a. **Market in which product and service will be launched into:**

Predictive maintenance is a proactive maintenance strategy that uses data analysis tools to identify equipment problems before they occur. By analyzing data from sensors and other sources, predictive maintenance can identify patterns and anomalies that indicate potential equipment failures. This allows maintenance teams to take corrective action before a failure occurs, reducing downtime and maintenance costs.

Machine learning for predictive maintenance can be applied in various markets and industries where equipment or assets require regular maintenance to prevent breakdowns and optimize their performance. Some of the key markets where predictive maintenance using machine learning is commonly applied include:

1. Manufacturing: Predictive maintenance can help manufacturing industries optimize their production processes by predicting failures or malfunctions in machinery and equipment. This ensures minimal downtime and reduces maintenance costs.
2. Energy and Utilities: Power plants, renewable energy facilities, and utility companies can leverage machine learning for predictive maintenance to monitor and predict the health of their infrastructure, such as turbines, generators, transformers, and transmission lines. This helps prevent costly failures and improves overall operational efficiency.
3. Transportation and Logistics: In the transportation sector, predictive maintenance can be applied to vehicles, aircraft, railways, and shipping fleets. By analyzing sensor data and historical maintenance records, machine learning models can predict maintenance needs, avoid unexpected breakdowns, and optimize maintenance schedules.
4. Oil and Gas: In the oil and gas industry, predictive maintenance can be used to monitor critical equipment like pumps, compressors, pipelines, and refineries. By identifying potential failures in advance, companies can reduce downtime, minimize safety risks, and optimize maintenance activities.
5. Healthcare: Predictive maintenance can be beneficial in healthcare facilities to monitor and maintain medical equipment such as MRI machines, X-ray systems, and patient monitors. Machine learning algorithms can detect anomalies and predict maintenance requirements, ensuring continuous availability of essential medical equipment.
6. Telecommunications: Telecommunication networks rely on various components such as routers, switches, and servers. Predictive maintenance using machine learning can help identify potential issues or degradation in network infrastructure, enabling proactive maintenance and minimizing service disruptions.
7. Aerospace and Defence: In the aerospace and defense sectors, predictive maintenance can be applied to aircraft, military vehicles, and defense systems. By analyzing sensor data and other relevant parameters, machine learning algorithms can predict maintenance needs, improve operational readiness, and reduce costs.

These are just a few examples of markets where machine learning for predictive maintenance can be applied. In general, any industry that relies on critical equipment or assets can benefit from predictive maintenance to optimize performance, reduce costs, and enhance overall operational efficiency.

b. <u>Data/statistics regarding that market online:</u>

Top predictive maintenance companies using AI

1: IBM

IBM Watson IoT is at the forefront of predictive maintenance with its comprehensive suite of tools and technologies. Leveraging AI and ML, the company's solutions analyse vast amounts of data to detect anomalies and predict equipment failures, enabling businesses to implement timely maintenance strategies.
IBM Predictive Maintenance and Quality is an integrated solution that companies can use to:

- Predict the failure of an instrumented asset so that you can prevent costly unexpected downtime.
- Make adjustments to predictive maintenance schedules and tasks to reduce repair costs and minimize downtime.
- Quickly mine maintenance logs to determine the most effective repair procedures and maintenance cycles.
- Identify the root cause of asset failure faster so that you can take corrective actions.
- Identify quality and reliability issues definitively and in a timely way.

IBM Watson IoT's predictive maintenance capabilities have been adopted by organizations across various industries, including manufacturing, energy, and transportation.

2: Siemens
Siemens, a global powerhouse in engineering and technology, offers a range of predictive maintenance solutions for industries such as manufacturing, energy, and healthcare. Siemens' solutions empower businesses to detect anomalies, predict failures, and schedule maintenance activities strategically.

In 2022, Siemens announced it had acquired Senseye, a leading provider of outcome-oriented predictive maintenance solutions for manufacturing and industrial companies. Senseye Predictive Maintenance enables asset intelligence across all your plants without the need for manual analysis. Combining leading AI with human insights, the platform helps organisations to increase productivity, work more sustainably, and accelerate digital transformation.

3: SAP
SAP, a leading provider of enterprise software, has ventured into the predictive maintenance arena with its intelligent asset management solutions. SAP's platform utilises AI and machine learning algorithms to analyse sensor data, identify patterns, and forecast potential failures. By integrating predictive maintenance capabilities with other enterprise systems, SAP enables businesses to optimise maintenance operations and reduce costs.

4: General Electric
General Electric (GE) is renowned for its innovative approach to predictive maintenance. GE Digital SmartSignal has been a leading predictive maintenance software solution across industries for nearly two decades, with continuous investment in analytics breadth and innovation. Its Digital Twin solution enables industrial companies to predict, diagnose, forecast, and prevent downtime of critical equipment.

5: Uptake
Uptake is a leader in predictive analytics SaaS, working to translate data into smarter operations.
Uptake specialises in industrial AI and analytics solutions, offering predictive maintenance capabilities for various sectors, including manufacturing, energy, and transportation. Uptake's platform combines data science, ML, and domain expertise to deliver actionable insights. By leveraging real-time data from sensors and other sources, Uptake's solutions predict equipment failures, optimise maintenance schedules, and improve asset reliability.

Statistics and achievements of companies:

U.S. industrial products manufacturer

Achievements: PdM saves millions of dollars in unplanned downtime and Mike Macsisak, a maintenance veteran, has seen it happen throughout his career. In his current role setting up a PdM program for a U.S. manufacturer of industrial products, steam trap problems such as boiler steam pipeline flaking are being caught and corrected early, and his team is consistently putting the right oil in the right machines. A mine he previously worked at had 91% uptime because of PdM. And he recently heard that a bearing solution he implemented seven years ago for a food manufacturer solved the root cause of a recurring problem and is still running “like new” today.

Tennessee snack food manufacturer

Achievements: Year-to-date equipment downtime is 0.75% and unplanned downtime is 2.88% at PepsiCo’s Fayetteville, TN, Frito-Lay plant, said Carlos Calloway, the site’s reliability engineering manager, in his presentation at the Leading Reliability 2021 conference.

San Diego energy utility

Achievements: San Diego Gas & Electric (SDG&E) Company is actively exploring a variety of AI, ML, and emerging technology opportunities to improve operations and maintenance. In one example, previously unleveraged data applied to ML algorithms predicted the failure of T-splices, a crucial underground power distribution asset, with a high degree of accuracy and sufficient time for crews to plan repairs. Due to its success, the program is being extended to other critical assets such as oil switches, load break elbows, and transformers.

Louisiana alumina refinery

Achievements: The Noranda Alumina plant in Gramercy, LA, realized a 60% decline in bearing

changes in the second year of using a new lubrication solution, saving approximately $900,000 in bearing purchases and avoiding costly downtime. “Four hours of downtime is about $1 million dollars’ worth of lost production,” said Russell Goodwin, a reliability engineer and millwright instructor at Noranda Alumina in his Leading Reliability 2021 presentation. In addition, the grease completion rate reached 92% this year.

Singapore rail operator

Achievements: A significant goal was met in August 2019 for Singapore rail operator SMRT Trains Ltd. when it achieved one million mean kilometers between failure (MKBF) across all its lines. This is the equivalent of traveling over the entire network thousands of times before seeing a service delay of five minutes or more. Hundreds of manual planning hours have been eliminated, and about 20 maintenance train deployments per year are avoided. Engineers have a better idea of the work conditions and the work crews’ maximum work capacity per shift is optimized.

1. Market Size and Growth:
    - The global predictive maintenance market size was estimated to be around $3.3 billion.
    - The market is expected to experience significant growth, with a projected CAGR of 24.8% during the forecast period of 2021-2026.
    - The manufacturing sector holds a significant share of the predictive maintenance market due to its emphasis on optimizing production processes and reducing downtime.
2. Benefits of Predictive Maintenance:
    - Predictive maintenance can lead to cost savings by reducing maintenance expenses by up to 30%.
    - Downtime can be reduced by approximately 45% through proactive maintenance practices.
    - Predictive maintenance improves asset reliability by around 25% and extends equipment lifespan by 20-30%.
3. Predictive Maintenance Technologies:
    - Machine learning algorithms are widely employed for predictive maintenance in the manufacturing industry. These algorithms analyze historical data, sensor readings, and other relevant parameters to detect patterns and anomalies that indicate potential equipment failures.
    - Other technologies used in predictive maintenance include artificial intelligence (AI), Internet of Things (IoT) sensors, data analytics, and condition monitoring systems.
4. Case Studies:
    - Numerous case studies highlight successful implementations of predictive maintenance in manufacturing:

- A leading automotive manufacturer implemented predictive maintenance on its assembly lines, resulting in a 20% reduction in downtime and a 25% decrease in maintenance costs.
- A steel manufacturing company utilized predictive maintenance to monitor machinery health and achieved a 30% improvement in equipment reliability, leading to higher productivity and reduced maintenance expenses.

5. Key Challenges:
    - Implementing predictive maintenance requires integrating and managing large volumes of data from diverse sources, including sensors, maintenance logs, and operational systems.
    - The shortage of skilled personnel with expertise in data analysis and machine learning poses a challenge for organizations adopting predictive maintenance.
    - Ensuring data security and integrity is crucial to maintaining the effectiveness of predictive maintenance solutions.

Top Predictive Maintenance Start-ups and Companies in India

1. **Utvyakta**:
   Our solution - Kompress.AI is a predictive maintenance and energy-saving solution specifically customized for air compressors. This provides monitoring of critical parameters and analytics to derive specific performance and utilization insights.
2. **CLAIRVIZ TECHNOLOGY SYSTEMS PVT LTD**:
   ClairViz Systems is a Smart Manufacturing company offering Products and Bespoke End to End solutions to help Manufacturing companies increase their Efficiencies & Profitability

   We offer Enterprise, SaaS, and Mobility Products for Industry 4.0 by leveraging IIOT, Edge Computing, Machine Learning & Analytics to drive sustainable Benefits

   We have two products.
   1. DOMMS (Digital Operations and Maintenance Management System)- For Prescriptive, Proactive and Predictive Maintenance
   2. Osprey
3. **Starlly-Spectra**:
   Spectra helps companies using machines/equipment at their sites/units, and companies building machines/equipment for a certain domain, with a workflow that helps take care of monitoring/managing machines/equipment remotely.
4. **INOVMAC PRIVATE LIMITED**:
   Inovmac builds smart power tools/machines to ensure reliable service, transparency in machine failure, and quick service time leading to a happy customer. Inovmac's solution of using machine modularity and IIoT (Industrial Internet of Things) with

robust hardware helps to provide visibility on machine failures at a granular level, and quickly resolve the issue.

5. **Sensiwise**:

   Offers solutions in the areas of Cold-Chain Logistics & Industrial Asset Tracking & Monitoring. Our solutions help enterprises become more agile, efficient, transparent & innovative.s