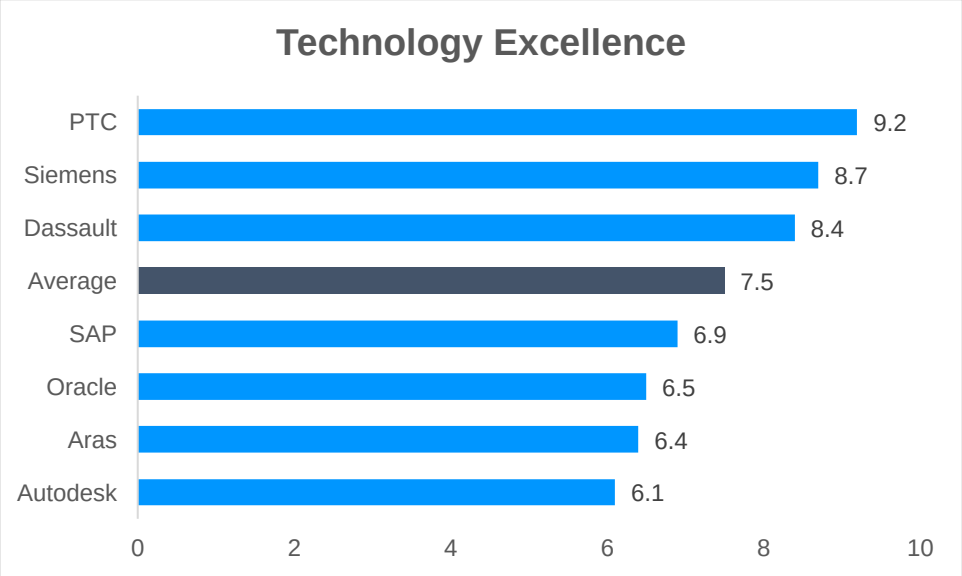
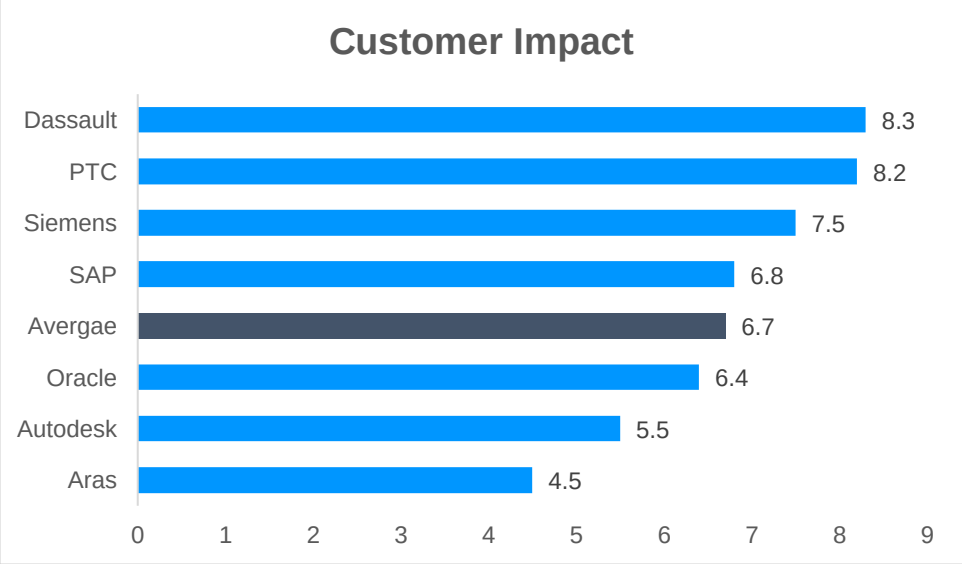


Figure: 2019 SPARK Matrix Analysis
Customer Impact: PLM Vendors Performance against Average Rating



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PTC

URL: https://www.ptc.com/

Founded in 1985, PTC is the leading innovator and provider of 3D, Product Lifecycle, Industrial Orchestration, and Experience Platforms as well as engineering, manufacturing, and service solutions. PTC offers Windchill PLM software, an open and integrated PLM application suite that leverages multiple system data orchestrations for a unified, comprehensive view of the product information and associated BOM, multi-CAD data, and visualization management. Windchill includes various highly tailorable out-of-the-box applications for product data management (PDM), BOM management, change & configuration management, quality management, requirement management (Windchill RV&S), and enterprise visualization with AR. Windchill is available on-premises, in the cloud with PTC cloud or optimized via a strategic partnership with Microsoft Azure, or through a hybrid deployment.

Windchill provides unified views to manage multi-CAD data in a single place with tight integration with Creo, SolidWorks, AutoCAD, and other CAD tools. It enables engineering teams to manage, share, and review their product data from a centralized collaborative environment. With its role-based, self-service applications, and 3D visualization, Windchill enables concurrent engineering and secure sharing of product data to the non-engineering team members with tailored views for different disciplines. Windchill's BOM management allows the organization to adopt a part-centric approach in managing bill of materials by creating a complete, digital BOM in a centralized hub to provide a single source of truth for all product data across the organization.

Windchill's change and configuration management capabilities provide the traceability and governance of changes to a product configuration throughout its lifecycle. Windchill provides change management notifications to CAD designers linked with requirements, helping them to make the right decision based on the most up-to-date product data. The solution improves enterprise visibility, enables the faster and accurate response to the market pressure, and ensures that all stakeholders have access to the most up-to-date product information. Windchill RV&S (formerly Integrity Lifecycle Manager) automatically communicates the product changes and requirements across stakeholders to enhance transparency and create digital product traceability throughout the product lifecycle for better digital design and validation. Windchill's quality management solution connects product quality information with the product information automated quality services. Organizations can feed information about product issues identified during manufacturing, service, or operation, into the lifecycle to enable continuous product improvements.

PTC integrates Windchill with Vuforia, PTC's augmented reality platform, to enable users to create and publish AR experiences easily within the PLM environment, and instantly share with team members across global locations. Users can dynamically visualize, interact, and collaborate with product data through AR experiences for faster

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decision making and to optimize time-to-market. PTC, with its integrations of Windchill, Vuforia, and the ThingWorx Industrial IoT platform, enables organizations to create and maintain a digital thread across enterprise systems with up-to-date and synchronized information throughout the product lifecycle.

Analyst Perspectives: Windchill, with comprehensive, configurable, and out-of-the-box applications for various PLM use cases, is well recognized amongst its customers for managing complexity at scale, delivering a strong customer ownership experience. PTC provides industry-specific configurations, developed in collaboration with its customers, for aerospace & defense, medical devices, and retail & consumer goods sectors. The company provides the foundation for the smart, connected enterprise enabling organizations to maintain a comprehensive digital thread by orchestrating data across product lifecycle stages, from design to engineering, manufacturing, operations, and service. PTC's integrated offerings of Windchill, ThingWorx, and Vuforia help industrial organizations to leverage the digital twin of their product and production processes for improved understanding of their operational performance, and accordingly improve product design for enhanced product performance, quality, and usability. PTC enables organizations to collect and visualize operational data in ThingWorx, integrate it with product data in Windchill, and further enrich the information with other enterprise domain systems with Vuforia.

PTC continues to invest in improving digital thread capabilities, such as enhancing digital twin interfaces to drive data-driven design and AR procedural guidance, AR for industrial use cases to support configuration-specific procedural guidance, and concurrent SaaS-driven engineering, leveraging the recently acquired Onshape. Additionally, the company is also investing in leveraging artificial intelligence for PLM use cases with advanced predictive and prescriptive analytics. PTC has received strong ratings for its sophisticated technology platform, competitive differentiation strategy, scalability, vision & roadmap, and overall customer impact. PTC is positioned as the technology leader in the 2019 SPARK Matrix analysis of the global product lifecycle management market.

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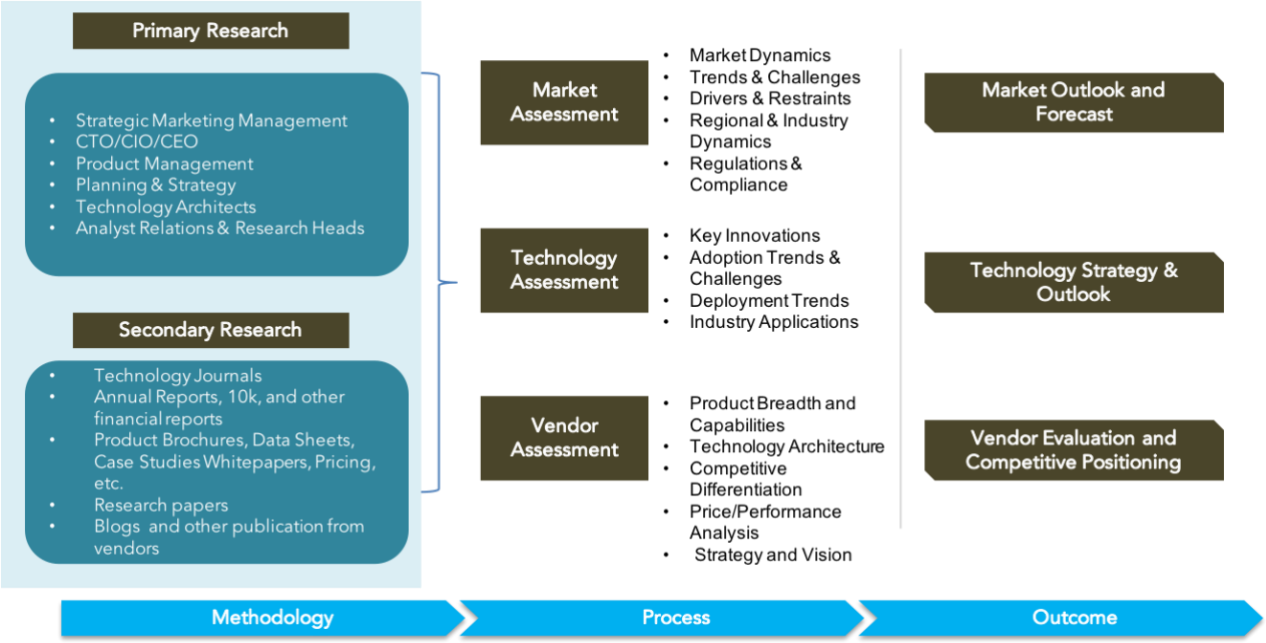
Research Methodologies

Quadrant Knowledge Solutions uses a comprehensive approach to conduct global market outlook research for various technologies. Quadrant's research approach provides our analysts with the most effective framework to identify market and technology trends and helps in formulating meaningful growth strategies for our clients. All the sections of our research report are prepared with a considerable amount of time and thought process before moving on to the next step. Following is the brief description of the major sections of our research methodologies.



Secondary Research

Following are the major sources of information for conducting secondary research:

Quadrant's Internal Database

Quadrant Knowledge Solutions maintains a proprietary database in several technology marketplaces. This database provides our analyst with an adequate foundation to kick-start the research project. This database includes information from the following sources:

- Annual reports and other financial reports
- Industry participant lists
- Published secondary data on companies and their products
- Database of market sizes and forecast data for different market segments
- Major market and technology trends

Literature Research

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Quadrant Knowledge Solutions leverages on several magazine subscriptions and other publications that cover the wide range of subjects related to technology research. We also use the extensive library of directories and Journals on various technology domains. Our analysts use blog posts, whitepaper, case studies, and other literature published by major technology vendors, online experts, and industry news publications.

Inputs from Industry Participants

Quadrant analysts collect relevant documents such as whitepaper, brochures, case studies, price lists, datasheet, and other reports from all major industry participants.

Primary Research

Quadrant analysts use a two-step process for conducting primary research that helps us in capturing meaningful and most accurate market information. Below is the two-step process of our primary research:

Market Estimation: Based on the top-down and bottom-up approach, our analyst analyses all industry participants to estimate their business in the technology market for various market segments. We also seek information and verification of client business performance as part of our primary research interviews or through a detailed market questionnaire. The Quadrant research team conducts a detailed analysis of the comments and inputs provided by the industry participants.

Client Interview: Quadrant analyst team conducts a detailed telephonic interview of all major industry participants to get their perspectives of the current and future market dynamics. Our analyst also gets their first-hand experience with the vendor's product demo to understand their technology capabilities, user experience, product features, and other aspects. Based on the requirements, Quadrant analysts interview with more than one person from each of the market participants to verify the accuracy of the information provided. We typically engage with client personnel in one of the following functions:

- Strategic Marketing Management
- Product Management
- Product Planning
- Planning & Strategy

Feedback from Channel Partners and End Users

Quadrant research team researches with various sales channel partners, including distributors, system integrators, and consultants to understand the detailed perspective of the market. Our analysts also get feedback from end-users from multiple industries and geographical regions to understand key issues, technology trends, and supplier capabilities in the technology market.

Data Analysis: Market Forecast & Competition Analysis

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Quadrant's analysts' team gathers all the necessary information from secondary research and primary research to a computer database. These databases are then analyzed, verified, and cross-tabulated in numerous ways to get the right picture of the overall market and its segments. After analyzing all the market data, industry trends, market trends, technology trends, and key issues, we prepare preliminary market forecasts. This preliminary market forecast is tested against several market scenarios, economic scenario, industry trends, and economic dynamics. Finally, the analyst team arrives at the most accurate forecast scenario for the overall market and its segments.

In addition to market forecasts, our team conducts a detailed review of industry participants to prepare competitive landscape and market positioning analysis for the overall market as well as for various market segments.

SPARK Matrix: Strategic Performance Assessment and Ranking

Quadrant Knowledge Solutions' SPARK Matrix provides a snapshot of the market positioning of the key market participants. SPARK Matrix representation provides a visual representation of market participants and provides strategic insights on how each supplier ranks in comparison to their competitors, concerning various performance parameters based on the category of technology excellence and customer impact.

Final Report Preparation

After finalization of market analysis and forecasts, our analyst prepares necessary graphs, charts, and table to get further insights and preparation of the final research report. Our final research report includes information including market forecast; competitive analysis; major market & technology trends; market drivers; vendor profiles, and such others.

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