

# Industry 4.0 Background



*Industry 4.0 Market Research*

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***Industry 4.0 Market Research** (division of **HSRC**) is an international market and technology research publisher specializing in premium Industry 4.0 and Quantum Technologies market. With an extensive portfolio of Industry 4.0 and Quantum Computing reports, **Industry 4.0 Market Research** has been recognized as the global leader in the Fourth Industrial Revolution market research.*

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## Table of Contents

1	Industry 4.0: Evolution .....	4
2	Industry 4.0: Introduction .....	6
2.1	Industry 3.0 Factory Vs. Industry 4.0 Factory .....	9
2.2	Industry 4.0 Ecosystem and Outlook .....	9
3	Industry 4.0 Implementation Principles .....	11
4	Industry 4.0 Technologies, Architecture and Supply Chain Intra-Relationship .....	12
5	Industry 4.0 Introduction Strategies .....	13
6	Cobots .....	15
7	In-memory Computing .....	15
8	Edge Computing .....	15
9	Industry Cyber-Physical Systems (CPS) .....	16
10	Industry 4.0 Trends .....	17
11	Predictive Maintenance 4.0.....	17
12	Smart Factories .....	19
13	“Society 4.0” .....	19
14	Customized Manufacturing 4.0.....	20
15	Industry 4.0: Value Chain.....	21
16	Logistics 4.0 & Smart Supply Chain 4.0 Management .....	23
17	Value of Industry 4.0 Partnerships.....	25
18	Disclaimer & Copyright.....	26

## List of Figures

Figure 1 - Effects of Industry 4.0 Modalities .....	8
Figure 2 - Industry 4.0 Technologies, Architecture and Supply Chain Intra- relationship .....	12
Figure 3 - Manufacturers Industry 4.0 Levels & Value Drivers .....	13
Figure 4 - Cyber-Physical Systems (CPS) .....	16
Figure 5 - Industry 4.0 Industry Value Chain.....	22
Figure 6- Industry 4.0 Supply Chain Logistics Layers .....	23

## 1 Industry 4.0: Evolution

During the first years of the so-called fourth industrial revolution (Industry 4.0), the main attempts that tried to define the main ideas and tools behind this new era of manufacturing, always ended up referring to the concept of smart machines that would be able to communicate with each other and with the environment. In fact, the defined cyber physical systems connected by the internet of things take all the attention when referring to the new industry 4.0. Nevertheless, the new industrial environment will benefit from several tools and applications that complement the real formation of a smart, embedded system that is able to perform autonomous tasks. In addition, most of these revolutionary concepts rest in the same background as artificial intelligence does, where the analysis and filtration of huge amounts of incoming information from different types of sensors, assist the interpretation and suggestion of the most recommended course of action. For this reason, artificial intelligence engineering suits perfectly with the challenges that arise in the consolidation of the fourth industrial revolution (Industry 4.0).

Compared to earlier industrial revolutions, induced by steam and electrification, the spread of inventions that can transform production will transpire over a shorter period. However, it could take considerable time for new technologies, once invented, to diffuse throughout the economy and for their productivity effects to be fully realized. Moreover, the duration of this period is uncertain. The past has seen unrealistic enthusiasm regarding timescales for the delivery of several production technologies.

❑ **The First Industrial Revolution:**

The 1st industrial revolution was driven by the advent of steam engines being used to power production facilities. This provided a more flexible and powerful energy source for machinery not situated near a natural source of power such as a river.

❑ **The Second Industrial Revolution:** The 2nd industrial revolution was driven by the proliferation of electric assembly line, exemplified by Henry Ford a century ago.

❑ **The Third Industrial Revolution:** The 3rd industrial revolution, which occurred in the 1970s, was driven by the use of computers in production.

### Industry 4.0

*Industry 4.0 will revolutionize the design, manufacture, operation, and service of products and production systems.*

*Inter & Intra manufacturing connectivity and interaction among parts, machines, and humans will make production systems faster and more efficient and elevate mass customization to new levels.*

The widespread use of CNC machines, computer processing of quality and logistics information, as well as the computerization of a wide variety of manual tasks such as accounting, inventory control, and scheduling, were all transformed during the 3rd industrial revolution. Integrated smart processes and products generating so-called big data that are completely changing the landscape of manufacturing and the marketplace, as it has come to be known, are driving the 4th industrial revolution, or “Industry 4.0.”

- ❑ **The Fourth Industrial Revolution:** Industry 4.0 stems from the realization that a 4th industrial revolution is upon us. Industry 4.0 will revolutionize the design, manufacture, operation, and service of products and production systems. Inter & Intra manufacturing connectivity and interaction among parts, machines, and humans will make production systems faster and more efficient and elevate mass customization to new levels.

The terminology “Industry 4.0”, or its term in German “Industrie 4.0”, has been embraced by the German industry (Hannover fair 2011), is one of the main precursors of the new technological shift as part of the High-Tech strategy 2020 action plan. Anyhow, a variety of different terms is used around the world to describe the phenomenon of Industrie 4.0. Some countries like Japan seem to have maintained “industry 4.0”, but others like the U.S. have defined terms like the “Internet of Everything”. Nomenclature like “Smart Production”, “Smart Manufacturing”, “Smart Industry” or “Smart Factory” is used in Europe, China and also the U.S. to refer specifically to digital networking of production to create smart manufacturing systems.

In a different field of interpretation, the terms “Advanced Manufacturing” or “Predictive Manufacturing” embrace a broader spectrum of modernization trends in the manufacturing environment. Advanced manufacturing is by definition: “a family of activities that depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. It involves both new ways to manufacture existing products, and the manufacture of new products emerging from new and advanced technologies”.

***"You need to decide  
whether you want to be part  
of the (Industry 4.0) change  
– or be changed yourself."***

**J. Kaeser  
CEO Siemens AG**

Individual companies such as General Electric also invented their own name when they launched in 2012 a broad-based initiative named “Industrial internet”, with applications in several areas, but where manufacturing only plays a minor role. Others like Bosch have been using “connected manufacturing” to emphasize precisely the importance in manufacturing aspects.

Anyway, independently of the specific given name, all these proposals are driven towards the need for the construction of an automated, self-conscious, interconnected, heterogeneous, embedded system that will push manufacturing to the next level.

## 2 Industry 4.0: Introduction

Industry 4.0 is a high-tech project started by the German government, which promotes the computerization of manufacturing. Before moving onto Industry 4.0, let us see in brief about what Industry 1.0, 2.0 & 3.0 were.

The first industrial revolution (1.0) was the mechanization of production using water and steam power. The second industrial revolution (2.0) then introduced mass production with the help of electric power, followed by the third industrial revolution (3.0) digital revolution and the use of electronics and IT to further automate production. Now, the Fourth industrial revolution (4.0).

Industry 4.0 is a collective term for technologies and concepts of value chain organization. Based on the technological concepts of cyber-physical systems, the Internet of Things and the Internet of Services, it facilitates the vision of the Smart Factory. Within the modular structured Smart Factories of Industry 4.0, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, Cyber-physical systems communicate and cooperate with each other and humans in real time. Via the Internet of Services, both internal and cross-organizational services are offered and utilized by participants of the value chain.

Like Germany, in the United States an initiative known as the Smart Manufacturing Leadership Coalition (SMLC) is also working on the future of manufacturing. Their aim is to enable stakeholders in the manufacturing industry to form collaborative R & D, implementation and advocacy groups for development of the approaches, standards, platforms and shared infrastructure that facilitate the broad adoption of manufacturing intelligence.

On these lines, GE has been working on an initiative called 'The Industrial Internet'. It aims to bring together the advances of two transformative revolutions:

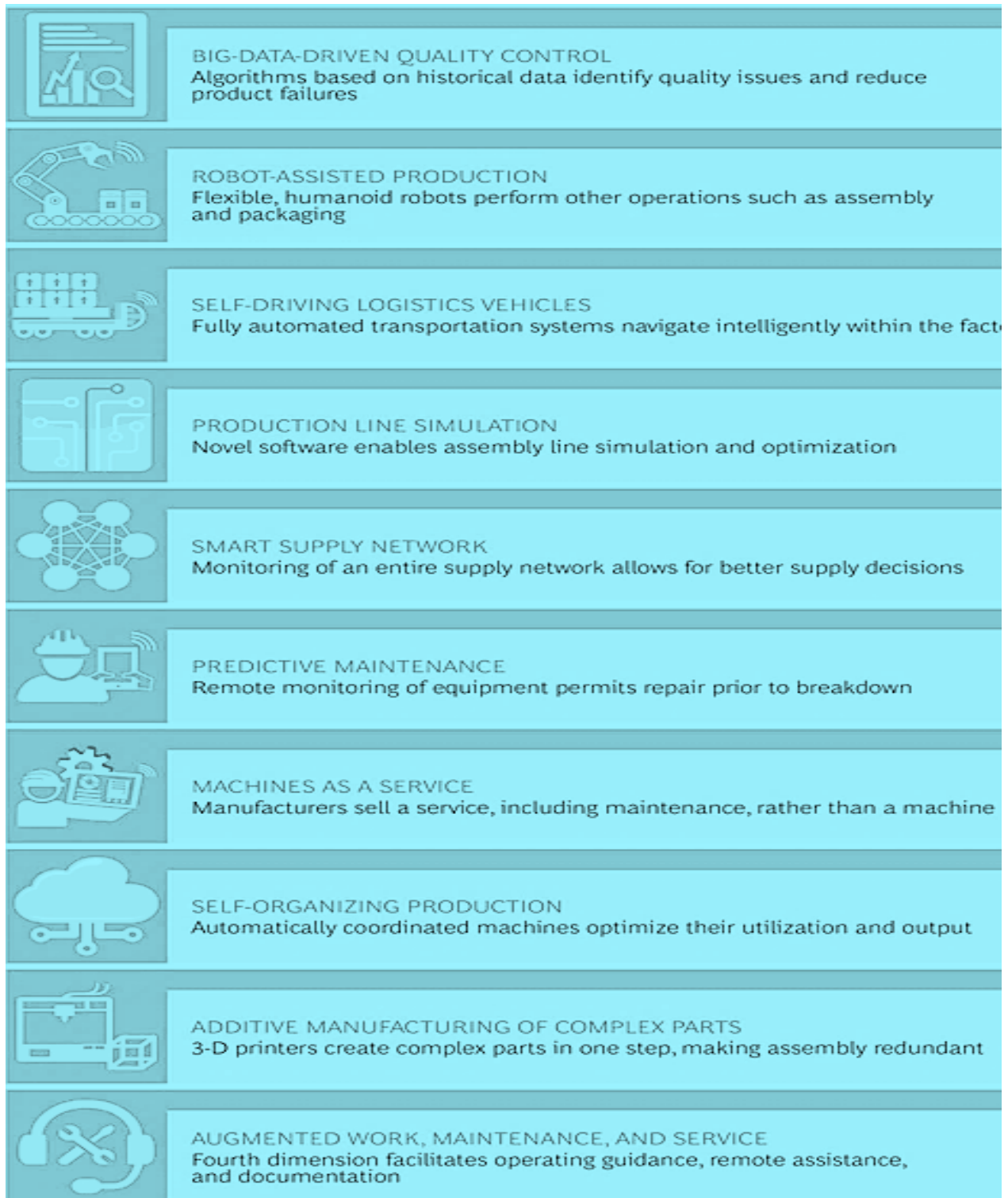
- The myriad machines, facilities, fleets and networks that arose from the Industrial Revolution, and
- The more recent powerful advances in computing, information and communication systems brought to the fore by the Internet Revolution.

The industrial sector is important to every country's economy and remains the driver of growth and employment. Industry, which in this context focuses on manufacturing, provides added value through the transformation of materials into

products. The term “Industry 4.0” became publicly known in 2011, when an initiative called “Industry 4.0” where an association of representatives from industry, business, politics, and academia promote the idea as an approach to strengthen the competitiveness of the German manufacturing industry. Germany has one of the most competitive manufacturing industries in the world and is a global leader in the manufacturing equipment sector. Since the German federal government announced Industry 4.0 as one of the key initiatives of its high-tech strategy in 2011, the topic of Industry 4.0 has become famous among many companies, research centers, and universities. Numerous academic publications, practical articles, and conferences have discussed this topic. The German Federal Government presents Industry 4.0 as a new, emerging structure in which manufacturing and logistics systems in the form of Cyber-Physical Production Systems (CPPS) intensively use the globally available information and communications network for an extensively automated exchange of information and in which production and business processes are matched.



Figure 1 - Effects of Industry 4.0 Modalities



Source: Expert Interviews BCG



## **2.1 Industry 3.0 Factory Vs. Industry 4.0 Factory**

In the current industry environment, providing high-end quality service or products with the least cost is the key to success, and industrial factories are trying to achieve as much performance as possible to increase their profit. In this way, various data sources are available to provide worthwhile information about different aspects of the factory. In this stage, the utilization of data for understanding the current condition and detecting faults and failures is an important topic to research.

For instance, in production, there are various commercial tools available to provide OEE (Overall Equipment Effectiveness) information to factory management in order to highlight root cause of problems and possible faults in the system.

In comparison, in an Industry 4.0 factory, in addition to condition monitoring and fault diagnosis, components and systems are able to gain self-awareness and self-prediction, which will provide management with more insights on the status of the factory. Furthermore, peer-to-peer comparison and fusion of health information from various components provide a precise health prediction in component and system levels and force factory management to trigger required maintenance at the best possible time to reach just-in time maintenance and gain near zero downtime.

Modern information and communication technologies like Cyber-Physical Systems, Big Data and Cloud Computing will help predict the possibility to increase productivity, quality and flexibility within the manufacturing industry and thus to understand advantages within the competition.

## **2.2 Industry 4.0 Ecosystem and Outlook**

In most companies, products are delivered to customers through a very standardized process. Marketing analyzes customer demand and tries to predict sales for the coming period. With that information, manufacturing orders raw materials, components, and parts for the anticipated capacity. Distribution accounts for upcoming changes in the amount of product coming down the pipeline, and customers are told when to expect shipment. If all goes well, the gap between demand and supply at every point in the system is small.

This rarely happens, of course. Forecasting remains an inexact science and the data it depends on can be inconsistent and incomplete. Too often, manufacturing operates independently from marketing, from customers, and from suppliers and other partners. Lack of transparency means that none of the links in the supply chain really understand what any other link is doing or needs. Inevitably, it seems the orderly flow from marketing to customer is disrupted somewhere.

Over the course of the next few years, this will all start to change. This will not be because we will have fewer disruptive weather events, flat tires, or outsourcing

snafus. What is changing is the supply chain itself. With the advent of the digital supply chain, silos will dissolve and every link will have full visibility into the needs and challenges of the others. Supply and demand signals will originate at any point and travel immediately throughout the network. Low levels of a critical raw material, the shutdown of a major plant, a sudden increase in customer demand all such information will be visible throughout the system, in real time. This in turn will allow all players and most importantly, the customer to plan accordingly.

Better yet, transparency will enable companies not just to react to disruptions but to anticipate them, modeling the network, creating “what-if” scenarios, and adjusting the supply chain immediately as conditions change.

The goal of the digital supply chain is ambitious: to build an altogether new kind of supply network that is both resilient and responsive.

However, if companies are to make the digital supply chain or perhaps more properly, the digital supply chain ecosystem a reality, they can't just gather technologies and build capabilities. They must also find people with the right skills, and manage the shift to a culture that's willing to carry out the effort. In other words, they must transform their entire organization.

The digital supply chain, as we envision it, consists of eight key elements: integrated planning and execution, logistics visibility, Procurement 4.0, smart warehousing, efficient spare parts management, autonomous and B2C logistics, prescriptive supply chain analytics, and digital supply chain enablers. Companies that can put together these pieces into a coherent and fully transparent whole will gain huge advantages in customer service, flexibility, efficiency, and cost reduction; those that delay will be left further and further behind.

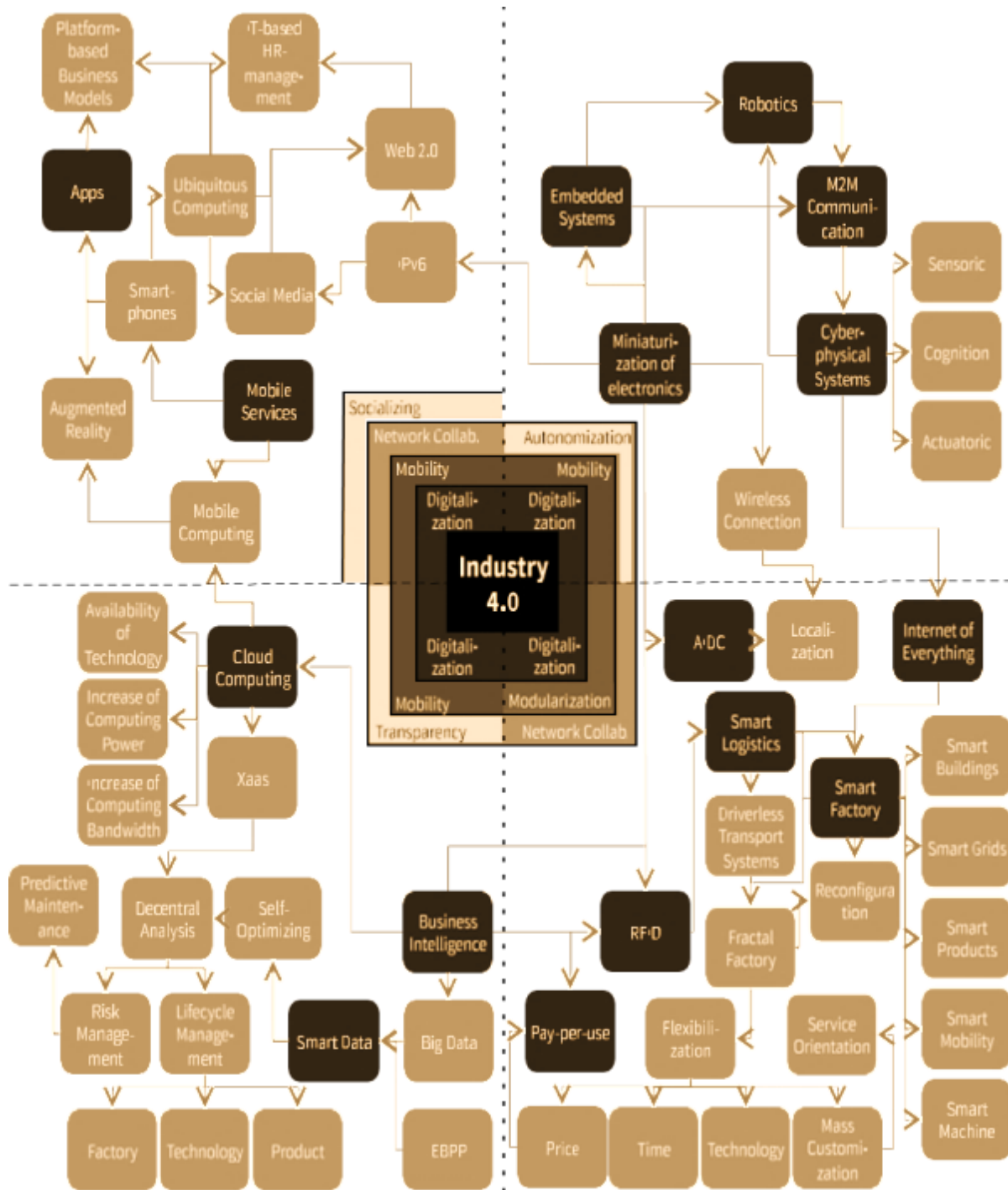
### 3 Industry 4.0 Implementation Principles

Industry 4.0 is based on six design principles. These principles support companies in identifying and implementing Industry 4.0 scenarios.

- **Interoperability:** the ability of cyber-physical systems (i.e. work piece carriers, assembly stations and products), humans and Smart Factories to connect and communicate with each other via the Internet of Things and the Internet of Services.
- **Virtualization:** a virtual copy of the Smart Factory, which is created by linking sensor data (from monitoring physical processes) with virtual plant models and simulation models.
- **Decentralization:** the ability of cyber-physical systems within Smart Factories to make decisions on their own.
- **Real-Time Capability:** the capability to collect and analyze data and provide the insights immediately.
- **Service Orientation:** offering of services (of cyber-physical systems, humans and Smart Factories) via the Internet of Services.
- **Modularity:** flexible adaptation of Smart Factories for changing requirements of individual module.

## 4 Industry 4.0 Technologies, Architecture and Supply Chain Intra-Relationship

Figure 2 - Industry 4.0 Technologies, Architecture and Supply Chain Intra-relationship



Source: B. Yahsi Et Al

## 5 Industry 4.0 Introduction Strategies

To sort through the choices, manufacturing leaders can use a “digital compass”. The compass consists of eight basic value drivers and 26 practical Industry 4.0 levers. Cross-functional discussions will help companies find the levers that are best suited to solve their problems. The “digital compass” (below) helps companies find tools to match their needs during maintenance, repair, and operations.

**Figure 3 - Manufacturers Industry 4.0 Levels & Value Drivers**



Source: McKinsey

One kind of lost value that is sure to interest manufacturers is process effectiveness. Industry 4.0 offers new tools for smarter energy consumption, greater information storage in products and pallets (so-called intelligent lots), and real-time yield optimization.

Swiss giant ABB used the latter in an Australian cement kiln. A computer-based system mimics the actions of an “ideal” operator, using real-time metrics to adjust kiln feed, fuel flow, and fan-damper position. The company found that the new tools boosted throughput by up to 5%.

Strategists should also take Industry 4.0 into account as they contemplate the company’s future directions - the second way to capture the potential. The traditional manufacturing business model is changing, and new models are emerging; incumbents must be quick to recognize and react to these new competitive challenges.

More specifically, executives must consider the following options - and watch for others that may be deploying them. 84% of the manufacturing suppliers surveyed expect new competitors to enter the market soon.

Businesses that monetize data - The SCiO, a Kick starter project, is a low-cost, pocket-sized spectrometer that uses near-infrared technology to assess the composition of Material “Platforms,” in which products, services, and information can be exchanged via predefined streams. Think open-source software applied to the manufacturing context. For example, a company might provide technology to connect multiple parties and coordinate their interactions. SLM Solutions, a 3-D-printer manufacturer, and Atos, an IT services company, are currently running a pilot project to develop such a marketplace. Customers can submit their orders to a virtual broker platform run by Atos. Orders are then allocated to SLM’s decentralized network of production sites, and subsequently produced and shipped to the customer. Some companies are also trying to build an “ecosystem” of their own, as Nvidia has in its graphics-processor business. It provides software developers with resources and offers start-ups help to build companies around Nvidia technologies.

Pay-by-use and subscription-based services, turning machinery from capex to opex for manufacturers – Rolls-Royce pioneered this approach in its jet-engine business; other manufacturers have followed suit.

Businesses that license intellectual property - Today, many manufacturing companies have deep expertise in their products and processes, but lack the expertise to generate value from their data. SAP offers consulting services that build on its software. Qualcomm makes more than half of its profits from intellectual-property royalties. Manufacturers might offer consulting services or other businesses that monetize the value of their expertise. It is expected to cost \$250, whereas traditional machines cost upward of \$10,000. Every time a SCiO is used, it contributes to a large database of scanned materials, helping to make the machine more accurate. To be sure, it is a consumer product, and not yet ready for industrial use. However, industrial models are on the way already.



Kaggle, a distributed network of about 270,000 data scientists, helped more than 20 Fortune 500 companies solve their toughest data problems.

To get the most out of Industry 4.0 technologies and to get past square one with a digital business mode prepare for a digital transformation, companies will have to take a third step: Manufacturers should begin today to join the hunt for the best digital talent, and think about how to structure their digital organization.

Data management and Cybersecurity will be critical problems to solve. Many companies will find that a “two speed” data architecture can help them deploy new technologies at the speed required, while also preserving mission-critical applications.

## 6 Cobots

A Cobot or co-robot (collaborative robot) is a robot intended to interact with humans in a shared workspace. This is in contrast with other robots, designed to operate autonomously or with limited guidance, which is what most industrial robots were up until the decade of the 2010s

With the pace of advancement in AI, many people talk about the jobs that will be replaced by robots. Instead of machine vs. human, Cobots leverage the collaboration of both. These robots are often highly adaptable and can support humans in repetitive jobs. Interesting examples include Festo’s ExoHand or Skoda’s factory where cobots support workers at the mechatronic assembly line.

## 7 In-memory Computing

This is important for Industry 4.0 and IoT to collect and analyze data in-memory on a single data copy on platforms such as SAP HANA.

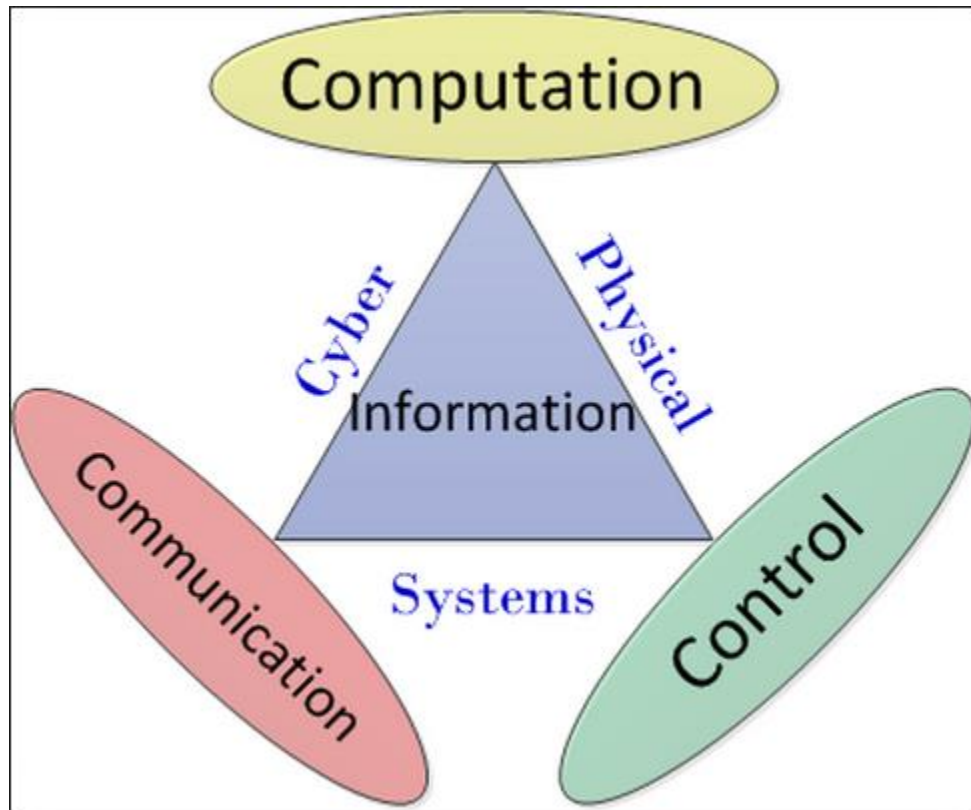
## 8 Edge Computing

Coined by Cisco, edge computing allows companies to process data as close as possible near the data source and not in the cloud. Advantages are less latency of transmitting the data to the cloud and higher safety.



## 9 Industry Cyber-Physical Systems (CPS)

Figure 4 - Cyber-Physical Systems (CPS)



A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities. CPS are physical and engineered systems whose operations are monitored, coordinated, controlled and integrated by a computing and communication core. They allow us to add capabilities to physical systems by merging computing and communication with physical processes.

CPS benefits include:

- Safer and more efficient systems
- Reduce the cost of building and operating the systems
- Build complex systems that provide new capabilities
- Reduced cost of computation, networking, and sensing
- Enables national or global scale CPS's

In the manufacturing environment, these Cyber-Physical Systems comprise smart machines, storage systems and production facilities capable of autonomously exchanging information, triggering actions and controlling each other independently.

Smart factories allow individual customer requirements to be met; i.e. even one-off items can be manufactured profitably. In Industry 4.0, dynamic business and engineering processes enable last-minute changes to production and deliver the ability to respond flexibly to disruptions and failures on behalf of suppliers. For example, end-to-end transparency is provided over the manufacturing process, facilitating optimized decision-making.

## 10 Industry 4.0 Trends

Globalization of demand goes hand in hand with the globalization of production. "Local content" plays an increasingly greater role in conquering foreign markets. Managing the resulting requirements for production control and company management requires an efficient networking of all locations and value creation partners. The networking of various companies and the necessity of communication between the many different software systems available today is just one of the significant challenges. In addition to the technical issues, intercultural collaboration between the people involved in the processes must be considered.

The demographic change demands new concepts in the design of the production environment. The ageing company with a simultaneously declining labor force potential requires, in addition to an increasing level of automation in production, modified interaction concepts with the production process. The interaction will be aligned with the user to a significantly greater extent and must consider the given work context. This also means that, from the large quantity of information to be expected, the information relevant to the specific situation must be filtered out and presented. In addition to tools, new interaction concepts also require people with the appropriate training.

## 11 Predictive Maintenance 4.0

Predictive maintenance (PdM) techniques are designed to help determine the condition of in-service equipment in order to predict when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance because tasks are performed only when warranted.

The main promise of predictive maintenance is to allow convenient scheduling of corrective maintenance and to prevent unexpected equipment failures. The key is "the right information in the right time". By knowing which equipment needs maintenance, maintenance work can be better planned (spare parts, people, etc.) and what would have been "unplanned stops" are transformed to shorter and fewer "planned stops", thus increasing plant availability. Other potential advantages include increased equipment lifetime, increased plant safety, fewer

accidents with negative impact on environment, and optimized spare parts handling.

Predictive maintenance differs from preventive maintenance because it relies on the actual condition of equipment, rather than average or expected life statistics, to predict when maintenance will be required.

Predictive maintenance evaluates the condition of equipment by performing periodic or continuous (online) equipment condition monitoring. The ultimate goal of the approach is to perform maintenance at a scheduled point in time when the maintenance activity is most cost-effective and before the equipment loses performance within a threshold. This is in contrast to time- and/or operation count-based maintenance, where a piece of equipment gets maintained whether it needs it or not. Time-based maintenance is labor-intensive, ineffective in identifying problems that develop between scheduled inspections, and so is not cost-effective.

The "predictive" component of predictive maintenance stems from the goal of predicting the future trend of the equipment's condition. This approach uses principles of statistical process control to determine at what point in the future maintenance activities will be appropriate.

Most predictive inspections are performed while equipment is in service, thereby minimizing disruption of normal system operations. Adoption of PdM can result in substantial cost savings and higher system reliability.

Reliability-centered maintenance (RCM) emphasizes the use of predictive maintenance techniques in addition to traditional preventive measures. When properly implemented, RCM provides companies with a tool for achieving lowest asset Net Present Costs (NPC) for a given level of performance and risk.

One area that many times is overlooked is how to, in an efficient way, transfer the PdM data to a computerized maintenance management system (CMMS) so that the equipment condition data is sent to the right equipment object in the CMMS system in order to trigger maintenance planning, execution and reporting. Unless this is achieved, the PdM solution Cloudis of limited value, at least if the PdM solution is implemented on a medium to large size plant with tens of thousands of pieces of equipment.

## 12 Smart Factories

Production systems are shaped by cyber-physical systems (CPS). One of the main properties of this CPS is the advanced networking of the production systems using Internet standards. It is not only the machines that are communicating with each other — the work pieces are communicating more and more with the production technology. To do this, resources and work pieces have an identity in the Internet of Things.

The decentralized organized production units have an unprecedented level of agility. The interaction between work pieces and production technology in smart factories allows flexible and application-based reconfiguration of production systems. The resources and capabilities of these production systems are visible and available in the Internet of Things ("Production as a service").

A key factor for the success of the smart factory concept is the integrative development of products and production systems. First and foremost, this means that the interdisciplinary collaboration, from the product development process to the development of the corresponding production technology, must be raised to a new level within the company. Agile production systems require equally agile software systems for the planning, simulation and control of manufacturing processes (Internet of Services). Today's centralist concepts will be replaced with smart, high-resolution decentralized systems as a result of the gradual development of CPS.

## 13 “Society 4.0”

Industry 4.0 must be understood as a future concept for society as a whole, "Society 4.0" so to speak, in which people, perhaps more than ever, are at the forefront. The profiles of certain job descriptions are certain to change or be completely reformed. The increasing diversity of products with short delivery cycles and simultaneously decreasing numbers of specialist personnel available can present an additional challenge for many companies. It is also important not to forget that the urban production of the future is moving closer to where people live. This will require different logistics concepts for production supply and disposal.

People are not being disregarded, quite the opposite in fact. Their requirements must be taken into account to a much greater extent in corporate planning in the future. The Industry 4.0 eco system consists not only of smart factories and intelligent products with a memory that control production. It is a question of allowing people to perform high quality and creative work and giving them the opportunity to achieve a work/life balance – with just as much flexibility as the production systems of the future that will be controlled by people.

## 14 Customized Manufacturing 4.0

How an individual customer's requirements can be met? The dynamic value chains of Industry 4.0 enable customer- and product-specific coordination of design, configuration, ordering, planning, production and logistics. This also provides the opportunity to incorporate last-minute requests for changes immediately prior to or even during production.

For example, today's automotive industry is characterized by static production lines (with predefined sequences) which are hard to reconfigure to make new product variants. Software-supported Manufacturing Execution Systems (MES) are normally designed with narrowly defined functionality based on the production line's hardware and are therefore equally static. Individuality is not encouraged. As a result, it is not possible to incorporate individual customer requests to include an element from another product group made by the same company, for example to fit a Volkswagen with Porsche seats.

Industry 4.0 results in the emergence of dynamic production lines. Vehicles become smart products that move autonomously through the assembly shop from one CPS-enabled processing module to another. The dynamic reconfiguration of production lines makes it possible to mix and match the equipment with which vehicles are fitted; furthermore, individual variations (e.g. fitting a seat from another vehicle series) can be implemented at any time in response to logistics issues (such as bottlenecks) without being constrained by centrally prescribed timings. It is simple to execute this type of reconfiguration and the cars move autonomously to the relevant workstation.

## 15 Industry 4.0: Value Chain

Supply chains are extremely complex organisms, and no company has yet succeeded in building one that is truly digital. Indeed, many of the applications required are not yet widely used. However, this will change radically over the next years, with different industries implementing DSC at varying speeds. Companies that get there first will gain a difficult-to-challenge advantage in the race to Industry 4.0, and will be able to set or at least influence technical standards for their particular industry. The advantage will by no means be limited to the greater efficiencies. The real goal will be the many new business models and revenue streams the digital supply chain will open.

- ❑ Industry 4.0 - Opportunities and Challenges of the Industrial Internet Study Industry 4.0 requires comprehensive digitization of the horizontal and vertical value chains
- ❑ At the heart of all this activity sits the Industry 4.0 supply chain, and it is key to the operations of every company that manufactures or distributes anything. Indeed, for many companies the supply chain is the business. It extends the vertical integration of all corporate functions to the horizontal dimension, knitting together relevant players, the suppliers of raw materials and parts, the production process itself, warehouses and distributors of finished products, and finally the customer.
- ❑ Industry 4.0 will make supply chains and production processes more interconnected, efficient and flexible, allowing mass-customization and virtual production.

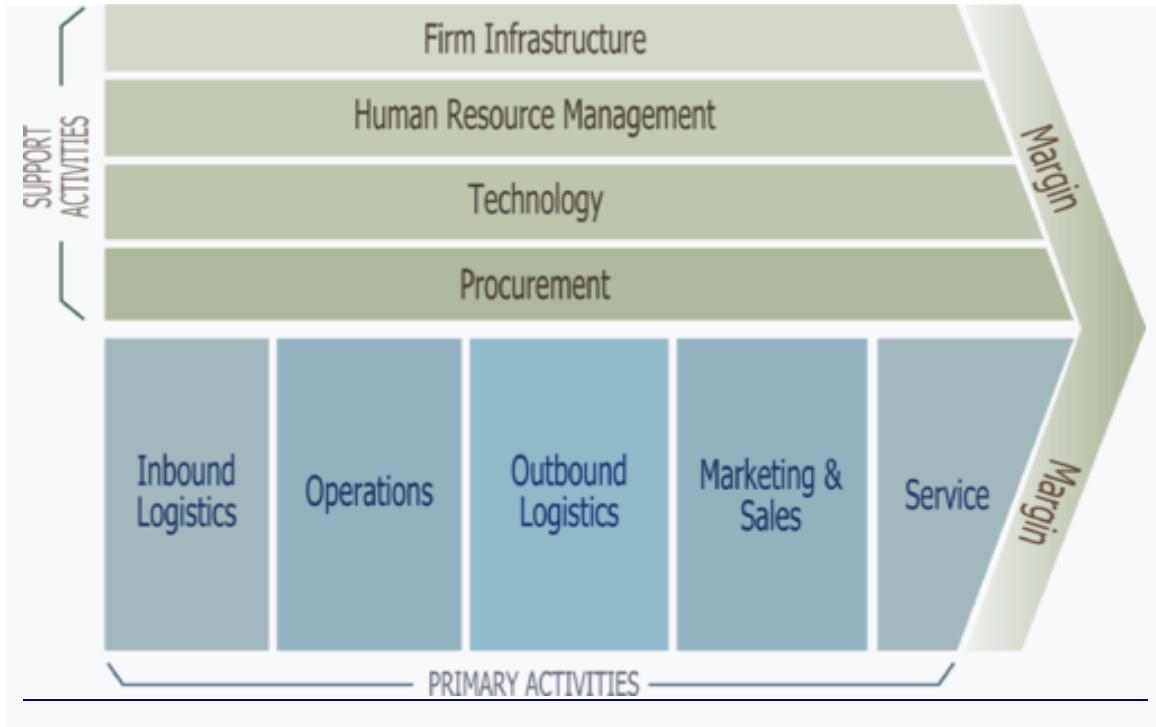
The Industry 4.0 value chain is complex with many significant players across different segments of the market, including hardware providers, software providers, professional services providers, end-to-end solution providers and vertical enterprises, as well as networking infrastructure, storage & compute infrastructure, infrastructure software database analytic platforms & applications, cloud platforms and Industry 4.0 services.

Integrated planning and execution platforms connect all parts of the Industry 4.0 value chain:

- **Metrics:** One set of numbers shared across the value chain
- **Operational execution:** Companies share location, tracking, and transfer invoice information; automated replenishment and order-taking systems; rapid problem identification and joint resolution
- **Tactical planning:** Companies share planning, scenarios, and forecast information, along with a collaborative sales and operations planning process, and capable-to-promise checks across the entire value chain

- **Strategic collaboration:** Joint strategic volume and market planning; joint supply chain improvement activities

**Figure 5 - Industry 4.0 Industry Value Chain**



The activity of the Industry 4.0 manufacturer illustrates the difference between cost and the value chain. The cutting activity may have a low cost, but the activity adds much of the value to the end product, since a rough diamond is significantly less valuable than a cut diamond. Typically, the described value chain and the documentation of processes, assessment and auditing of adherence to the process routines are at the core of the quality certification of the business, e.g. ISO 9001.

A firm's value chain forms a part of a larger stream of activities, which Porter calls a value system. An Industry 4.0 value system, or an Industry 4.0 industry value chain, includes the suppliers that provide the inputs necessary to the firm along with their value chains. After the firm creates products, these products pass through the value chains of distributors (which also have their own value chains), all the way to the customers. All parts of these chains are included in the value system. To achieve and sustain a competitive advantage, and to support that advantage with information technologies, a firm must understand every component of this value system.

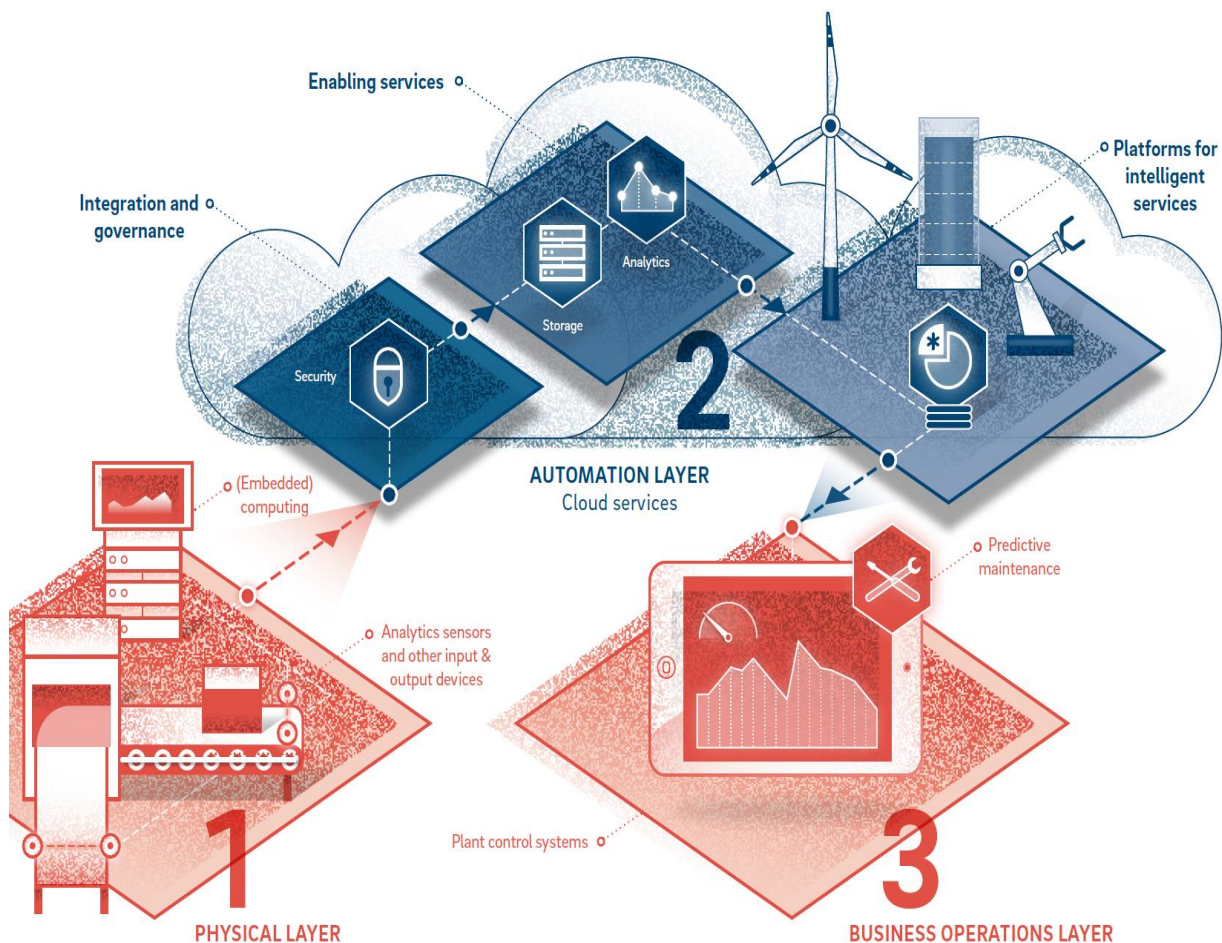


## 16 Logistics 4.0 & Smart Supply Chain 4.0 Management

Industry 4.0 is about more than just the smart factory or the implementation of technologies. In this chapter, we outline the essential elements of smart logistics, logistics management and supply chain management (SCM) in Industry 4.0, often called Logistics 4.0.

Just as Industry 4.0 is a holistic given with a (partial) transfer of autonomy, intelligence and autonomous decisions to machines and to the edge, supply chain and logistics in Industry 4.0 is very similar, albeit with, on top of the overlaps, different applications, technologies, human and business aspects and elements.

**Figure 6- Industry 4.0 Supply Chain Logistics Layers**



**Source:** Ronald Berger

There are many types of logistics and there are many definitions of logistics, ranging from the organization, planning and management of something complex, such as the logistics of setting up an event, to activities whereby many moving parts and processes are involved. It's in the latter sense of moving things (goods, assets, materials, data and more) around in a business, supply chain and Industry 4.0 context that we look at logistics.

When we see logistics as essentially getting things from A to Z with the many intermediary steps and the components of the supply chain and intelligent and efficient movement across all these different steps in a holistic way and add the aspect of autonomy to it, we quickly see what types of applications we really talk about: from driverless transportation to intelligent containers, smart warehousing and smart shelves to the human and information exchange in all possible logistical chains and contexts.

The benefits of an Industry 4.0 smart supply chain are:

- Multichannel offerings will require advanced real-time in-store inventory management capabilities
- End-to-end transparency will show availability while reducing safety stock at the same time
- Real-time information and predictive analytics will elevate planning and allocation to the next level
- Horizontal integration will drive down costs to handle complex supply chain networks
- Seamless channel integration will depend on convenient and cost-efficient last-mile delivery
- Transparency on quality and origin will help companies to differentiate in market and fulfill consumer demands

## 17 Value of Industry 4.0 Partnerships

For some companies, the data they produce can even become a new revenue stream. Take the humble umbrella. Mary Poppins' had special powers, and you might think that of connected umbrellas too. A clothing manufacturer might want to know where umbrellas have been used to supply stores with waterproof clothing that might sell well, and show adverts with offers to encourage passers-by to purchase them. A building owner might find it useful to know how many employees are coming to work with umbrellas to schedule the cleaning operators to mop floors to prevent anyone slipping up and change the temperature so that damp employees feel comfortable. A taxi company might want to know where umbrellas were congregated to adjust where its fleet was operating to take advantage of travelers not wanting to stand in the rain. Context data adds insight and can drive revenue.

These partnerships will become increasingly important and new relationships will form within industries and across industries like never before. Having a place where those industrial relationships can grow and flourish, accompanied by the expertise to facilitate it such as IBM's IoT HQ in Munich will see more connections being made that consumers will benefit from.

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