

Market Outlook: Product Lifecycle Management (PLM), 2018-2023, Worldwide

December 2018

Executive Overview

This research service includes a detailed analysis of the global product lifecycle management (PLM) market regarding short-term and long-term growth opportunities, emerging technology trends, market trends, and future market outlook. The study also provides a detailed 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. All figures in this research document are in millions of USD unless otherwise stated.

Key Research Findings

Followings are the key research findings:

Deployment Trend:

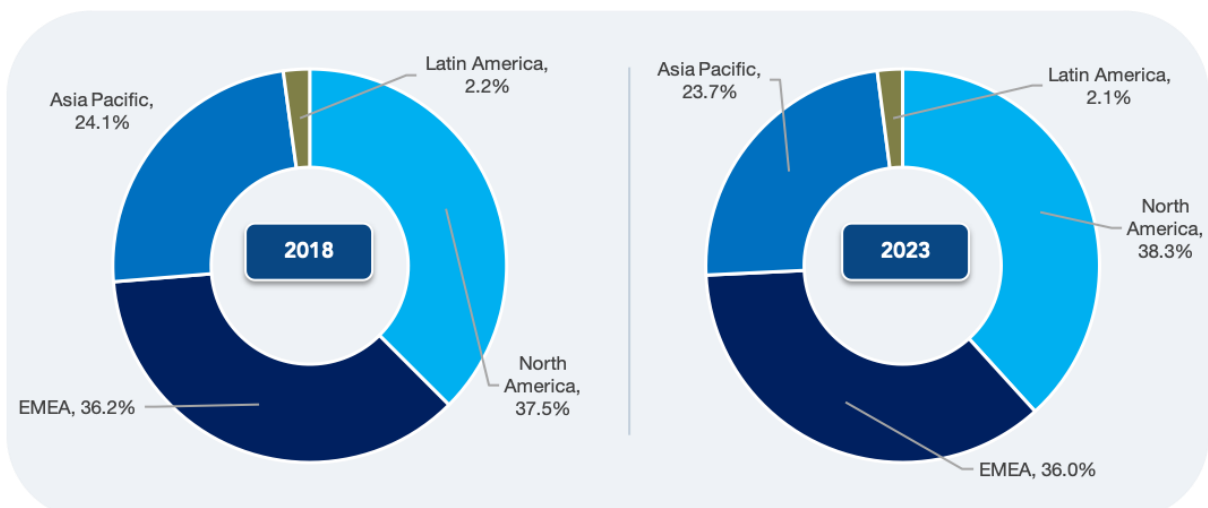
PLM market is expected to grow at a CAGR of 7.2% from 2018-2023

Global PLM market is expected to increase significantly in the next five to six years from the market size of \$18.57 billion in 2018 to over \$26.33 billion by 2023. The global PLM market is expected to grow at a compound annual growth rate (CAGR) of 7.2% from 2018-2023.

Regional Trends:

North America region continues to dominate the global PLM market as well as market growth throughout 2018-2023

Figure: Revenue Share by Geographical Regions
2018 vs. 2023



Majority of the PLM software market revenue is coming from North America and EMEA regions. Together, they constitute 73.7% of the total market revenue with an individual share of 37.5% and 36.2% respectively. 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. North Americas and EMEA region are expected to grow at a CAGR of 7.7% and 7.1% respectively during 2018-2023.

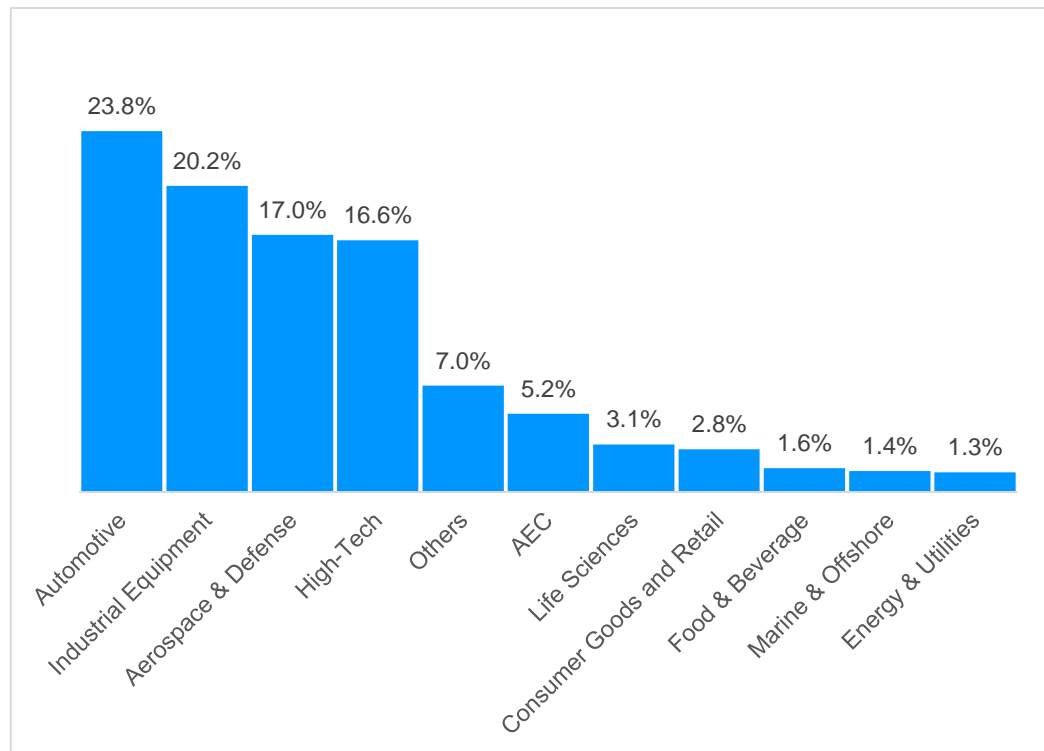
Industry Vertical Trend:

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

Automotive & transportation, industrial equipment, aerospace & defense (A&D), and high technology industry sectors are the primary users of PLM solution, and they contribute 23.8%, 20.2%, 17.0%, and 16.6% respectively to the global market revenue in 2018. These sectors are expected to grow at a CAGR of 7.4%, 7.1%, 6.8%, and 7.2% respectively from 2018-2023. PLM solution deployment and value proposition are no longer limited to discrete industries as vendors have significantly improved their technology value proposition to target diverse industry sectors. PLM vendors continue to make in-roads into the emerging market applications and emerging industries. While discrete industries are

Figure: Revenue Share by Industry Verticals

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



still the primary market for vendors, non-traditional industries such as consumer packaged

goods, life sciences, food & beverage, shipbuilding, energy & utilities, chemicals, medical devices and others are increasingly embracing advanced PLM technologies. In terms of market growth, life science, food & beverage, architecture, engineering, & construction (AEC), and consumer goods & retail sectors are expected to grow at the highest CAGR of 8.1%, 8.0%, 8.0%, and 7.8% respectively.

Competition Dynamics & Trends:

The sophistication of technology platforms, integrations & APIs, are amongst the top competitive differentiators

PTC, Dassault Systemes, and Siemens are the top performers and the top three technology leaders in the global PLM 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 visualization, analytics, IoT, collaborative engineering, and other innovative technologies in their PLM solution portfolio. SAP is also positioned in the leader section owing to their comprehensive PLM solution tightly integrated with business systems, collaborative innovation, and analytics capabilities.

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 a 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 by incorporating emerging technology trends.

Large manufacturing organizations are often associated with a 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 difficult to integrate with enterprise business systems.

Large industrial companies are either in the midst of 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.
- ◆ **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 include 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.

Market Adoption and Deployment Trends

PLM solution market is expected to grow significantly in the next four to five years.

- ◆ PLM market adoption is primarily driven by organizations digital transformation and Industry 4.0 initiatives, IoT implementations, upgrade from traditional PLM solutions, and the importance of PLM solutions to support customer-centric product development approach. Organizations across industry sectors well understand PLM value proposition in accelerating innovation, improving product quality, and reducing time to market in the present dynamic and competitive market. Global PLM market is expected to grow from an estimated market size of \$18.57 billion in 2018 to reach over \$26.33 billion by 2023.
- ◆ The global PLM market which has grown by 6.5% in 2018 is expected to grow at a CAGR of 7.2% from 2018-2023. Global PLM vendors continue to gain market traction for a greenfield opportunity in the emerging markets and industries and a brownfield upgrade opportunity from existing users.
- ◆ The growing popularity of PLM functionalities to support advanced visualization, predictive analytics, additive manufacturing, and model-based engineering and manufacturing are accelerating the technology adoption. Besides, cloud PLM market is also gaining increasing market traction amongst SMB sectors and non-traditional industries. 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.
- ◆ PLM solutions are well accepted as a core technology solution in designing and developing the next generation of smart connected products and intelligent factories. PLM vendors are also accelerating the value proposition by improving integration capabilities with enterprise business systems and supply chain solutions.
- ◆ On deployment type, PLM market is primarily dominated by on-premise deployments capturing 83.8% of the global market compared to 16.2% of the SaaS-based deployments in 2018. On overall revenue type, professional services capture 57.2% of the total PLM market in 2018. Regarding market trends, on-premise deployment is expected to remain a preferred choice especially by large organizations from traditional 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 2018-2023. Cloud PLM solution promises to reduce/eliminate the users' primary challenges related to implementation, customization, software upgrades, and higher licensing costs.

Figure: Market Adoption Trends

PLM market is expected to grow at a CAGR of 7.2% from a forecasted period of 2018-2023.

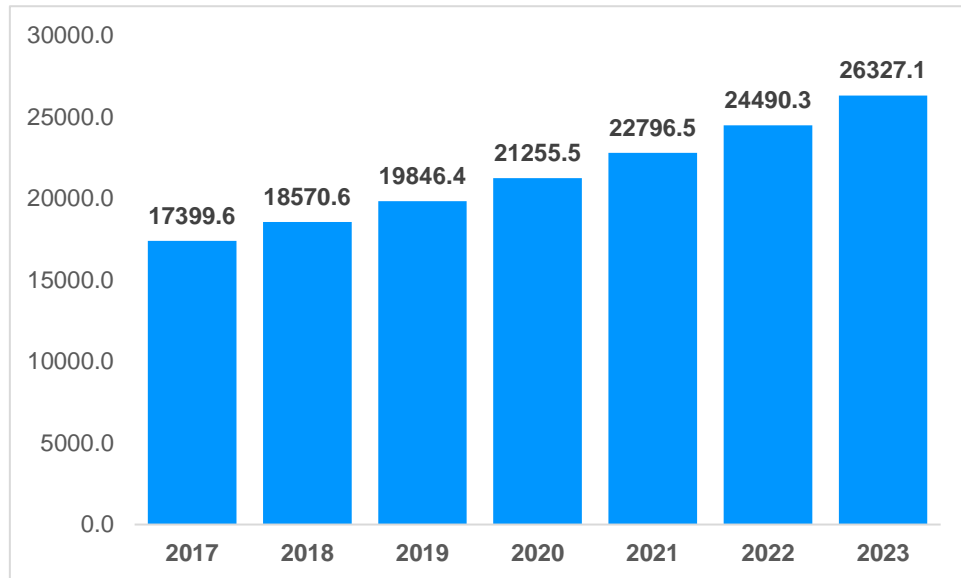
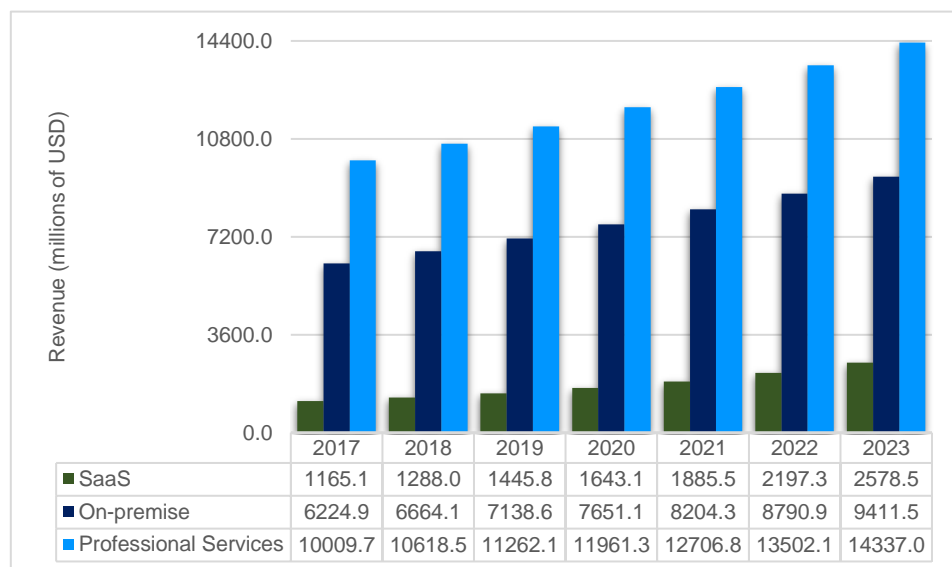


Figure: Revenue and Deployment Trends

On-premise deployment is expected to remain the preferred choice for the adoption of PLM solutions during 2018-2023



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

Digital transformation trends are prompting 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 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 systems. Additionally, it is creating additional revenue form PLM vendors in addressing complexities of smart product and processes across industry segments.

Increasing Demand for PLM Functionalities to Support Emerging 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 for incorporating emerging technologies such as additive manufacturing, virtual reality (VR), and augmented reality (AR).

- ◆ 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 parts that otherwise require complex machining. This helps in eliminating tooling costs for obsolete service parts.
- ◆ PLM vendors continue to improve 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 a 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 improve operational efficiency and reduce time to market significantly.

Increasing Integration of PLM Solution with IoT Platforms

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 operational data into PLM platforms to gain insights into how products are performing in the field enabling 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.

Growing Popularity of Cloud PLM Solution

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. However, traditional PLM vendors are making a significant investment in improving cloud PLM capabilities for private, multi-tenant and hybrid deployments. Majority of the current cloud PLM deployments is focused on the non-tradition industries and SMB organizations.

Evolution of PLM Solution towards Product Innovation Platform

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 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 building 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.

Regional Trends and Forecasts

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

Majority of the PLM software market revenue is coming from North America and EMEA regions. Together, they constitute 73.7% of the total market revenue with an individual share of 37.5% and 36.2% respectively. 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.

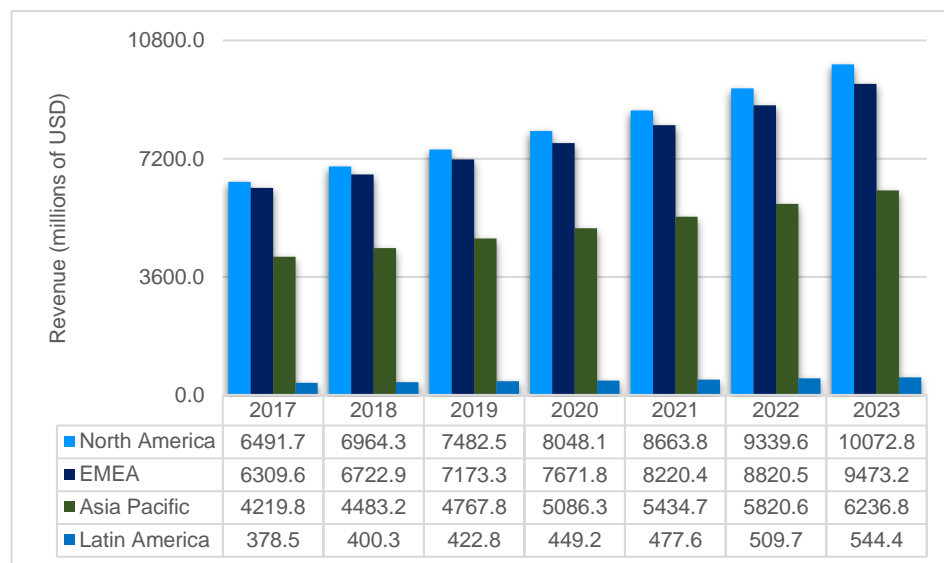
- ◆ North America region is considered to be an early adopter in embracing next-generation of emerging technologies. North America region is also the front-runner in embracing various next generation of technologies including internet of things (IoT), connected industries and infrastructure, advance telecommunication technologies (4G, 5G, LTE), advanced analytics, additive manufacturing, augmented reality, artificial intelligence & machine learning platform, and such others. Large industrial companies in the regions are increasingly adopting and upgrading their PLM solution to accommodate long-term technology trends into their enterprise to support customer-centric product development, marketing, and support. In the global PLM market analysis, North Americas region which currently holds 37.5% of the market share in 2018, is expected to grow at the highest CAGR of 7.7% from 2018-2023.
- ◆ EMEA market growth is primarily driven by increasing adoption in markets, including Germany, UK, France, Middle East countries, South Africa and others. PLM software demand is growing in these regions due to widespread adoption of digital transformation strategy with industry 4.0, IoT, and connected value chain initiatives. EMEA region currently holds 36.2% of the total PLM market and is expected to grow at a CAGR of 7.1% during 2018-2023.
- ◆ 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. The market growth is primarily driven by increasing industrial and infrastructure expansion activities in China and India. 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 PLM market in Japan is almost flat, PLM vendors are finding market growth in Australia and New Zealand regions. Asia

Pacific region currently holds 24.1% of the total PLM market and is expected to grow at a CAGR of 6.8% during 2018-2023.

- ◆ Asia Pacific market, which constitutes 24.1% of the total market in 2018, is expected to grow at a CAGR of 6.8% during 2018-2023 driven by rapid adoption in China, India Australia, New Zealand and improved penetration rate in Hong Kong, Malaysia, and Thailand. PLM vendors are also finding increasingly market traction from the Latin America region; however, the market growth continued to be below average compared to the global adoption trends. Latin America region currently holds 2.2% of the global PLM market is expected to growth at a CAGR of 6.3% during 2018-2023.

Figure: Market Forecast by Geographical Regions

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



Industry Forecasts and Trends

PLM solution deployment and value proposition are no longer limited to discrete industries as vendors have significantly improved their technology value proposition to target a diverse industry sector. PLM vendors continue to make in-roads into the emerging market applications and industries. While discrete industries are still the primary market for vendors, non-traditional industries such as consumer packaged goods, life sciences, food & beverage, shipbuilding, energy & utilities, chemicals, medical devices, retail, and others are embracing advanced PLM technologies.

Digital transformation trends are leading to widespread adoption of smart products, intelligent factories, and connected value chain solutions. Additionally, 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 a complex process of specification, design, and validation. 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 and factories. This trend is expected to play a significant role in the adoption of advanced PLM functionalities across industry verticals to support the vision of connected industries and enterprise.

Followings are the adoption trends by major industry segments:

- ◆ Over 77.7% of the global PLM market is dominated by primary industries including automotive & transportation, industrial equipment, aerospace & defense, and high technology industries with a market share of 23.8%, 20.3%, 17.1%, and 16.6% respectively.
- ◆ **Automotive, rail and mobility** industry is in the midst of significant disruption and revolution with the growing popularity of autonomous vehicles, shared mobility, and electric vehicles. Electric vehicles and autonomous transportation are significantly driving the industrial transformation and adoption of advanced PLM 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 23.8% in 2018 and is expected to hold 24.0% of the total market by 2023. The automotive sector is projected to grow at an above average CAGR of 7.4% from 2018-2023.

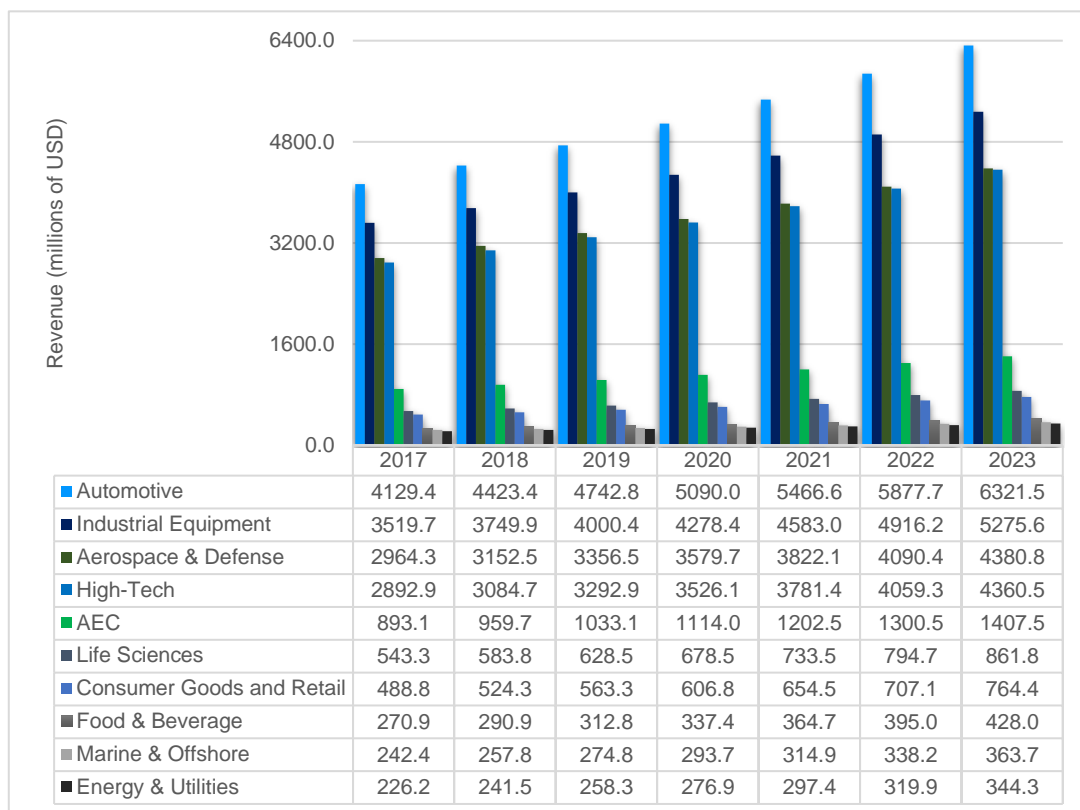
- ◆ **Investment in the aerospace & defense** industry is rising with growing demands for commercial aviation, space systems, and rising defense spending. However, A&D industry is facing challenges of rising customer expectations, cost escalations, complex regulations & certification requirements, global competition, and increasing program complexities. A&D organizations are increasingly adopting an integrated PLM solution with integrated program planning & execution capabilities. 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 2018 and is expected to hold 16.6% by 2023 and is expected to grow at a CAGR of 6.8% from 2018-2023.
- ◆ **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 2018 and is expected to hold 20.0% by 2023 and is expected to grow at a CAGR of 7.1% from 2018-2023.
- ◆ **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 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 customer experience. The high-tech sector currently holds a market

share of 16.6% in 2018 and is expected to hold 16.6% by 2023 and is expected to grow at a CAGR of 7.2% from 2018-2023.

- ◆ 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. Regarding market growth, life science, food & beverage, architecture, engineering, & construction (AEC), and consumer goods & retail sectors are expected to grow at the highest CAGR of 8.1%, 8.0%, 8.0%, and 7.8% respectively.

Figure: Market Forecast by Industry Verticals

Life science, food & beverage, AEC and consumer goods & retail sectors are expected to grow at the highest CAGR of 8.1%, 8.0%, 8.0%, and 7.8% respectively.



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 Autodesk, Dassault Systemes, IFS, Oracle, PTC, SAP, and Siemens.

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 bill of material (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 substantial 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 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 the increased complexities of BOM management. Additionally, growing product varieties and multiple content authoring by multiple 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. Leading 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 development through actual product release and after-sales services. The sophistication of integrated BOM management is amongst the essential value proposition and technology differentiator.

- ◆ **Model-based Enterprise Strategy with Digital Twin and Digital Thread Technologies:** 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. Digital thread facilitates collaboration between product engineering with manufacturing engineering for creating a consistent 3D model integrated with the digital twin of products and production processes. While leading PLM vendors supports 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 a 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, ERP, CRM, SCM, and other is an important differentiator to support organizations in unifying product and process data across domains and locations. PLM vendors capability may differ concerning 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 the capability to improve data access, reporting, and analytics to drive enhanced business value by utilizing comprehensive product information generated and available in the PLM/PDM platforms.

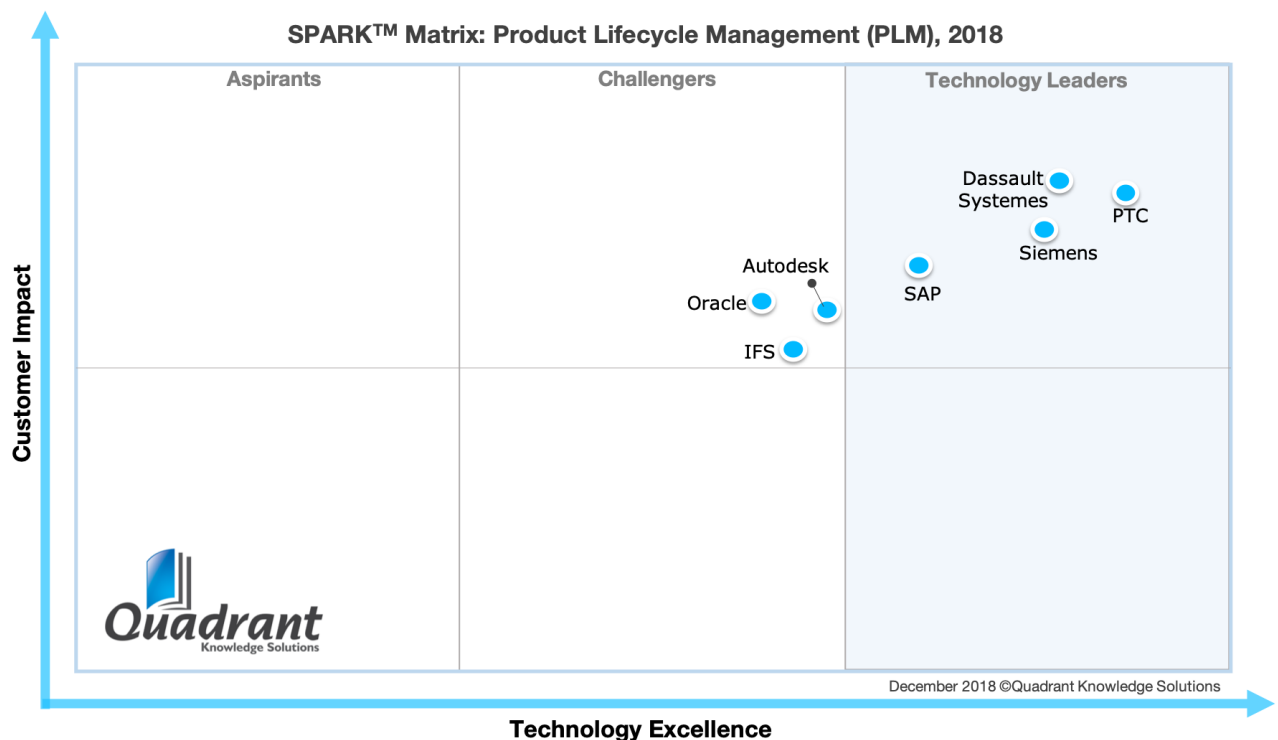
SPARK Matrix: Product Lifecycle Management (PLM)

Strategic Performance Assessment and Ranking

SPARK Matrix provides a visual representation of market participants and provides strategic insights on how each vendor ranks related to their competitors, concerning various performance parameters based on the category of technology excellence and customer impact. Quadrant's SPARK Matrix 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.

Figure: 2018 SPARK Matrix
(Strategic Performance Assessment and Ranking)
Product Lifecycle Management (PLM) Market



Leading Vendors Profile

Following are the profiles of the top five PLM vendors with the global impact. Quadrant research team derived this information from the company's website, whitepapers, and discussions with senior executives. A detailed vendor profile and analysis along with various competitive scenarios is available as a custom research deliverable to our clients. Users are advised to directly speak to respective vendors for a more comprehensive understanding of their technology capabilities. Users are advised to consult Quadrant Knowledge Solutions before making any purchase decisions, regarding PLM technology and vendor selection based on research findings included in this research service.

PTC

Founded in 1985, PTC is the leading innovator and provides industrial IoT platforms, PLM, and digital transformation solutions. PTC's PLM portfolio includes Creo View, ThingWorx Navigate, Integrity, and Windchill platform. Creo View is a scalable visual collaboration solution that enables users to share 3D CAD information internally and with outside partners without the need for native authoring applications. This helps organizations in improving collaboration and accelerating the design processes. ThingWorx Navigate includes the out-of-the-box role and task-based applications that provide contextualized information, and it can be customized to suit specific business requirements. PTC Integrity Lifecycle Manager automatically communicates the product changes and requirements across stakeholders to enhance transparency and create digital product traceability throughout the product lifecycle. PTC Windchill is an open and integrated PLM application suite that uses multiple system data orchestration for a comprehensive view of the product information and associated BOM, multi-CAD data, and visualization management. The company supports a wide range of configurable and out-of-the-box applications, including BOM management, change & configuration management, quality management, requirement & validation management, component & supplier management, PDM, MOM, collaboration, service & part information, project management, and such others. The Windchill platform supports visual engagement with 3D data visualization on screen or through augmented reality. The company also offers FlexPLM, an industry-specific PLM solution for retailers. PTC platform can be deployed on-premise, in the cloud, or as fully-hosted SaaS-based deployment.

Key Strengths:

- ◆ PTC with its comprehensive solution portfolio has received strong ratings for its sophisticated technology platform, competitive differentiation strategy, application diversity, ease of deployment & use, and overall customer impact. Based on the strong overall ratings, PTC has emerged as the clear technology leader in the global PLM market.

- ◆ PTC successfully combines PLM capability with its ThingWorx IoT technology to enable manufacturers to connect their product's operational data to the platform. This allows product planning and quality teams to monitor product's operational performance and accordingly improve their product's value proposition, quality, and usability.
- ◆ PTC Windchill platform supports role-based and task-based applications that enables a more significant number of stakeholders across the organization to access product information from multiple sources based on user-specific needs.
- ◆ Leveraging Vuforia an industrial augmented reality solution, PTC provides unique capability of incorporating AR and immersive experience to improve and accelerate the product development process.

Dassault Systèmes

Dassault Systemes has the largest number of PLM customers across global regions and offers comprehensive PLM functionalities to support customers throughout product lifecycle stages. Dassault major PLM products include CATIA, SOLIDWORKS, ENOVIA, DELMIA and SIMULIA. CATIA includes applications for design/styling, engineering, and system engineering to enable organizations to boost innovation, the rapid development of mechanical products, and cross-discipline complete system development process. SOLIDWORKS solution helps in simplifying complex design and engineering processes. It includes multiple applications, including 2D CAD, 3D CAD, CAM, collaboration, and electrical design, online configuration, PDM, and simulation, and communication. ENOVIA is a collaborative innovation platform for PDM and includes a broad portfolio of applications to enable stakeholders across the enterprise to collaborate on globally consistent product information. It includes applications for business modelling & planning, product configurations, and quality and compliance management. DELMIA solution includes disciplines for collaborative operations, digital manufacturing, manufacturing operations management, and supply chain planning & operations. DELMIA solution provides advanced 3D visualization capability to enable organizations to experience their entire production system and supply chain in a virtual environment. SIMULIA is a simulation solution to explore product behavior for its performance, reliability, and safety early in the lifecycle. Dassault Systemes also offers EXALEAD application for PLM analytics and GEOVIA for environment sustainability solution. Additionally, the company offers 3DVIA, an industry-specific consumer experience solution for retail and brand manufacturers for 3D space planning.

Key Strengths:

- ◆ Dassault Systemes is the global market leader with the largest number of PLM users due to its deep capabilities in providing advanced PLM solutions. Driven by its comprehensive PLM capabilities and support for advanced functionalities,

Dassault Systems have received strong ratings for technology excellence and the higher ratings for customer impact. Based on the strong overall ratings, Dassault Systemes has been positioned as the top three technology leader in the global PLM market.

- ◆ The company offers 3DEXPERIENCE platform based on 3D design, analysis, simulation and intelligent software in a collaborative, interactive environment. The platform provides a collaborative and integrated environment to connect all of its PLM applications. The platform with several out-of-the-box solution capabilities helps organizations in improving the overall business experience to create differentiating consumer experiences.
- ◆ Dassault Systemes offers industry-specific solutions for a wide variety of industry verticals to address industry-specific challenges with functional domain expertise.
- ◆ Dassault Systemes is committed to supporting organizations with a long-term vision for their digital transformation journey and support functionalities for emerging technologies including additive manufacturing, digital twin, social collaboration, augmented and virtual reality.

Siemens

Headquartered in Plano, Texas, Siemens PLM Software is a business unit of the Siemens Digital Factory Division of Siemens AG. Siemens PLM solution portfolio includes NX, Teamcenter, Simcenter, Tecnomatix, and PLM components. Siemens NX is an integrated solution for design, engineering, and manufacturing solution (CAD, CAE, CAM). With its integrated toolset, it supports collaboration, preserves data integrity and design intent, and transforms the complete product development processes. Teamcenter is Siemens PDM platform that provides a centralized repository to manage product data and processes. Leveraging Teamcenter organizations can manage product data and multi-CAD & multi-domain design processes, including 3D designs, electronics, embedded software, documentation, and BOM in a single centralized environment. Teamcenter includes a broad set of solutions including BOM management, change management & workflow, document management, environment compliance & sustainability, manufacturing process management, materials data & lifecycle management, system engineering, process configuration, product cost management, product requirement engineering, program planning & project execution, simulation management, software design & asset management, sourcing & supplier integration, search & analytics, visualization, and such others. Tecnomatix is a comprehensive portfolio of digital manufacturing solution. Tecnomatix allows the organization to achieve synchronization between product engineering, manufacturing engineering, production, and service operations to optimize efficiency and realize innovative ideas into real products. Leveraging Teamcenter, it helps in bridging the gap between product design and delivery by managing the design and execution of manufacturing processes. Simcenter helps in deploying predictive engineering analytics (PEA) approach to support closed-loop, systems-driven product

development. It allows organizations to build and maintain the digital twin to enable realistic product performance prediction. Siemens PLM supports flexible deployment and offers on-premise as well as cloud-based deployments.

Key Strengths:

- ◆ Siemens continues to invest 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 platform provides seamless integration of its multiple solutions including PLM, EDA, ALM, MOM, TIA, and IoT.
- ◆ Siemens with its comprehensive PLM capabilities and technology strategy has received strong ratings for its sophisticated technology platform, application diversity, competitive differentiation strategy, and overall customer impact. With its strong overall ratings, Siemens is positioned as the top three technology leaders in the global PLM market.
- ◆ Siemens offers the advanced capability for creating a digital twin for product, production and performance and facilitate integration between them to create a digital thread.

SAP

SAP is amongst the widely recognized and the largest provider of enterprise business application. SAP PLM is part of the SAP Business Suite along with other fully integrated business applications, including ERP, CRM, SRM, SCM, and HCM. SAP PLM suite. 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 offers a comprehensive solution for collaborative PDM, portfolio and project management, BOM, quality management, collaborative development, documentation management, change management, innovation management, and such others. SAP PLM suite provides an integrated software solution to support all product-related processes from its ideation through manufacturing to product service. It also provides an integrated solution for managing a single source of all product related information to enable multi-discipline collaboration. Leveraging SAP Visual Enterprise, the company provides advanced visualization and digital mock-up capabilities to support model-based engineering. SAP is focusing on improving its capability for authoring tools to enhance the overall value proposition of its PLM offerings. Additionally, SAP is looking at improving multi-disciplinary collaboration solution for mechanical, electric/electronic, and software, advanced functionalities for model-based engineering with digital twin strategy, advanced visualization, and such others.

Key Strengths:

- ◆ SAP PLM provides seamless integration capability with its enterprise business application suite widely deployed amongst the world's largest enterprise organizations. With its integrated SAP Business Suite, the company is successfully leveraging its existing customer base to provide advanced PLM functionalities to support connected enterprise strategy.
- ◆ SAP continues to focus on improving advanced PLM capabilities and integrating functionalities to support integrated IoT platform, model-based engineering, digital twin and digital thread, and such others.
- ◆ With its strong technology capability and customer value proposition, SAP has received strong overall ratings for technology excellence and customer impact and has been positioned in the leadership section of the SPARK Matrix.

Autodesk

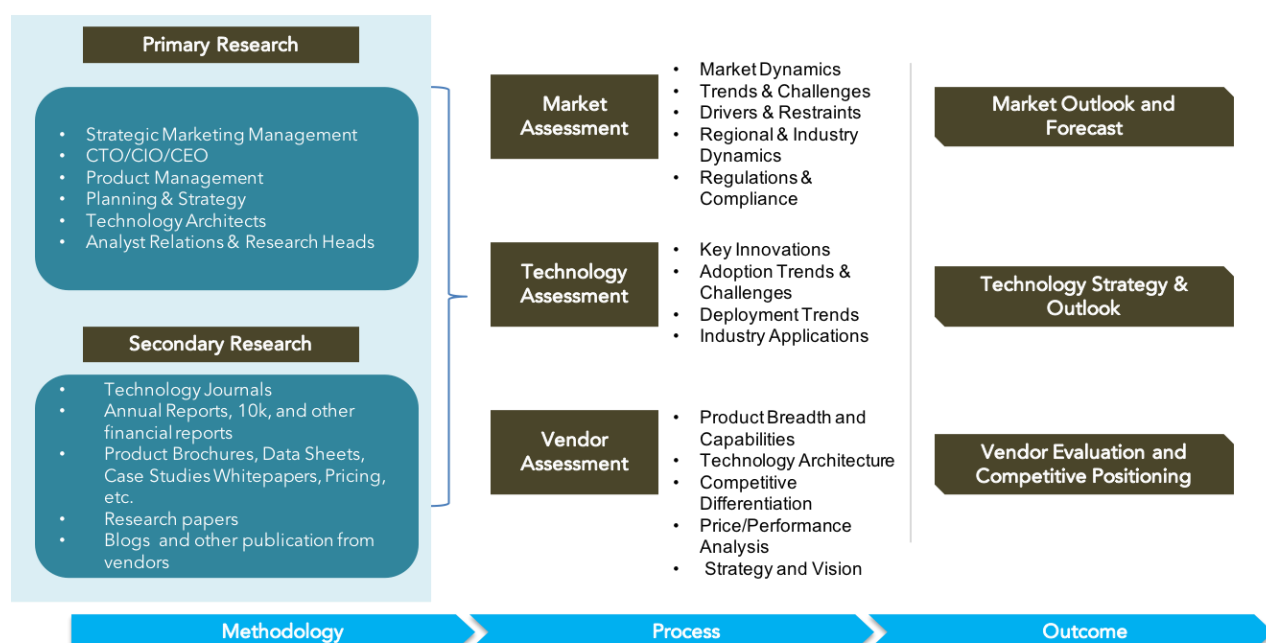
Autodesk is amongst the most recognized vendor in the 2D and 3D design, engineering, and entertainment software. Autodesk Fusion Lifecycle is a multi-tenant SaaS-based PLM solution which can be accessed from any device using the browser or native iOS and Android apps. Autodesk PLM capabilities include new product introduction (NPI), BOM management, change management, quality management, supplier collaboration, and product data management (PDM). Autodesk NPI provides program management capabilities with functionalities for configurable process workflows, project management, task management, and dashboard & reporting to monitor real-time status and trends. Autodesk configurable BOM management enables organizations to manage structured BOMs and items in a centralized system and provides real-time and context-specific product information to all the stakeholders. Also, it enables organizations to perform interactive BOM comparison on different revisions and configurations efficiently. Change management application provides a collaborative environment for managing product changes that are fully defined, reviewed, approved and implemented. Quality management application provides a closed-loop system to visualize product quality data and critical processes to prevent and rapidly respond to quality issues. Supplier Collaboration provides a single and secure environment for managing comprehensive supplier information and enables collaboration between global supply chain partners. Autodesk Vault PDM solution enable engineering teams to organize, manage, share, and track consistent product data across teams in a collaboration environment. Autodesk also provides application suites for design and simulation with key products including Fusion 360, AutoCAD, 3D Max, and Inventor. Fusion 360 is an integrated platform for CAD, CAM, and CAE software. AutoCAD is a software application for 2D and 3D CAD. 3ds Max is a solution for 3D modelling, animation, and rendering software for game-like design visualization and virtual reality experience. Inventor is a 3D CAD software for 3D mechanical design, documentation, and product simulation tool.

Key Strengths:

- ◆ 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 ownership experience with increased usability, easy implementation, automatic updates, and flexible to suit growing customer requirements.
- ◆ Autodesk has received good overall ratings regarding technology excellence and customer impact and has been positioned amongst the top five vendors in the global market.

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

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 a 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. 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 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

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.

Competitive Factor Analysis – Technology Excellence						
	Sophistication of Technology	Technology Application Diversity	Scalability	Competitive Differentiation & Strategy	Industry Impact	Final Rating
Weightages	20%	20%	20%	20%	20%	100%
Leader						
Competitor 1						
Competitor 2						
Competitor 3						

Source: Quadrant Knowledge Solutions

Competitive Factor Analysis – Customer Impact						
	Addressing Unmet Needs	Product Performance	Proven Record	Ease of Deployment	Customer Service Excellence	Final Rating
Weightages	20%	20%	20%	20%	20%	100%
Leader						
Competitor 1						
Competitor 2						
Competitor 3						

Source: Quadrant Knowledge Solutions

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.