‘Lighthouse’ manufacturers lead the way—can the rest of the world keep up?

Manufacturing leaders are sprinting ahead with digital and analytics, and changing the rules of the game. A broad scale-up of innovation across the value chain is needed to ensure more winners share the spoils.

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JANUARY 2019 • OPERATIONS

The long-anticipated Fourth Industrial Revolution is no longer some far-off horizon. Early-adopting "lighthouse" factories are implementing advanced manufacturing and AI-driven technology, at scale, and seeing significant gains. What insights can the leaders share to accelerate digital scale-up broadly? What is needed to ensure these benefits spread across regions and sectors?

Some answers to these questions are addressed in the paper, Fourth Industrial Revolution: Beacons of Technology and Innovation in Manufacturing, *by the World Economic Forum, in collaboration with McKinsey & Company. The team identifies top-performing factories and explores insights from these "lighthouses"—16 of the world's most advanced sites implementing technologies of the Fourth Industrial Revolution, selected from a survey of over 1,000 manufacturing sites globally. The rest of this article, extracted from the full report, summarizes the key findings.*

Emitting powerful light that pierces fog and darkness, lighthouses are key to maritime navigation. With this research, we seek out manufacturers across a broad range of industries who are leading the way in Fourth Industrial Revolution innovation. Connected within the framework of the World Economic Forum's platform, these model factories, which have been recognized as Fourth Industrial Revolution "lighthouses," are starting a unique learning journey that will benefit the production ecosystem.

Manufacturing has experienced a decade of **productivity stagnation** and demand fragmentation; thus **innovation is long overdue**. Where Fourth Industrial Revolution innovation has been taken to scale beyond the pilot phase, **unprecedented increases in efficiency have occurred**, with minimal displacement of workers. However, most companies appear to be stuck in **"pilot purgatory."**

By contrast, this select group of manufacturing sites represent the leading edge of **technology adoption at scale**. These sites serve as beacons for the world, exemplifying the type of production approach that can drive the next engine of global economic growth. They demonstrate how forward-thinking engagement of **technology can create a better, cleaner world through new levels of efficiency in manufacturing**. Likewise, they illustrate how Fourth Industrial Technology at scale can transform the nature of work itself by upskilling and engaging human workers with minimal displacement.

Lighthouses serve as real-world evidence to dispel widespread myths and misunderstandings posing obstacles to innovative technology adoption at scale; in addition, these beacons shed light on the characteristics, differentiators, and success factors that realize optimal scaling.

Seeing the light: a radical leap forward for Fourth Industrial Revolution front-runners

Three technological megatrends—connectivity, intelligence, and flexible automation—are the principal drivers of a Fourth Industrial Revolution paradigm shift in production:

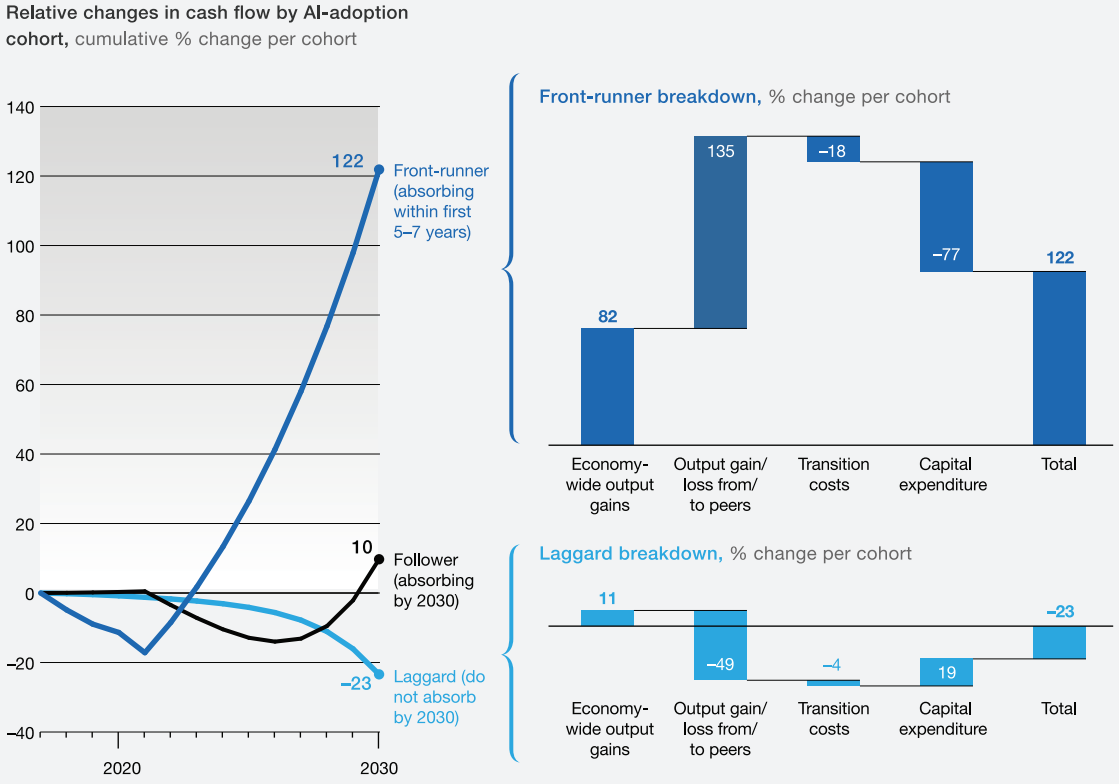
- Connectivity—Creates links between discreet network nodes, increasing visibility
- Flexible automation—Incorporates response mechanisms, automation, and remote movement
- Intelligence—Automates event recognition and translation for decision making

Technology adoption at scale can have a radical impact upon organizations. A close look at one of these three megatrends can make clear just how powerful this effect can be. For example, a McKinsey Global Institute analysis projects a remarkable gap

Exhibit 1

Faster AI adoption and absorption by front-runners can create larger economic gains

SIMULATION



Note: Numbers are simulated figures to provide directional perspectives rather than forecasts.

Source: McKinsey Global Institute analysis

between companies that adopt and absorb artificial intelligence (AI) within the first 5-7 years and those that follow or lag behind. The analysis suggests that "front-runners" in AI adoption can anticipate a cumulative 122% cash flow change, while "followers" will see a significantly lower impact of only 10% cash flow change. This shows the importance of early technology adoption, since companies waiting risk missing a large share of the benefits.

Company leaders who move to implementation early, rather than waiting for decreased technology and transition costs, will realize the greatest benefit. Thus, the largest factor here is related to the competitive advantage of front-runners, which by far outweighs the higher transition costs and capital expenditure related to the early adoption.[1]

Identifying lighthouses

The lighthouses are the factories that have taken Fourth Industrial Revolution technology from pilots to integration at scale, thus realizing significant financial and operational benefits. Qualification as a lighthouse requires meeting high standards

across four categories: significant impact achieved, successful integration of several use cases, a scalable technology platform, and strong performance on critical enablers such as change management, capability building, and collaboration with a Fourth Industrial Revolution community.

Identification of lighthouses followed a comprehensive scanning of more than 1,000 leading manufacturers across all industries and geographies. Contact with more than 150 of the most advanced companies yielded proposals from many companies' most sophisticated sites to be considered lighthouses. Site visits were carried out to document findings, which were then presented to a Fourth Industrial Revolution expert panel from private organizations, universities, and technology pioneers. This panel selected 16 lighthouses and recognized them as the most advanced production sites.

Understanding lighthouses

Numerous myths and misunderstandings pose obstacles to Fourth Industrial Revolution adoption. Dispelling them is vital to understanding how accessible the Fourth Industrial Revolution is to organizations of all kinds.

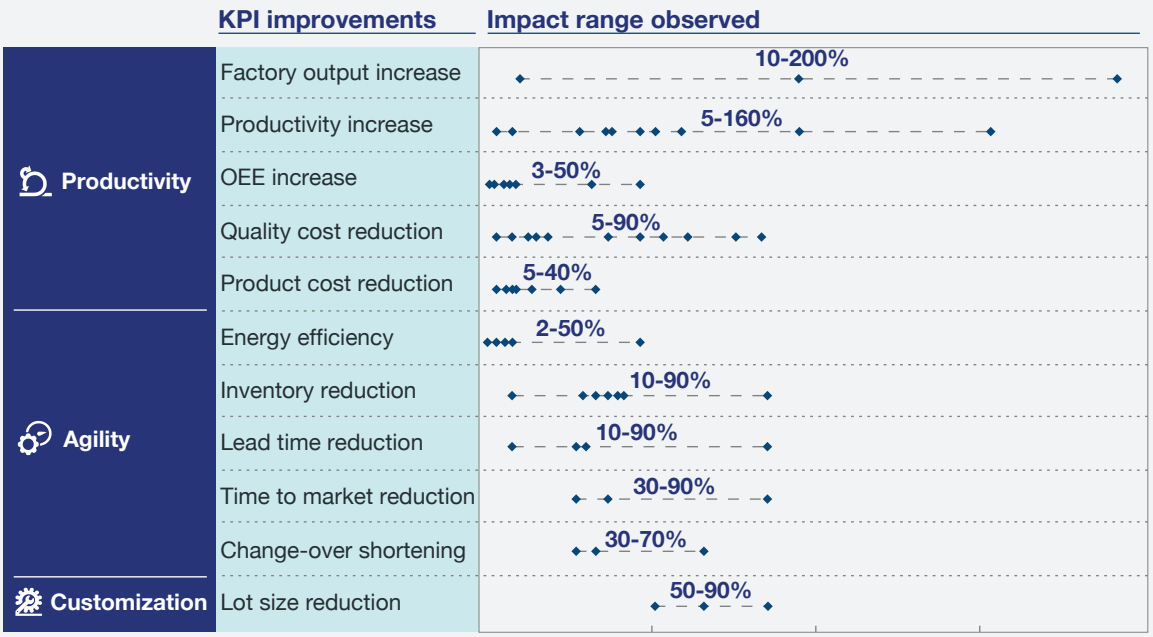
Exhibit 2 **Locations of WEF Lighthouses around the world**

- *Lighthouses inject human capital*—Contrary to widespread concerns about worker displacement, the lighthouse factories are not deploying Fourth Industrial Revolution technology to replace operators. A McKinsey report suggests that less than 5% of occupations consist of activities that are 100% automatable with today's technology, while 62% of occupations have at least 30% of automatable tasks. Consequently, employees in production enjoy a working routine which is becoming less repetitive, but more interesting, diversified, and productive.

- *Resetting benchmarks*—The Fourth Industrial Revolution differs from the continuous improvement efforts that have characterized factories for decades. It is not incremental; rather, it involves a step change—it is resetting benchmarks. Lighthouses leverage different Fourth Industrial Revolution use cases to transform their operations. They have, on average, 10-15 use cases at an advanced stage and are working on the development of an additional 10-15. Accordingly, lighthouses are resetting industry benchmarks for operational and financial key performance indicators (KPIs). Some lighthouses even outperformed their internal expectations by a factor of 2. With this transformative approach, lighthouses transform their operations and achieve a step change in performance increase—thereafter, they can engage in accelerated continuous improvement efforts,

Exhibit 3

Impact of Fourth Industrial Revolution use cases on select KPIs in lighthouse factories



Source: World Economic Forum and McKinsey & Company lighthouse site analysis

leveraging the new Fourth Industrial Revolution technologies and capabilities.

- *Open innovation and collaboration*—The lighthouses demonstrate that the Fourth Industrial Revolution journey need not be solitary—beacons can guide the way. Indeed, lighthouses are part of an innovation ecosystem that involves universities, startups, and other technology providers.

- *Large and small companies*—Notably, innovation is accessible not only to large organizations, but also to small and medium-sized enterprises (SMEs), which can achieve a transformative impact by focusing on pragmatic solutions that don't require large investments.

- *From emerging and developed economies*—Access to technologies is not the exclusive domain of developed economies. In fact, China is one of the leaders with a high number of lighthouses, and other lighthouses are located in Eastern Europe. This shows that other financial and operational benefits are more relevant than labor cost reduction.

- *High impact with minimal replacement of equipment*—Despite the misconception that legacy equipment and older facilities create a barrier to innovation, most of these lighthouses were in fact created by transforming existing brownfield operations.

Achieving impact at scale

The lighthouses have overcome typical challenges faced by companies, such as engaging in too many proofs-of-concept exercises, scaling too slowly, lacking an integrated business case for technologies, implementing too many isolated solutions, and creating countless data silos. How did they overcome these myriad typical challenges to achieve transformational impact and agile continuous improvement?

Charting a course for scale: two routes

The lighthouses prove that there is more than one way to embrace Fourth Industrial Revolution. Rather, there are two principal "routes to scale" and these routes are not mutually exclusive; rather, they can complement each other:

- *Innovation of the production system.* Companies expand their competitive advantage through operational excellence. They aim to optimize their production system, increasing the productivity and quality performance of their operations. Typically, they start to innovate in one or a few manufacturing sites and then roll out from there.

- *Innovation of the end-to-end value chain.* Companies create new businesses by changing the economics of operations. They innovate across the value chain, offering new or improved value propositions to customers by way of new products, new services, more customization, smaller lot sizes, or significantly shorter lead times. Companies stay focused on innovation and transforming one value chain first, then scale learnings and capabilities to other parts of the business.

Value drivers for impact at scale

The lighthouses exhibit five unique ways in which they create value—differentiators that transform how technology is implemented, how people interact with technology, and how it affects business decisions as well as results:

- *Big-data decision making*—Decisions are not hypothesis-driven, but rather, based on big data deciphered by pattern recognition—and not by humans.

- *Democratized technology*—Technology on the shop floor is transforming ways of working, as operators develop their own apps and solutions to facilitate and automate their tasks.

- *Agile working mode*—The lighthouses implement new use cases in an agile working mode, which allows them to do proofs of concept in a short time, improve the solution based on learning, and go quickly from pilot to scale-up. This is a matter of weeks versus years.

- *Minimal incremental cost to add use cases*—Use cases can be deployed at minimal additional cost, allowing factories to work on multiple areas at once.

- *New business models*—Fourth Industrial Revolution technologies enable the lighthouses to develop new business models which complement and/or disrupt the traditional business and value chain.

Scale-up enablers

The lighthouses exhibit four distinct capabilities—important success factors in the implementation journey:

- *Strategy and business case*—The lighthouses have a Fourth Industrial Revolution strategy linked to the creation of fundamental business value. It is clearly articulated and communicated, and has enterprise-wide validity.

- *IoT architecture built for scale-up*—The lighthouses have an IoT architecture built for scale-up and interoperability. All information flows into one central data lake and interfaces between applications are standardized.

- *Capability building*—The lighthouses have a very strong focus on capability building. Digital academies and smart factories allow all employees to learn the basics of new digital use cases and a smooth, efficient way of implementing them.

- *Workforce engagement*—In the lighthouses, the leaders act as role model for the change, they communicate a clear change story through various channels and ensure all employees feel part of the journey. Workers are actively involved in the development and deployment of use cases.

A call to action: what's next for the world's manufacturers?

To ensure the manufacturing ecosystem transitions as smoothly as possible through the Fourth Industrial Revolution while avoiding increased inequality and a "winner-takes-all" outcome, public and private leaders need to act responsibly. They have the power to influence the outcome of Fourth Industrial Revolution and mitigate these risks with a proactive approach. The following actions could support these goals:

- *Augment, instead of replace, the operator*—Factories should deploy technologies that allow the human operators to focus on the most value-adding activities, where the unique human skills of decision-making and adaptability to new situations brings most value—and, at the same time, create a more attractive workplace.

- *Invest in capability building and lifelong learning*—The private and public must prepare the workforce for the Fourth Industrial Revolution transition, including re-tooling the education system and investing in training as well as lifelong learning to create a mobile workforce which can benefit from the opportunities related to the Fourth Industrial Revolution.

- *Diffuse technologies across geographies and include SMEs*—The full benefit of the Fourth Industrial Revolution in manufacturing can only be realized if complete value chains and production ecosystems are transformed, including all geographies and SMEs, which are contributing 50-60% of value add in OECD countries. Therefore, companies should diffuse Fourth Industrial Revolution technologies across their entire production network and include developing economies as well as suppliers of all sizes. This will not only lead to improved overall results, but also ensure knowledge is spread more equally.

- *Address climate change challenge with Fourth Industrial Revolution technologies*—The world faces a significant challenge with regard to climate change, with a recent report from the IPCC stating that emissions must be cut by 45% by 2030 to keep below 1.5°C warming. Thus factories should leverage Fourth Industrial Revolution technologies to improve their energy efficiency, increase yield, and reduce waste and emissions while enhancing overall competitiveness.

If the manufacturing sector is to benefit individual organizations and all of society, technologies and digital capabilities must be adopted at scale and across the entire value chain. Though this is easier said than done, the full report provides key opportunities and lessons learned from each identified Lighthouse, as well as additional opportunities for public-private collaboration. ■

The original white paper is part of the World Economic Forum's "Technology and Innovation for the Future of Production," *and was created in collaboration with McKinsey & Company. Enno de Boer, a partner in the firm's manufacturing and supply chain practice, is the lead partner for the World Economic Forum Technology and Innovation for the Future of Production project.*

The white paper originally appeared on the World Economic Forum website and is excerpted here by permission.

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[2] *Ibid.*

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