

## Emerging Technologies

### Overview of Emerging Technologies

In the information technology domain, the term **emerging technology** has different meanings for different people. Businessdictionary.com defines emerging technologies as “new technologies that are currently developing or will be developed over the next five to ten years, and which will substantially alter the business and social environment.” This definition considers new technologies as emerging technologies, which is not entirely accurate.

Some people consider emerging technologies as innovations of existing technologies, which are used creatively for modernity. For example, artificial intelligence was first developed in the 1950s. However, up to date, this is still considered an emerging technology because this development is still progressing and is embedded in various research areas.

Technology can also be labeled as an emerging technology through its characteristics. *Table 1* shows the descriptions of emerging technology’s five (5) main characteristics and how technologies emerge, according to Rotolo, Hicks, and Martin (2015).

CHARACTERISTICS	DESCRIPTION
<b>Radical novelty</b>	Emerging technology may take the form of progressing technology. Novelty or newness can also be generated by putting existing technology to a new use. For example, the applications of artificial intelligence are applied to different uses to achieve different results.  Emerging technologies are radically novel. For example, they fulfill a given function by using a different basic principle as compared to what the previous technology used to achieve a similar purpose.
<b>Relatively fast growth</b>	Emerging technologies show relatively fast growth rates compared to non-emerging technologies. Growth may be observed across a number of dimensions, such as the number of actors involved, public and private funding, knowledge outputs produced, prototypes, products, and services.  For example, users of artificial intelligence are growing. (e.g., various companies, universities, and individuals)
<b>Coherence</b>	Emerging technology is a convergence of previously separated research streams and technologies that have already moved beyond the purely conceptual stage. Coherence refers to the internal characteristics of a group being united and having logical interconnection. Coherence and its persistence over time distinguish technologies that have acquired a certain identity and momentum from those still in a state of flux and, therefore, not yet emerging.  For example, cloud, artificial intelligence, data analytics, and robotics are grouped to achieve different use.
<b>Prominent impact</b>	Emerging technology provides benefits for a wide range of sectors, transforms an industry, and exerts much enhanced economic influence. It applies a noticeable impact with narrow scope, as well as wide-ranging impact across domains and potentially the entire socio-economic system by changing the composition of actors, institutions, patterns of interactions among those, and the associated knowledge production processes.  For example, artificial intelligence provides a prominent impact and enormous changes in different sectors, such as businesses, academe, healthcare, and individuals around the world.
<b>Uncertainty and ambiguity</b>	The prominent impact of emerging technologies lies somewhere in the future. Thus, uncertainty features in the emergence process. On the other hand, ambiguity arises because proposed applications are still malleable. Even the knowledge of the emergence’s possible outcomes is incomplete.  Uncertainty and ambiguity are key starting concepts for a wide variety of science and technology studies that focus on the role of the expectations in technological emergence. Emerging technologies are also characterized by uncertainty in their possible outcomes and uses, which may be unintended and undesirable, and by ambiguity in the meaning that different social groups associate with the given technology.  For example, there are various applications or uses of artificial intelligence that some people can predict, but these applications may or may not be successfully developed.

*Table 1.* Characteristics of an emerging technology  
Source: What is an Emerging Technology?, 2015, p. 4

In conclusion, these characteristics define emerging technology as a radically novel and relatively fast-growing technology through a certain degree of coherence persisting over time. These also have the potential to exert a considerable impact on the socio-economic domain(s), which is observed in terms of actors and institutions, as well as their patterns of interactions, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future, and so the emergence phase is still somewhat uncertain and ambiguous (Rotolo, Hicks, & Martin, 2015, p. 4).

### Emerging Technology Areas

According to the World Economic Forum, the following areas of emerging technologies have the potential of altering deep-rooted practices of industries in the future:

- **Augmented Reality (AR)** – AR is the technology that overlays computer-generated display, sound, text, and effects on a user's view of the real world. It combines real and computer-based scenes and images to deliver a unified but enhanced view of the world. There are various applications of AR, such as an in-car display with guides to help the driver drive and reverse park safely, games such as Pokémon GO, and applications that help shoppers view how a piece of furniture will look in their living room before buying it.

AR is also set to leap forward in terms of sophistication and everyday use. It is having a great impact on the industry, where it is an integral component of the Fourth Industrial Revolution.

- **Artificial Intelligence (AI)** – AI is the simulation of human intelligence processes by machines. These processes include learning, reasoning, and self-correction.
  - **Machine learning** – This is the application of AI that provides a machine with the ability to learn from experience like humans. Machine learning is used in various applications such as healthcare, financial and marketing services, and transportation. In healthcare, for example, machine learning algorithms will be applied to identify and develop new medicines at a rapid pace.

- **Quantum Computers** – Computers that use quantum mechanics to perform calculations can solve some problems far more efficiently than a conventional computer. Quantum computers use *qubit* as their basic unit of computation. Qubit is analogous to the standard bit (0 or 1), but it is in a quantum superposition between two (2) computational quantum states. It can be a 0 and a 1 at the same time. So far, the largest quantum computers that laboratories have demonstrated are from IBM, Google, Rigetti Computing, and IonQ.

Researchers and a growing number of academics are developing programs and quantum computing software. Once refined, powerful quantum computers in the future could simulate nature itself, such as atoms, molecules, and could help in designing materials.

### The Fourth Industrial Revolution

The technical advances change the way of production technology. The stages of production technology are called the “industrial revolution.” The industrial revolution is the systematic transformation of manufacturing through the integration of physical and digital systems to improve quality, lower costs, and increase efficiency. Because of this, production technologies fundamentally changed the working conditions and lifestyles of people. There are four (4) stages of the industrial revolution:

- **First Industrial Revolution, or Industry 1.0**, began in the 18<sup>th</sup> century. This is the introduction of mechanical production using hydroelectric and steam-powered equipment.
- **Second Industrial Revolution, or Industry 2.0**, began in the 19<sup>th</sup> century. New technological systems that use electricity were introduced during this revolution, which allowed for even greater production and more sophisticated machines.
- **Third Industrial Revolution, or Industry 3.0**, began with the first computer era. This industrial revolution evolved the use of electronics and information technology (IT) to automate a production process further. Manufacturing and automation advanced considerably because of Internet access, connectivity, and renewable energy.
- **Fourth Industrial Revolution, or Industry 4.0**, is the current and developing environment. The disruptive and cutting-edge technologies, such as the Internet of Things (IoT), robotics, virtual reality (VR), AR, and AI, are changing the way we live and work. Industry 4.0 will lead to changes in traditional production relationships among suppliers, producers, customers, as well as between humans and machines.

Some of the technologies from the building blocks of Industry 4.0 are the following:

- **Big Data Analytics** – This is the process of collecting, organizing, and analyzing large sets of data from different resources to discover patterns and other useful information. This is used to support real-time decision-making in production and customer management systems. Using cutting-edge technologies, it's possible to analyze large data and immediately get answers from them.
- **Internet of Things (IoT)** – IoT is a computing concept that describes the idea of everyday physical objects being connected to the Internet and being able to communicate and interact with other devices. This may include sensor and wireless technologies. IoT allows field devices to interact with one another and with more centralized controllers. It will also decentralize analytics and decision-making, thereby enabling real-time responses and results.
- **Cloud Computing** – This is the general term for anything that involves delivering hosted services over the Internet. The performance of cloud technologies will improve, which results in achieving reaction times of several milliseconds. Machine data and functionality will increasingly be deployed to the cloud, thus enabling more data-driven services in production systems.
- **Augmented Reality (AR)** – AR-based systems support a variety of services, such as selecting parts in a warehouse and sending repair instructions over mobile devices. These systems are currently in their infancy, but in the future, companies will make much broader use of AR to provide workers with real-time information to improve decision-making and work procedures.

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