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## Industrial Revolution (IR) 4.0

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### Keywords

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### Abstract

Abstract: Industry 4.0, which is “synonymous with smart manufacturing, is the realization of the digital transformation of the field, delivering real-time decision making, enhanced productivity, flexibility and agility to revolutionize the way companies manufacture, improve and distribute their products. The rapid advancements in manufacturing technologies and applications in the industries help in increasing productivity. The term Industry 4.0 stands for the fourth industrial revolution which is defined as a new level of organization and control over the entire value chain of the life cycle of products; it is geared towards increasingly individualized customer requirements. Industry 4.0 is still visionary but a realistic concept which includes Internet of Things, Industrial Internet, Smart Manufacturing and Cloud based Manufacturing. Industry 4.0 concerns the strict integration of human in the manufacturing process so as to have continuous improvement and focus on value adding activities and avoiding wastes. The objective of this paper is to provide an overview of Industry 4.0 and understanding of the nine pillars of Industry 4.0 with its applications and identifying the challenges and issues occurring with implementation the Industry 4.0 and to study the new trends and streams related to Industry 4.0.”

**Introduction:** Manufacturers are integrating new technologies, including Internet of Things (IoT), cloud computing and analytics, and AI and machine learning into their production facilities and throughout their operations.

Smart factories are equipped with advanced sensors, embedded software and robotics that collect and analyze data and allow for better decision making. Even higher value is created when data from production operations is combined with operational data from ERP, supply chain, customer service and other enterprise systems to create whole new levels of visibility and insight from previously siloed information.

These digital technologies lead to increased automation, predictive maintenance, self-optimization of process improvements and, above all, a new level of efficiencies and responsiveness to customers not previously possible.

Developing smart factories provides an incredible opportunity for the manufacturing industry to enter the fourth industrial revolution. Analyzing the large amounts of big data collected from sensors on the factory floor ensures real-time visibility of manufacturing assets and can provide tools for performing predictive maintenance in order to minimize equipment downtime.

Using high-tech IoT devices in smart factories lead to higher productivity and improved quality. Replacing manual inspection business models with AI-powered visual insights reduces manufacturing errors and saves money and time.

With minimal investment, quality control personnel can set up a smartphone connected to the cloud to monitor manufacturing processes from anywhere. By applying machine learning algorithms, manufacturers can detect errors immediately, rather than at later stages when repair work is more expensive.

Industry 4.0 concepts and technologies can be applied across all types of industrial companies, including discrete and process manufacturing, as well as oil and gas, mining and other industrial segments.

### Historical context for Industry 4.0:

#### First industrial revolution

Starting in the late 18th century in Britain, the first industrial revolution helped enable mass production by using water

and steam power instead of purely human and animal power. Finished goods were built with machines rather than painstakingly produced by hand.

### **Second industrial revolution**

A century later, the second industrial revolution introduced assembly lines and the use of oil, gas and electric power. These new power sources, along with more advanced communications via telephone and telegraph, brought mass production and some degree of automation to manufacturing processes.

### **Third industrial revolution**

The third industrial revolution, which began in the middle of the 20th century, added computers, advanced telecommunications and data analysis to manufacturing processes. The digitization of factories began by embedding programmable logic controllers (PLCs) into machinery to help automate some processes and collect and share data.

### **Fourth industrial revolution**

We are now in the fourth industrial revolution, also referred to as Industry 4.0. Characterized by increasing automation and the employment of smart machines and smart factories, informed data helps to produce goods more efficiently and productively across the value chain. Flexibility is improved so that manufacturers can better meet customer demands using mass customization—ultimately seeking to achieve efficiency with, in many cases, a lot size of one. By collecting more data from the factory floor and combining that with other enterprise operational data, a smart factory can achieve information transparency and better decisions.

### **What technologies are driving Industry 4.0?**

#### **Internet of Things**

The IoT is a key component of smart factories. Machines on the factory floor are equipped with sensors that feature an IP address that allows the machines to connect with other web-enabled devices. This mechanization and connectivity make it possible for large amounts of valuable data to be collected, analyzed and exchanged.

#### **Cloud computing**

Cloud computing is a cornerstone of any Industry 4.0 strategy. Full realization of smart manufacturing demands connectivity and integration of engineering, supply chain, production, sales and distribution as well as service. Cloud helps make that possible. In addition, the typically large amount of data being stored and analyzed can be processed more efficiently and cost-effectively with cloud. Cloud computing can also reduce startup costs for small- and medium-sized manufacturers who can right-size their needs and scale as their business grows.

#### **AI and machine learning**

AI and machine learning allow manufacturing companies to take full advantage of the volume of information generated not just on the factory floor, but across their business units, and even from partners and third-party sources. AI and machine learning can create insights providing visibility, predictability and automation of operations and business processes. For instance, industrial machines are prone to breaking down during the production process. Using data collected from these assets can help businesses perform predictive maintenance based on machine learning algorithms, resulting in more uptime and higher efficiency.

#### **Cybersecurity**

Manufacturing companies have not always considered the importance of cybersecurity or cyber-physical systems. However, the same connectivity of operational equipment in the factory or field (OT) that enables more efficient manufacturing processes also exposes new entry paths for malicious attacks and malware. When undergoing a digital transformation to Industry 4.0, it is essential to consider a cybersecurity approach that encompasses IT and OT equipment.

#### **Characteristics of a smart factory**

##### **Data analysis for optimal decision making**

Embedded sensors and interconnected machinery produce a significant amount of big data for manufacturing companies. Data analytics can help manufacturers investigate historical trends, identify patterns and make better decisions. Smart factories can also use data from other parts of the organization and their extended ecosystem of suppliers and distributors to create deeper insights. By looking at data from human resources, sales or warehousing, manufacturers can make production decisions based on sales margins and personnel. A complete digital representation of operations can be created as a "digital twin".

##### **IT-OT integration**

The smart factory's network architecture depends on interconnectivity. Real-time data collected from sensors, devices and machines on the factory floor can be consumed and used immediately by other factory assets, as well as shared across other components in the enterprise software stack, including enterprise resource planning (ERP) and other business management software.

##### **Custom manufacturing**

Smart factories can produce customized goods that meet individual customers' needs more cost-effectively. In fact, in many industry segments, manufacturers aspire to achieve a lot size of one in an economical way. By using advanced simulation software applications, new materials and technologies such as 3-D printing, manufacturers can easily create small batches of specialized items for particular customers. Whereas the first industrial revolution was about mass production, Industry 4.0 is about mass customization.

### Supply chain

Industrial operations are dependent on a transparent, efficient supply chain, which must be integrated with production operations as part of a robust Industry 4.0 strategy. This transforms the way manufacturer's resource their raw materials and deliver their finished products. By sharing some production data with suppliers, manufacturers can better schedule deliveries. For example, if an assembly line is experiencing a disruption, deliveries can be rerouted or delayed in order to reduce wasted time or cost. Also, by studying weather, transportation partner and retailer data, companies can use predictive shipping to send finished goods at just the right time to meet consumer demand. Block chain is emerging as a key technology to enable transparency in supply chains.

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