In collaboration with
McKinsey & Company

WORLD ECONOMIC FORUM

Global Lighthouse Network: Shaping the Next Chapter of the Fourth Industrial Revolution

WHITE PAPER

JANUARY 2023

Images: Getty Images, Unsplash

Contents

Foreword 3

Executive summary 4

1 A dynamic network continues to expand 5

1.1 More than 100 lighthouses mark the start of a new chapter 5

1.2 Diverse use cases convey a compelling narrative 12

1.3 Sustainability leaders have set a new green standard 20

2 A new chapter begins 22

2.1 Scaling across production networks and beyond: the high impact lever 22

2.2 Scaling reality check: revealing the truth 24

2.3 Lighthouses are writing the scaling success story 25

3 Leaders in scaling Fourth Industrial Revolution: case studies 29

3.1 Danone: A people-led network approach 30

3.2 Cipla: Network-wide transformation using seven key enablers 31

3.3 Midea: A strong transformation office to deploy Fourth Industrial Revolution at scale 32

3.4 Join the Global Lighthouse Network to write the next chapter 33

Contributors 34

Foreword

Francisco Betti
Head, Shaping the Future
of Advanced Manufacturing
and Value Chains; Member,
Executive Committee,
World Economic Forum

Enno de Boer
Senior Partner,
McKinsey & Company

The Global Lighthouse Network started with a vision at the World Economic Forum's Annual Meeting 2018 in Davos-Klosters, Switzerland, when public- and private-sector leaders set out to identify manufacturers from a broad range of industries who were demonstrating frontrunner leadership in Fourth Industrial Revolution innovation. The Forum, in collaboration with McKinsey & Company, scanned thousands of leading manufacturers in search of the most advanced sites, leading to the identification of the first 16 lighthouses, which ranged from global blue chips to small local businesses with fewer than 100 employees. The network continued to grow, becoming a neutral collaboration platform to accelerate the adoption of Fourth Industrial Revolution technologies in manufacturing through new alliances, partnerships and a shared, cross-industry learning journey.

The Global Lighthouse Network today counts 132 sites, 13 of which are additionally recognized sustainability lighthouses for their technology-enabled improvements on environmental footprint. Lighthouses are leaders who have embraced vision, innovation and responsibility as they adopt advanced technologies across production networks and beyond, unlocking value while prioritizing environmental sustainability. They have been the lead authors of the Fourth Industrial Revolution's opening chapter – a compelling story told across a series of white papers exploring the evolution of technology deployment from factories to value chains end-to-end and beyond. Along the way, lighthouses have left waypoints that others can follow to emulate their progress and navigate challenges. This is vital because the chapter ahead – scaling Fourth Industrial Revolution technologies across entire organizations – is sure to be no less demanding and exciting. That is the focus of the research presented in this paper.

While localized transformations have confirmed the opportunity to achieve double-digit impact on throughput, costs or lead time through Fourth Industrial Revolution technologies, the challenge – and the opportunity, since lighthouses consider this a key lever to achieve strategic imperatives such as productivity, sustainability and resilience – is now to drive this transformation at scale across production networks and beyond. This means at multiple manufacturing sites, with thousands of people; moreover, it means extending technology deployment even beyond to suppliers and customers, or toward new functions like research and development (R&D), procurement and logistics. An ongoing, critical aspect of strategy will be successfully engaging the workforce to encourage Fourth Industrial Revolution technology adoption.

Informed by the perspectives from 132 sites around the globe, the analysis presented in this latest Global Lighthouse Network white paper offers a valuable look at how frontrunners have taken their place as leaders, progressing on realistic time horizons with a mature understanding of resources and enablers needed to scale. As they have done so, they have established scaling waypoints, enabling other companies to engage in a "smart follower strategy" that takes advantage of what they have learned along the way – particularly about where to invest efforts for maximum impact.

Executive summary

Since 2018, lighthouses recognized by the World Economic Forum, working in collaboration with McKinsey & Company, have been frontrunners of the Fourth Industrial Revolution. Their ability to drive impact at scale in all geographies and sectors has remained the essential differentiator, even as the challenges have changed with time. A total of 139 use cases resulting in double-digit improvements in financial, operational and sustainability metrics are their markers of success.

A new chapter of the Fourth Industrial Revolution – scaling advanced technologies throughout production networks and beyond – is under way amid continuing major global disruptions that include soaring energy prices and inflation, talent shortages, supply chain disruption, and the increasing impact of climate change. Against this backdrop, a survey was conducted to understand the positions of lighthouse and non-lighthouse companies on this next chapter. The results revealed the top three strategic priorities of respondents across all industries and regions: productivity, sustainability and resilience – and the scaling of Fourth Industrial Revolution technologies across production networks is considered a high-impact lever to achieve these by most.

This type of scaling, however, is difficult. While most companies have been confident about emerging out of pilot purgatory for several years, relatively few were able to move quickly from concept to execution of use cases. Similarly, scaling Fourth Industrial Revolution technologies across all facilities of a company's production network is significantly more difficult than deploying in one facility. Lighthouses are aware of what it takes to succeed and realistic about the time it will take, whereas many other manufacturers surveyed have a less concrete understanding.

This apparent "awareness gap" is a telling sign: 88% of lighthouse organizations report to be on or ahead of their schedule for scaling Fourth Industrial Revolution to at least half of their production network, while only 60% of non-lighthouses run on schedule and none ahead of schedule. When starting the journey towards digitalization, organizations would thus do well to be realistic with their timelines and to consider a wide variety of contingencies. While only 7% of production networks are considered advanced in the use of advanced techniques for non-lighthouse companies, it yields 20% for the lighthouses.

When asked about the principal obstacle of scaling, most non-lighthouses point to a lack of leadership commitment and investment, whereas lighthouses consider a lack of strategy the principal obstacle. Regarding the top enablers of digitalization, lighthouses overwhelmingly consider workforce engagement and transformation offices to be the most critical.

These differences represent an awareness gap about what it takes to scale. If non-lighthouses engage in a "smart follower strategy", taking into account what lighthouses have already learned, they will be able to scale faster and avoid pitfalls. It starts by recognizing the three must-haves for success. First, build a clear, value-driven strategy. Without clear direction, the breadth of possibilities and the variety of use cases and technologies threaten to mire organizations in pilot purgatory. Second, invest in people. Without the right resource and capability models, a transformation will soon run out of resources and steam. Third, set up the right governance. Without value assurance and governance – coupled with the right execution engine – companies cannot capture the value they seek or generate real impact. Case studies provided herein will concretely illustrate these must-haves.

As manufacturers begin the next chapter of the Fourth Industrial Revolution, the challenge is to achieve scaling across production networks and beyond, to suppliers and customers, and towards new functions. Organizations must redouble their commitment to the strategies for responsible growth, working both hard and smart by engaging key enablers for productivity gains while prioritizing sustainability and workforce development. This is the call for the global manufacturing community: join the Global Lighthouse Network to further learn from lighthouses and to follow their example, or become part of the group of leaders that lights the way to the next chapter of the Fourth Industrial Revolution.

1 A dynamic network continues to expand

The size of the Global Lighthouse Network shows that Fourth Industrial Revolution technologies are being adopted at scale.

The world has undergone fundamental changes since the early days of the Fourth Industrial Revolution. From the perspective of the Global Lighthouse Network, that revolution crystallized in 2018 with the recognition of the first manufacturing frontrunners as lighthouses.

Detailed analysis of many sites yielded a small group of frontrunners who were doing something special. The ability to engage transformation at scale was the essential differentiator then and remains so now. The challenges have changed with time, however, and so too have the requisite approaches to build and maintain momentum.

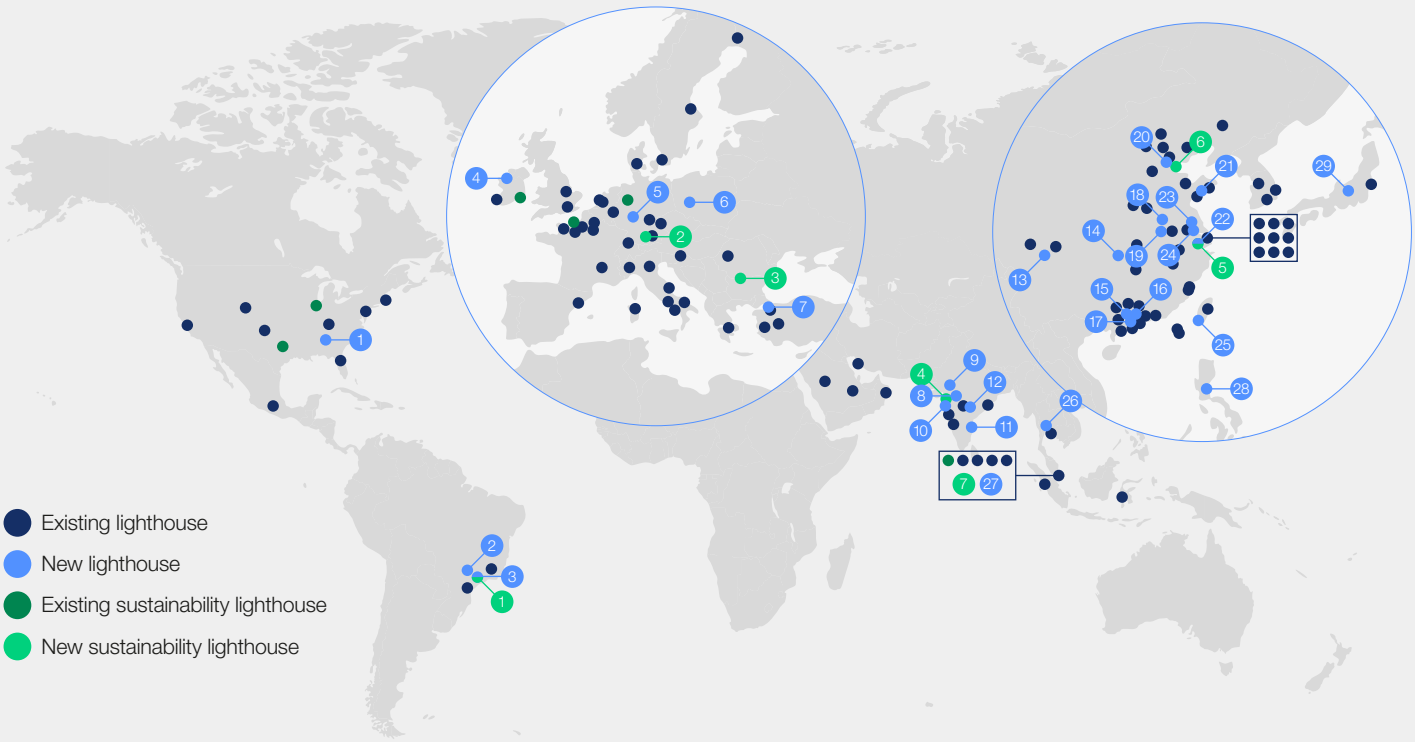
It is known that for any production network to succeed economically and sustainably, it must succeed both locally and globally. Members of the Global Lighthouse Network have crystallized how Fourth Industrial Revolution technology and working modes can help companies succeed at both levels while being more resilient to a future reshuffling of production networks.

1.1 More than 130 lighthouses mark the start of a new chapter

Since 2018, the Global Lighthouse Network has grown to include 132 member sites selected by an independent expert panel. This includes 29 new lighthouses in 2022 and the designation of seven sustainability lighthouses. The network spans industry sectors from consumer-packaged goods, process industries and advanced industries, to pharmaceutical and medical products.

Just as they have since the network's inception, these sites have demonstrated impact across operational performance indicators, including sustainability, productivity, agility, speed to market and customization.

FIGURE 1 | **The Global Lighthouse Network comprises 132 lighthouses as of January 2023**



New lighthouses in 2022

1 **LG Electronics** Clarksville, US

2 **Unilever** Indaiatuba, BR

3 **Flex** Sorocaba, BR

4 **The Coca-Cola Company** Ballina, IE

5 **MantaMESH** Fröttstädt, DE

6 **Danone** Opole, PL

7 **Bosch** Bursa, TR

8 **Cipla** Indore, IN

9 **CEAT** Halol, IN

10 **Johnson & Johnson Consumer Health** Mulund, IN

11 **Mondelēz** Sri City, IN

12 **Dr. Reddy's Laboratories** Hyderabad, IN

13 **Contemporary Amperex Technology** Yibin, CN

14 **Sany Heavy Industry** Changsha, CN

15 **Wistron** Zhongshan, CN

16 **Foxconn Industrial Internet** Shenzhen, CN

17 **Midea** Foshan, CN

18 **Lenovo** Hefei, CN

19 **Haier** Hefei, CN

20 **Unilever** Tianjin, CN

21 **Haier** Qingdao, CN

22 **Western Digital** Shanghai, CN

23 **Mondelēz** Suzhou, CN

24 **Huayi New Material** Shanghai, CN

25 **Advanced Semiconductor Engineering** Kaohsiung, TW, CN

26 **Western Digital** Bang Pa-in, TH

27 **Agilent Technologies** Singapore, SG

28 **Western Digital** Laguna, PH

29 **Procter & Gamble** Takasaki, JP

1 **Flex** Sorocaba, BR

2 **Siemens** Amberg, DE

3 **Arçelik** Ulmi, RO

4 **Unilever** Dapada, IN

5 **Western Digital** Shanghai, CN

6 **Haier** Tianjin, CN

7 **Micron** Singapore, SG

Source: World Economic Forum Global Lighthouse Network

FIGURE 2 | **Lighthouses' digital journey reveal impact across operational performance indicators and environmental sustainability**

*Overall equipment effectiveness

Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 3 | **The Global Lighthouse Network is growing in size and diversity across all industry sectors**

Consumer packaged goods

Alibaba
Apparel, Hangzhou, CN

The Coca-Cola Company
Beverages, Ballina, IE

Danone
Food products, Opole, PL

Henkel
Home / fabric care products, Düsseldorf, DE

Henkel
Home / fabric care products, Montornès, ES

Henkel
Home / fabric care products, Toluca, MX

Mondelēz
Food products, Sri City, IN

Mondelēz
Food products, Suzhou, CN

Procter & Gamble
Fabric care products, Amiens, FR

Procter & Gamble
Personal care, Guangzhou, CN

Procter & Gamble
Fabric care products, Lima, OH, US

Procter & Gamble
Home / fabric care products, Rakona, CZ

Procter & Gamble
Personal / fabric care products, Taicang, CN

Procter & Gamble
Home / fabric care products, Takasaki, JP

Tsingtao Brewery Co
Beverages, Qingdao, CN

Unilever
Fabric care products, Dapada IN

Unilever
Personal care products, Dubai, UAE

Unilever
Care products, Hefei, CN

Unilever
Fabric care products, Indaiatuba, BR

Unilever
Food products, Taicang, CN

Unilever
Food products, Tianjin, CN

Process industries

Baoshan Iron & Steel
Steel products, Shanghai, CN

DCP Midstream
Oil and gas, Denver, CO, US

Huayi New Material
Chemicals, Shanghai, CN

MODEC
Oil and gas, Rio de Janeiro, BR

Petkim
Chemicals, Izmir, TR

Petrosea
Mining, Tabang, ID

POSCO
Steel products, Pohang, KR

Renew Power
Renewable energy, Hubli, IN

Saudi Aramco
Oil and gas, Abqaiq, SA

Saudi Aramco
Oil and gas, Khurais, SA

Saudi Aramco
Oil and gas, Uthmaniyah, SA

STAR refinery
Oil and gas, Izmir, TR

Tata Steel
Steel products, Ijmuiden, NL

Tata Steel
Steel products, Jamshedpur, IN

Tata Steel
Steel products, Kalinganagar, IN

Advanced industries

Advanced Semiconductor Engineering (ASE)
Semiconductors, Kaohsiung, TW, CN

AGCO
Agricultural equipment, Marktoberdorf, DE

Arçelik
Home appliances, Eskişehir, TR

Arçelik
Home appliances, Ulmi, RO

AUO
Optoelectronics, Taichung, TW, CN

BMW Group
Automotive, Regensberg, DE

BOE Optoelectronics Technology
Optoelectronics, Fuzhou, CN

Bosch
Automotive, Bursa, TR

Bosch
Automotive, Changsha, CN

Bosch
Automotive, Suzhou, CN

Bosch
Automotive, Wuxi, CN

Contemporary Amperex Technology
Electronics, Nindge, CN

Contemporary Amperex Technology
Electronics, Yibin, CN

CEAT
Automotive, Halol, IN

CITIC Dicastal
Automotive, Qinhuangdao, CN

Danfoss
Industrial equipment, Tianjin, CN

De'Longhi
Home appliances, Treviso, IT

Ericsson
Electronics, Lewisville, TX, US

Fast Radius with UPS
Additive manufacturing, Chicago, IL US

Flex
Electronics, Althofen, AT

Flex
Electronics, Sorocaba, BR

Ford Otosan
Automotive, Kocaeli, TR

FOTON Cummins
Automotive, Beijing, CN

Foxconn
Electronics, Chengdu, CN

Foxconn Industrial Internet
Electronics, Shenzhen, CN

Foxconn Industrial Internet
Electronics, Shenzhen, CN

Foxconn
Electronics, Wuhan, CN

Foxconn
Electronics, Zhengzhou, CN

Groupe Renault
Automotive, Cléon, FR

Groupe Renault
Automotive, Curitiba, BR

Groupe Renault
Automotive, Maubeuge, FR

Haier
Home appliances, Hefei, CN

Haier
Home appliances, Qingdao, CN

Haier
Home appliances, Qingdao, CN

Haier
Home appliances, Shenyang, CN

Haier
Home appliances, Tianjin, CN

Haier
Home appliances, Zhengzhou, CN

Hitachi
Industrial equipment, Hitachi JP

HP
Electronics, Singapore, SG

Infineon
Semiconductors, Singapore, SG

Innolux
Optoelectronics, Kaohsiung, TW, CN

Lenovo
Electronics, Hefei, CN

LG Electronics
Electronics, Clarksville, TN, US

LG Electronics
Electronics, Changwon, KR

LS ELECTRIC
Electrical components, Cheongju, KR

MantaMESH
Industrial Equipment, Fröttstädt, DE

Micron
Semiconductors, Singapore, SG

Micron
Semiconductors, Taichung, TW, CN

Midea
Home appliances, Foshan, CN

Midea
Home appliances, Guangzhou, CN

Midea
Home appliances, Hefei, CN

Midea
Home appliances, Jingzhou, CN

Midea
Home appliances, Foshan, CN

Nokia
Electronics, Oulu, FI

Phoenix Contact
Industrial automation, Blomberg, DE

Protolabs
Additive manufacturing, Plymouth, MN US

Rold
Electrical components, Cierro Maggiore, IT

SAIC Maxus
Automotive, Nanjing, CN

Sandvik Coromant
Industrial tools, Gimo, SE

Sany Heavy Industry
Industrial equipment, Beijing, CN

Sany Heavy Industry
Industrial equipment, Changsha, CN

Schneider Electric
Electrical components, Batam, ID

Schneider Electric
Electrical components, Hyderabad, IN

Schneider Electric
Electrical components, Le Vaudreuil, FR

Schneider Electric
Electrical components, Lexington, KY, US

Schneider Electric
Electrical components, Wuxi, CN

Siemens
Industrial automation products, Amberg, DE

Siemens
Industrial automation products, Chengdu, CN

Weichai
Industrial machinery, Weifang, CN

Western Digital
Electronics, Bang Pa-in, TH

Western Digital
Electronics, Laguna, PH

Western Digital
Electronics, Penang, MY

Western Digital
Electronics, Prachinburi, TH

Western Digital
Electronics, Shanghai, CN

Wistron
Electronics, Kunshan, CN

Wistron
Electronics, Zhongshan, CN

Source: World Economic Forum Global Lighthouse Network

FIGURE 3 | **The Global Lighthouse Network is growing in size and diversity across all industry sectors (continued)**

Pharmaceuticals and medical products

Agilent Technologies
Medical equipment, Singapore, SG

Bayer
Pharmaceutical, Garbagnate, IT

Cipla
Pharmaceuticals, Indore, IN

Dr. Reddy's Laboratories
Pharmaceuticals, Hyderabad, IN

GE Healthcare
Medical equipment, Hino, JP

GSK
Pharmaceuticals, Ware, UK

Johnson & Johnson Consumer Health
Self-care products, Bangkok, TH

Johnson & Johnson Consumer Health
Self-care products, Helsingborg, SE

Johnson & Johnson Consumer Health
Self-care products, Mulund, IN

Johnson & Johnson DePuy Synthes
Medical devices, Bridgewater, NJ, US

Johnson & Johnson DePuy Synthes
Medical devices, Cork, IR

Johnson & Johnson DePuy Synthes
Medical devices, Suzhou, CN

Johnson & Johnson Janssen
Pharmaceuticals, Cork, IR

Johnson & Johnson Janssen
Pharmaceuticals, Latina, IT

Johnson & Johnson Vision Care
Medical devices, Jacksonville, FL, US

Johnson & Johnson Vision Care
Medical devices, London, UK

Novo Nordisk
Pharmaceuticals, Hillerød, DK

Sanofi
Pharmaceuticals, Paris, FR

Teva
Pharmaceuticals, Amsterdam, NL

Zymergen
Biotechnology, Emeryville, CA, US

Source: World Economic Forum Global Lighthouse Network

FIGURE 4 | **Lighthouses are deploying 139 use cases, with some focusing within the manufacturing site and others on connecting the end-to-end value chain (1/2)**

Manufacturing site

Digital assembly and machines

- Additive manufacturing (3D printing)
- Advanced industrial internet of things (IIoT) applied to process optimization
- Artificial intelligence (AI)-guided machine performance optimization
- AI-powered material handling system
- AI-powered process control
- Automated material handling
- Automated tool design
- Collaborative robotics and automation
- Cycle time optimization through big-data analytics on lines PLCs*
- Digital engineering
- Digital lean tools (e.g. eKanban)
- Digital twin for flexible production
- Digitally enabled flexible manufacturing
- Digitally enabled modular production configuration
- Digitally enabled variable takt time
- Light-guided assembly sequence
- Mixed reality to enable digital training
- Real-time locating system (RTLS) for key manufacturing components
- Repair process automation
- Automated line balancing

Digital maintenance

- Analytics platform for deviation root-cause identification
- Cost optimization of heavy operations through sensor analysis
- Digitally enabled pipeline leak prevention and detection
- Machine alarm aggregation, prioritization and analytics-enabled problem solving
- Predictive maintenance aggregating data based on historical and sensor data
- Real-time pipeline cost optimization based on edge sensors
- Remote assistance using augmented reality
- Unmanned vehicles for inspection

Digital performance management

- Analytics platform for remote production optimization
- Analytics platform for yield management and root-cause analysis
- Digital dashboards to monitor OEE performance
- Digital recruitment platform tailored to shop floor
- Digital tools to enhance a connected workforce
- Digital twin for remote production optimization
- Digitally enabled man-machine matching
- Enterprise manufacturing intelligence system to upgrade operations management
- Integration platform to connect machine-level data with enterprise software
- Real-time asset performance monitoring and visualization
- Sensor-based manufacture key performance indicators (KPI) reporting
- Smart workforce upskilling tool
- Analytics-driven natural risk predictionDigital dashboards to monitor OEE performance

Digital quality management

- AI-enabled safety management
- AI-powered optical inspection
- AI-powered automated testing and repair
- Automated in-line optical inspection to replace end-product manual inspections
- Automated inspection enabled by digital thread
- Digital quality audit
- Digital work instructions and quality functions
- Digitally enabled batch release
- Digitally enabled quality failure diagnosis
- Digitized standard procedures for line operations with integrated workflow
- Field quality failures aggregation, prioritization and advanced analytics-enabled problem-solving
- Internet of things-enabled manufacturing quality management
- Mixed reality glasses to guide operators in the end-of-line inspection
- Quality improvement by predictive analytics
- Scanning to replace and improve performance for high-cost coordinated measuring machines (CMM)
- AI-powered noise inspection
- AI-powered testing optimization

Digitally enabled sustainability

- Advanced analytics enabled clean water reduction and contaminated water cleaning optimization
- End-to-end CO_2 tracking and reporting across entire value chain
- Advanced analytics enabled sustainability optimization
- Digital twin for sustainability
- IIoT real time sensor based data aggregation for energy, emissions, waste and water management
- IIoT and advanced analytics based energy consumption optimization
- AI-enabled energy consumption prediction and optimization

*Programmeable logic controller

Source: World Economic Forum Global Lighthouse Network

FIGURE 5 **Lighthouses are deploying 139 use cases, with some focusing within the manufacturing site and others on connecting the end-to-end value chain (2/2)**

End-to-end value chain

Supply network connectivity

- Agile buying through price prediction
- Aggregate demand across end-to-end supplier network
- Analytics-driven procurement supported by spend intelligence and automated spend cube
- Analytics-driven supply risk prediction
- AI to accelerate scaling of digital applications across sites
- AI-powered contract review for decision-making
- Digital supplier performance management
- Digitally enabled automatic material call-off system
- Digitally enabled negotiations
- Joint data analytics with equipment original equipment manufacturer for process optimization
- Part traceability from unique digital tag based on surface scanning
- Should-cost modelling to support make versus buy decisions
- Supplier and materials quality tracking
- Supplier material delivery by eKanban
- Supplier material quality prediction using advanced analytics
- Analytics platform for tenders
- Smart spend category creation
- Global spend data lake
- Logistic cost reduction through analytics enabled capacity and price prediction

End-to-end product development

- Advanced analytics for performance management across the idea to market
- Automated design for manufacturing analysis
- Big-data/AI-enabled product design and testing
- Crowdsourcing and competitions to develop digital solutions
- Digital thread implementation through product development life cycles
- Product development using robotics
- Rapid outsourced prototyping
- Testing automation
- Virtual-reality supported prototyping
- 3D printing for rapid design prototyping
- 3D simulations/digital twin for product design and testing
- Automated product design

End-to-end planning

- Advanced analytics to optimize manufacturing and distribution footprint
- Analytics for dynamic warehouse resource planning and scheduling
- Closed-loop planning
- Digital integrated business planning
- Dynamic network optimization
- Dynamic production scheduling with digital twin
- Dynamic simulation for warehousing design
- E2E real-time supply chain visibility platform
- No-touch master planning (allocation to the plants)
- Predictive demand forecasting
- Predictive inventory replenishment
- Production planning optimized by advanced analytics
- Real-time inventory management (internal/ extremal)
- Real-time sales and operations planning (S&OP)

End-to-end delivery

- Asset use and yard management for logistics
- Available to promise (ATP) based on real-time constraints
- Digital-enabled picking and transport
- Digital logistics control tower
- Digital track and trace
- Dynamic delivery optimization
- No-touch order management
- Predictive maintenance in fleet assets
- Robotics-enabled logistics execution
- Uberization of transport
- 3D printing
- Digital twin of material transport system
- Blockchain enabled logistics execution

Customer connectivity

- AI-enabled customer support
- Connected devices to track and measure consumer behaviours
- Connected devices to track and measure product performance
- Customer analytics enabled by radio frequency identification device (RFID)
- Customer end-user interface to configure and order a product, and track delivery
- Delivering to customers wherever they are through new delivery solutions
- Digital twin of customer system
- Digitally enabled customer performance monitoring
- Digitally enabled final-mile personalization
- Digitally enabled real-time connectivity with customer system
- GPS-based map and customer location
- Market insights generated by advanced analytics
- Mass customization and business-to-consumer online ordering
- Online communities for customer insights
- Smart/intelligent packaging, automated invoicing, payment and receivables system
- Digital-enabled flexible manufacturing

Source: World Economic Forum Global Lighthouse Network, 2022

1.2 Diverse use cases convey a compelling narrative

FIGURE 6 **The lighthouses show a variety of new use cases (1/8)**

Site	Change story	Top five use cases	Impact	
Advanced Semiconductor Engineering Kaohsiung, Taiwan, China	To improve productivity and reduce lead time in an increasingly complex manufacturing environment of over 100 process steps, ASE Kaohsiung's bumping factory deployed AI applications in their processes from inspection to dispatch. As a result, the site was able to increase output by 67% while reducing order lead time by 39%.	AI-powered optical inspection	↓ 67%	Scrap cost
		Automatic virtual measurement	↑ 14%	Throughput
		Smart yield management platform	↓ 78%	Hold time
		Intelligent dispatching system	↑ 4.5%	On-time delivery
		AR-enabled site safety patrol management	↓ 100%	Inspection time
Agilent Technologies Singapore, SG	With the ambition to simplify high-tech manufacturing in low-volume, high-complexity instruments to meet rising customer demand, Agilent Singapore deployed IIoT-powered digital twin, AI and robotic automation solutions to achieve sustainable growth, overcoming bottlenecks from specialized manpower and transforming the workforce into scalable Fourth Industrial Revloution-ready generalists. This resulted in increased output by 80%, improved productivity by 60%, improved cycle time by 30% and quality cost by 20%.	Digital twin for flexible production	↓ 25%	Overall manufacturing cost
		Cycle time optimization through big-data analytics on lines PLCs	↓ 33%	End-to-end cycle time
		Digitally enabled quality failure diagnosis	↓ 75%	Testing lead time
		Internet of things-enabled manufacturing quality management	↓ 19%	Cost of poor quality
		AI-powered optical inspection	↑ 31%	Labour productivity
Bosch Bursa, TR	To secure future investments and resources for production of new products such as hydrogen components, Bosch Powertrain Solutions Plant in Bursa needed to further strengthen its cost leadership. By deploying AI use cases such as close loop process control for hydro-erosion, and upskilling 100% of the workforce, they reduced unit manufacturing cost by 9% and improved OEE by 9%.	Anomaly detection engine at shopfloor	↑ 30pp*	OEE
		AI-powered optical inspection to detect coating defects	↑ 12%	Productivity
		Machining tool life tracking system	↓ 10%	Tool costs
		AI-powered process control at hydro-erosion	↓ -50%	Defect rate
		Digital alert-based logistics	↓ 23%	Inventories
CEAT Halol, IN	To capture greater market volumes, CEAT needed to incorporate greener materials and meet stringent in-process specifications. CEAT deployed Fourth Industrial Revolution use cases like advanced analytics to optimize cycle times and digitalization of operator's touchpoints. As a result, the site reduced cycle times by 20%, process scrap by 46%, and energy consumption by 15% . Overall, this resulted in approximately a 2.5 times increase in export and OEM sales in two years.	Advanced analytics-based cycle time optimization at mixer	↓ 20%	Cycle time (bottleneck)
		IoT-enabled dynamic heating process control at press	↓ 20%	Steam specific consumption
		Compressed air optimization using predictive analytics	↓ 25%	Air specific consumption
		Digitally enabled scrap monitoring with in-built root cause analyser	↓ 46%	Total scrap
		ML powered visual analytics for tire inventory management	↑ 29%	On time in full (OTIF)

*Percentage points **Original equipment manufacturer

Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 7 | **The lighthouses show a variety of new use cases (2/8)**

Site	Change story	Top five use cases	Impact	
Cipla Indore, IN	To preserve access to high quality affordable drugs globally while facing an increase in material and labour costs, Cipla deployed digital, automation and analytics solutions to 22 Indian sites in parallel. Indore's Oral Solid Dosage facility led this journey by implementing 30 Fourth Industrial Revolution use cases thereby improving total cost by 26% and enhancing quality by 300%, while reducing greenhouse gas (GHG) emissions by 28%.	Analytics-driven procurement supported by spend intelligence and automated spend cube	↓ 26%	Overall manufacturing cost
		Advanced IIoT applied to process optimization	↑ 16%	Product yield optimization
		AI-guided machine performance optimization	↑ 37%	Process OEE
		Production planning optimized by advanced analytics	↓ 22%	Process change-overs
		IIoT and advanced analytics-based energy consumption optmization	↓ 34%	Energy consumption
The Coca-Cola Company Ballina, IE	Ballina site, the company's largest concentrate manufacturing facility, delivers over 3,500 SKUs to 68 countries. To enable growth, build resilience and address increasing portfolio complexity, the site implemented digital, and analytics use cases. As a result, it improved cost by 16% while expanding its SKU portfolio by 30%, and led Fourth Industrial Revolution scaling across the network of 17 sites.	Integrated digital scheduling for manufacturing and filling	↑ 11%	Process orders
		Digital performance management	↑ 53%	OEE
		Juice manufacturing cycle time reduction through data analytics	↓ 17%	Batch cycle time
		ML-based process parameters optimization of filling line	↓ 15%	Average cycle time
		Beverage as a service supported by internet of things and automation	↓ 15%	Delivery shortages
Contemporary Amperex Technology Yibin, CN	To catch up with significant business growth, and higher quality and sustainability expectation, CATL builds up a large greenfield in Yibin city. The plant further deployed in depth AI, internet of things and flexible automation on top of CATL Ningde headquarters lighthouse digital initiatives, and has achieved 17% increased line speed, 14% reduced yield loss, and zero carbon emission.	AI-powered optical inspection	↓ 63%	Number of FTEs
		AI-powered process control	↑ 100%	Assembly efficiency
		IIoT real time sensor-based data aggregation for energy, emissions, waste and water management	↓ 13%	Energy consumption
		Digital twin for flexible production	↑ 128%	Automation rate
		AI-enabled safety management	↓ 100%	Production safety incidents
Danone Opole, PL	To address an increasing product portfolio complexity, Danone Opole engaged its whole workforce across functions and levels into a digital transformation journey to deploy connected shop floor, artificial intelligence and automation at scale. As a result, it improved costs by 19%, efficiency by 12% while improving quality and reducing GHG emissions by close to 50%. It became a transformation leader for the other 39 Danone plants in Europe and top employer in the local market.	AI-guided machine performance optimization	↓ 40%	Energy consumption
		Digitally enabled batch release	↑ 50%	Labour productivity
		Digital dashboards to monitor OEE performance	↑ 12%	Process OEE
		Digital tools to enhance a connected workforce	↓ 28%	Change-over time
		Integration platform to connect machine-level data with enterprise-software	↑ 50%	Labour productivity

*Stock keeping units

Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 8 | **The lighthouses show a variety of new use cases (3/8)**

Site	Change story	Top five use cases	Impact	
Dr. Reddy's Laboratories Hyderabad, IN	Facing business challenges from severe price erosion and rapidly evolving quality expectations, the 25-year-old site embarked on large scale digitalization to sustain and grow in the generics pharma market. The site deployed over 40 Fourth Industrial Revolution use cases by operating in garage mode and leveraging IIoT and democratized platform for advanced analytics. As a result, it improved manufacturing cost by 43% while proactively enhancing quality and reducing energy by 41%.	Dynamic production scheduling with digital twin	↓ 21%	Raw materials/overall manufacturing cost
		IoT-enabled manufacturing quality management	↓ 52%	Quality deviations
		Analytics platform for yield management and root-cause analysis	↑ 22%	Product yield optimization
		Field quality failures aggregation, prioritization and advanced analytics enabled problem-solving	↑ 90%	Labour productivity
		Real-time asset performance monitoring and visualization	↓ 20%	Energy consumption
Flex Sorocaba, BR	To improve site competitiveness, sustainability and health, Flex implemented Fourth Industrial Revolution initiatives along the end-to-end value chain, such as internet of things-enabled recycling of electronic waste and supply chain control tower. Digital transformation journey resulted into a 50% labour cost improvement, a 81% material loss reduction, while increasing customer satisfaction (+18%) and employees well-being.	Digital performance management	↑ 23%	Process OEE
		AI-enabled safety management	↓ 93%	Lost workday
		Digitally enabled circular economy	↓ 94%	Material waste
		Digitally-powered office productivity	↓ 38%	Non value added work
		Digital tools to enhance a connected workforce	↑ 18%	Customer satisfaction
Foxconn Industrial Internet Shenzen, CN	In response to customers' needs for rapid releases of new smartphone products and strict quality standards, Foxconn Industrial Internet enabled agile product introduction, quick capacity ramp-up, and smart mass production by deploying 37 different Fourth Industrial Revolution use cases at scale. This accelerated new product introduction by 29%, led to 50% faster ramp-ups, reduced quality non-conformance by 56% and reduced manufacturing cost by 30%.	AI-enabled new product introduction	↓ 29%	New product introduction time
		Next generation lights-out CNC workshop	↑ 313%	Labour productivity
		Autonomous anodizing with advanced controls	↑ 16pp	First yield pass
		High-precision automated quality inspection	↓ 54%	Direct labour
		Multi-site benchmarking and capacity optimization	↓ 59%	WIP inventories
Haier Hefei, CN	Facing challenges in product diversity, time-to-delivery and quality due to supplier base expansion, the site deployed 18 different Fourth Industrial Revolution use cases across their supply network, R&D, manufacturing and customer services, leveraging their bespoke IIoT platform designed to accelerate at-scale deployment of AI, machine vision and Advanced Analytics. Doing so cut order lead time in half and lowered on-site defect rates by 33%.	IIoT-enabled production resource optimization and supply risk forecast	↑ 6%	On-time delivery rate
		Acceleration of design failure detection and optimization based on aviation technology	↓ 75%	Failure quality loss rate
		AA-powered line balancing and operator dispatching	↑ 30%	Labour efficiency
		Adaptive optical inspection	↑ 67%	Inspection efficiency
		"Click-to-repair": one-click automated root cause problem solving in aftersales	↓ 33%	On-site defective rate

Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 9 | **The lighthouses show a variety of new use cases (4/8)**

Site	Change story	Top five use cases	Impact	
Haier Qingdao #2, CN	Facing growing demand for customized design, fast delivery and high quality, Haier refrigerator factory leveraged big data, digital twin and advanced visual inspection technology to accelerate R&D, upgrade manufacturing process and logistics scheduling mode. The order response lead time has been shortened by 35%, production efficiency has been increased by 35% and quality performance has been improved by 36%.	Big-data/AI-enabled product design and testing	↓ 85%	Market research time
		AI-powered process control	↓ 37%	Energy consumption
		AI-powered Optical inspection	↑ 50%	Inspection efficiency
		Collaborative robotics and automation	↑ 52%	Assembly efficiency
		Dynamic delivery optimization	↓ 52%	Loading time for finished goods
Huayi New Material Shanghai, CN	To respond to external challenges, such as 30% over-capacity and higher costs due to market volatility, the company has deployed 28 different Fourth Industrial Revolution use cases, such as machine-learning-enabled process optimization and AI-enabled safety management. As a result, labour productivity increased by 33%, conversion cost fell by 20%, energy consumption dropped 31%, and recordable safety incidents reached zero.	Digitally enabled profit optimizer across value chain	↑ 15%	Inventory turnover
		Machine learning enabled chemical reactor optimization	↓ 22%	Material waste
		IIoT enabled equipment monitoring and failure diagnosis	↑ 10%	OEE
		Artificial intelligence enabled safety management	↓ 100%	Total recordable incident rate
		Advanced analytics enabled steam network optimization	↓ 38%	Steam consumption
Johnson & Johnson Consumer Health Mulund, IN	Facing a volatile demand in a highly fragmented and complex network of distributors and vendors, Johnson & Johnson India deployed Fourth Industrial Revolution solutions such as demand sensing, smart logistics, robotics and 3D printing. As a result, they reduced OTIF losses by 66%, accelerated new product introduction by 33% and improved cost per piece by 34%.	AI/ML based demand sensing and inventory replenishment solution	↑ 4.5pp	OTIF
		Smart logistics to enable agility & real time visibility	↑ 14pp	Truckload utilization
		Robotics enabled agile product development	↓ 87%	Product development testing lead time
		Agile new product introduction enabled by 3D printing	↓ 92%	Design iteration lead time
		Predictive maintenance to improve asset reliability	↓ 50%	Unplanned machine down time
Lenovo Hefei, CN	Facing fierce competition, significant demand fluctuation and growing product customization, Lenovo Hefei, the world's largest single PC factory, deployed over 30 Fourth Industrial Revolution flexible automation and advanced analytics use cases, improving labour productivity by 45%, reducing supplier quality issue by 55%, while managing small-size yet numerous customer orders (80% of them being less than five units).	End-to-end AI-based production planning and scheduling	↑ 20%	Average scheduled orders
		Smart workforce planning and optimization	↑ 31%	Work-hour utilization rate
		End-to-end AI-enabled supply quality management on cloud	↓ 55%	Supply quality reject rate
		Lights-out flexible assembly testing automation	↓ 80%	Changeover time
		Smart bottleneck identification and close loop problem solving	↑ 30%	Units per worker per hour (UPPH)

Source: World Economic Forum Global Lighthouse Network

FIGURE 10 | **The lighthouses show a variety of new use cases (5/8)**

Site	Change story	Top five use cases	Impact	
LG Electronics Clarksville, US	Following the establishment of a plant in the US two years ago to be closer to customers, LG encountered various human resource risks and a lack of production know-how. By adopting Fourth Industrial Revolution technologies, such as deep learning, automation and digitalization, LG was able to strengthen its strategic production base in the US, increasing sales by 68% and growing net profit by 703%.	Product design automation	↓ 30%	Development lead time
		Virtual product performance verification	↓ 61%	Field failure rate
		Intelligent injection moulding system	↑ 21%	OEE
		Unmanned logistics system using AGV*	↑ 25%	Capability of productivity
		Zero quality defects by applying AI as a cognitive automation	↓ 43%	Process defect rate
MantaMESH Fröttstädt, DE	With cost leadership being critical to compete as a SME in a highly competitive commodity market, MantaMESH developed a Fourth Industrial Revolution an online manufacturing business model that connects customers to an automated fulfilment system. All customer interactions are automatically processed online with real-time connection to smart manufacturing plants. The result is a 261% increase in customer activity and 73% growth in production volumes while reducing energy consumption/kg produced by 32%.	Self service B2B customer portal with real time user behaviour analysis	↑ 238%	Number of transactions
		Online product design and ordering system generating “machine ready” data	↓ 99%	Quote to order time
		Connected digitally enabled flexible manufacturing	↓ 99%	Change over time
		Digital performance monitoring	↑ 53%	Labour productivity
		Automated invoicing, payment and receivables system	↓ 80%	Debtor days
Midea Foshan #2, CN	In order to meet demand for high quality products delivered in shorter lead times, Midea Shunde factory has deployed AI, digital twin and other Fourth Industrial Revolution technologies in the end-to-end value chain, achieving 24% lower unit production cost, 41% shorter lead times, 30% shorter R&D lead time and 51% less defect rate.	Advanced analytics to optimize manufacturing and distribution footprint	↓ 45%	Number of warehouses
		Connected devices to track and measure product performance	↓ 30%	Market research time
		Supplier material quality prediction using advanced analytics	↓ 63%	Incoming defect rate
		Field quality failures aggregation, prioritization and advanced analytics enabled problem-solving	↓ 36%	In-process defect
		Analytics for dynamic warehouse resource planning and scheduling	↓ 56%	Inventory cycle
Mondelēz Sri City, IN	Driven by the aspiration to outgrow the market through superior volume delivery, cost leadership and building further resilience and diversity in a volatile environment, Mondelez’s Sri City deployed end to end digitalization, predictive analytics, artificial intelligence and advanced automations to increase labour productivity by 89%, reduce manufacturing costs by 38% and sustain 50% female workforce. Thus, making it a benchmark manufacturing site for Mondelez globally.	Real-time asset performance monitoring and visualization	↑ 21%	Productivity
		Advanced IIoT applied to process optimization	↑ 31%	Product yield optimization
		Predictive maintenance aggregating data based on historical and sensor data	↓ 69%	Mean time between breakdowns
		Collaborative robotics and automation	↑ 28%	Productivity
		Advanced analytics enabled sustainability optimization	↓ 11%	GHG emissions

*Automated guided vehicle

Source: World Economic Forum Global Lighthouse Network

FIGURE 11 | **The lighthouses show a variety of new use cases (6/8)**

Site	Change story	Top five use cases	Impact	
Mondelēz Suzhou, CN	To quadruple retail channels in China and double store coverage to 4 million retail outlets, and address the impact of double-digit inflation related to labour and logistics costs, the company invested in multiple Fourth Industrial Revolution solutions. This allowed it to transform a linear supply chain into an integrated supply ecosystem, with improved OTIF by 18%, reduced lead times of 32% and securing growth in market share from 23.4% to 28.3%.	Digitally enabled customer continuous replenishment system	↑ 17pp	On-shelf availability
		IoT-enabled intelligent logistics/warehouse platform	↑ 50%	Warehouse throughput
		ML powered OREO cluster advance process control	↓ 78%	Quality defect
		Light-off baking workshop	↓ 32%	Manufacturing conversion cost
		Digitally enabled end-to-end material supply excellence	↑ 2.5pp	Material supply OTIF
Procter & Gamble Takasaki, JP	To address a 2-3% year-on-year business growth with limited footprint expansion potential, the site implemented Fourth Industrial Revolution use cases such as data flow integration, digital twin, machine learning across end-to-end value chain (from R&D to customers). As a a result, the innovation lead time accelerated by 72%, shutdown days for trial were reduced by 21%, and order horizon from customers improved 14-fold.	Optimized excess inventory by linear regression model	↓ 57%	Inventory scrap
		Data interconnectivity via digital backbone to accelerate formula change execution in MFG	↓ 92%	Human workload
		Digital twins and process modelling and simulation enabling shorter qualification trials in R&D	↓ 72%	R&D lead time formula change
		RPAs* for work process optimization and improve space utilization in warehouses	↓ 16%	Internal warehouse use
		Machine learning to improve forecast accuracy and order lead time	↓ 31%	Warehouse space
Sany Heavy Industry Changsha, CN	To address the challenges from industry specific market cycle fluctuations and product complexity (263 SKUs), Sany Changsha leveraged flexible automation, AI and IIoT at scale to build a digital and flexible heavy equipment manufacturing system. As a result, the site expanded capacity by 123%, improved labour productivity by 98%, and reduced unit manufacturing cost by 29%.	AI-powered process control	↓ 60%	Process cycle time
		Advanced IIoT applied to process optimization	↓ 73%	Change-over time
		Digital twin for flexible production	↑ 44%	Production capacity
		Digital-enabled flexible manufacturing	↑ 80%	Output in assembly
		Robotics-enabled logistics execution	↑ 11%	On-time delivery rate
Unilever Indaiatuba, BR	Facing a shrinking market, the Unilever site in Indaiatuba, the largest powder detergent factory in the world, top in productivity and second in cost globally but Unilever's biggest contributor to GHG emissions, implemented use cases such as digital twin and AI to improve cost leadership and agility to the market while minimizing environmental footprint. As a result, Indaiatuba reduced innovation lead time by 33%, production costs per tonne by 23% and nearly eliminated GHG emissions.	Digital twin for agility in product innovation	↓ 33%	Lead time to innovation
		Machine learning spray-drying tower powered by biomass	↓ 96%	CO_2 emission (scope 1)
		Digitally enabled perfect sealing to eliminate chronic quality defects	↓ 94%	Customer complaints due to leakage
		Predictive maintenance with AI for pneumatic devices life cycle management	↓ 45%	Maintenance cost
		End-to-end intelligent supply chain allocation for direct shipments	↓ 15%	Distribution cost

*Robotic process automation

Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 12 | **The lighthouses show a variety of new use cases (7/8)**

Site	Change story	Top five use cases	Impact	
Unilever Tianjin, CN	Having navigated the COVID-19 uncertainties in the catering industry in the past three years, Unilever accelerated market penetration in low tier cities by deploying over 30 Fourth Industrial Revolution use cases, such as tailor-made 24/7 digital selling, optimal end-to-end advanced planning and AI-enabled quality control. As a result, the number of served customers doubled, order-to-delivery lead time shrank by 40% and customer complaints fell by 62%.	Smart selling for targeted customers exploring and serving	↑ 100%	Number of customers
		AI empowered end-to-end optimal order fulfillment platform	↓ 91%	Order fulfillment loss
		End-to-end supplier integration for concurrent planning and automatic order allocation	↑ 5.5%	Supplier OTIF
		AI enabled taste assurance with parameters close loop optimization	↓ 96%	Labour work-hours per tonne
		Machine vision supervision platform for people safety and food safety compliance	↓ 78%	Unsafe behaviour
Western Digital Bang Pa-in, TH	Bang Pa-in is producing cost sensitive consumer hard disk drives (HDDs). Facing material cost increase caused by supply chain uncertainty and with the goal to limit capital deployment due to market shifting to solid-state drives (SSD), Bang Pa-in implemented diverse Fourth Industrial Revolution use cases to reduce factory cost by 33% while reducing energy consumption/peta byte (PB) by 40%.	Condition-based HDD testing optimization using ML	↓ 22%	Test cycle time
		ML based asset utilization optimization	↑ 7%	OEE
		Achieving best in class yield with advanced analytics	↑ 2%	First pass yield
		Automated HDD repair using ML	↑ 13%	Repair accuracy
		Agile logistics bidding through analytics-enabled capacity and price prediction	↓ 64%	Transport cost
Western Digital Laguna, PH	To build resilience in the face of volcanic eruptions, typhoons, long lead time for materials, volatile demand and tightened product specifications, the Laguna site deployed over 25 use cases at scale, such as event anomaly detection by advanced analytics and end-to-end production variation compensation by machine learning. As a result, the site was able to reduce unplanned shutdowns by 82% and production cost/unit by 54%.	Natural language processing (NLP) enabled natural calamity proactive crisis management	↑ 100%	Annual shutdown cost avoidance
		Advanced analytics enabled large scale end-to-end pre-post events anomaly detection	↓ 71%	Customer quality alerts
		Machine learning wafer variation compensation using end-end data	↑ 7.6%	Yield
		Tester anomaly detection with ML model prediction	↑ 181%	Anomaly detection accuracy
		Operation research model based factory capacity optimization	↓ 93%	Capacity optimization time
Western Digital Shanghai, CN	To address a 250% annual growth rate, short technology transition pace of 18 months and workforce challenges, Western Digital semiconductor backend factory in Shanghai implemented diverse Fourth Industrial Revolution use cases such as automated product design system, machine learning based virtual wafer test and intelligent planning system. The site reduced time to market by 40%, product cost by 62% and improved productivity by 221%.	Automated product design	↓ 62%	Market research time
		AI-powered optical inspection	↓ 35%	Energy consumption
		Automated inspection enabled by digital thread	↑ 221%	Productivity
		Analytics platform for yield management and root-cause analysis	↑ 0.3pp	Product yield optimization
		Digital integrated business planning	↓ 94%	Inventory reduction

Source: World Economic Forum Global Lighthouse Network

FIGURE 13 | **The lighthouses show a variety of new use cases (8/8)**

Site	Change story	Top five use cases	Impact	
Wistron Zhongshan, CH	Faced with the pressure to deliver 60% of orders in less than 72 hours, the company needed to accelerate end-to-end processes without compromising quality. Wistron transformed its entire value chain via 33 in house-built use cases. Despite supply shortages, productivity was enhanced by 32%, defect rates were reduced by 55% and delivery times shortened to 48 hours. Ultimately, manufacturing unit costs were reduced by 22%.	No-touch end-to-end sales and operation planning based on multi-objective optimization	↓ 36%	Delivery lead time
		Printed circuit board (PCB) power routing optimization and quality check based on best path AI algorithm	↓ 83%	Design cycle time per PCB
		AI-enabled line balance optimization based on motion detection	↑ 29%	OEE
		Manufacturing quality diagnostic system empowered by AI search engine	↓ -68%	Repair time
		NLP based end-user feedback mining for 3 years' quality prediction & improvement	↓ -56%	After-sales defect rate

Source: World Economic Forum Global Lighthouse Network, 2022

1.3 Sustainability leaders have set a new green standard

While all lighthouse sites have achieved impressive showings across multiple performance indicators including sustainability, some have truly set themselves apart with remarkable Fourth Industrial Revolution-enabled sustainability impact. These sites have earned the coveted designation of sustainability lighthouses.

FIGURE 14 **Sustainability lighthouses show Fourth Industrial Revolution-enabled sustainability impact (1/2)**

Site	Change story	Top two use cases	Impact	
Arçelik Ulmi, RO	Arçelik Ulmi greenfield factory, powered by 100% green electricity, deployed sustainability use cases such as digital-twin for energy management and closed loop water management system integrated to advanced water treatment plant. In an environment suffering from water stress, it resulted in a reduction of water consumption by 25% as well as a reduction of energy consumption by 17% and GHG emission by 22%, per unit manufactured.	IIoT real time sensor based data aggregation for energy, emissions, waste and water management	↓ 35%	Energy consumption – boiler
			↓ 35%	GHG emission – scope 1
		Advanced analytics enabled clean water reduction and contaminated water cleaning optimization	↓ 20%	Water withdrawal
			↑ 68%	Water recycling
Flex Sorocaba, BR	With an aim of reducing energy use, water consumption and GHG emissions, Flex's facility in Sorocaba implemented smart factory utilities management, and optimized electronic waste in their supply chain and manufacturing operations, using internet of things sensors to enable circular economy solutions. Flex Sorocaba reduced scope 1 and 2 GHG emissions by 41% and for scope 3 managed to avoid 44 kilotonnes of CO_2e* and reduced water consumption by more than 30%.	Smart factory utilities management	↓ 32%	Energy consumption
			↓ 31%	Water consumption
		Zero waste and circular economy	↑ 321%	Recycled resin produced
			↓ 44kt	GHG scope 3
Haier Tianjin, CN	To build resilience in the face of rising energy costs and also reduce carbon emissions, Haier applied big data and AI to establish a power load model of equipment, as well as a production scheduler optimizing for energy consumption, reducing energy consumption by 35% and GHG emissions by 36%.	Energy consumption optimization based on power load model of equipment	↓ 32%	Energy consumption
		Scheduling optimization based on production energy consumption	↓ 13%	Energy consumption
Micron Singapore, SG	With the growing demand for memory and storage solutions, there is a need for Micron Singapore to expand and increase Gigabyte production while reducing environmental footprint. From 2018 to 2021, Micron Singapore increased output by ~270% and simultaneously reduced resources used per gigabyte produced by ~45%. This is enabled by sustainable technology development with optimization of materials consumption through environmental footprint tracking.	Advanced analytics enabled sustainability optimization	↓ 16%	Waste reduction
			↓ 13%	GHG emission – scope 1 and 2
		Analytics-platform for yield management and root-cause analysis	↓ 26%	Waste
			↓ 24%	Water

*Carbon dioxide equivalent
Source: World Economic Forum Global Lighthouse Network, 2022

FIGURE 15 | **Sustainability lighthouses show Fourth Industrial Revolution-enabled sustainability impact (2/2)**

Site	Change story	Top two use cases	Impact	
Siemens Amberg, DE	To reach its net zero target already by 2026, four years ahead of the corporate pledge, Siemens adopted digital process analysis and measurements, reducing its scope 1 and 2 GHG emissions by 69% normalized to volumes. In addition, to decarbonize its entire supply chain (scope 3) the plant acts as an incubator to develop Fourth Industrial Revolution products such as a digital product pass and a blockchain-based software to exchange CO_2 data with suppliers.	Smart, holistic energy management system	↓ -5%	Energy consumption
			↓ -28%	GHG scope 3 upstream
		Resource efficiency with operations data analytics	↓ -16%	Energy consumption per volume
Unilever Dapada, IN	In a bid to achieve corporate sustainability goals of 70% reduction in scope 1 and 2 emissions by 2025 over baseline of 2015 and reducing water consumption while tackling rapidly increasing volumes, Unilever Dapada deployed 14 use cases such as ML powered energy optimization through integrated energy management system, digital twin to accelerate eco-friendly formulations. Dapada reduced its scope 1 and 2 emissions by 54%, its scope 3 emissions by 43% and its water consumption by 36%, and as a result is ahead of its goal to achieve the emission reduction targets.	Advanced analytics enabled sustainability optimization	↓ 34%	Energy consumption
			↓ 23%	GHG emission – scope 2
		Quality improvement by predictive analytics	↓ 22%	Water consumption
			↓ 25%	Material waste
Western Digital Shanghai, CN	In the context of growing demand, Western Digital doubled the site's PB output between 2017 and 2021 while reducing its environmental footprint per PB to achieve corporate ambitions. This result was enabled by multiple Fourth Industrial Revolution use cases such as machine learning to dynamically optimize the performance of the water recycling plant and should consumption prediction to detect abnormal energy consumption based on real-time operating data. These measures reduced water consumption by 62% and energy consumption by 51% per PB.	Advanced analytics enabled clean water reduction and contaminated water cleaning optimization	↑ 30%	Water recycle rate
			↓ 62%	Normalized water consumption
		Machine learning enabled should energy prediction	↓ 51%	Normalized energy consumption
			↓ 57%	Normalized GHG – scope 2

Source: World Economic Forum Global Lighthouse Network

2 A new chapter begins

If the criticality of scaling is clear for all companies, only lighthouses are aware of what it takes to scale.

Lighthouses can now be found across the globe, representing every manufacturing sector. This is the picture of an established and proven network. However, what marks the turning of a page and the beginning of a new chapter? Firstly, ample evidence suggests that the lighthouse network is no longer a vision – it is a proven reality with 139 use cases and over 130 member sites spanning all geographies and sectors.

They have shaped the story up to this point and have set a clear standard for what it will take to continue the revolutionary transformation of manufacturing. Their experience provides the foundation for the next chapter. A pulse check was taken to understand the experience and priorities of both lighthouse and non-lighthouse companies.

2.1 Scaling across production networks and beyond: the high impact lever

100% of the newly-designated lighthouses are showcasing significant sustainability impact, such as a reduction in energy consumption.

The second chapter of the Fourth Industrial Revolution has begun amidst major global disruption marked by soaring energy prices and inflation, talent shortages, supply chain disruption and the increasing impact of climate change. Confronting these challenges successfully requires manufacturers to meet a new scaling imperative. To play a role in authoring this next chapter of the future of manufacturing, the key will be the ability to scale technology in unison across production networks – and beyond – to achieve business priorities.

Consider that leaders of the first chapter of the Fourth Industrial Revolution became so by escaping from so-called "pilot purgatory"; that is, they were able to move quickly and efficiently from concept to execution of use cases and scaling within one site to achieve significant impact. Companies have shown this can be done locally; the challenge now is to do it globally. The new second-chapter imperative is to extend scaling to multiple production sites and beyond to suppliers, customers and new functions.

The survey has revealed that productivity, sustainability and resilience are the top three strategic priorities among respondents across all industries and regions. Nearly 80% of respondents have marked one of these three elements as their top strategic priority for the next twelve months, with productivity emerging as the clear outlier and foremost priority for more than a third of respondents (37%). The lighthouses have proven that Fourth Industrial Revolution technologies deployed at scale can support these three priorities simultaneously. In particular, they continue to demonstrate that productivity and sustainability do not have to be at odds with one another; instead, the Fourth Industrial Revolution-driven innovations that boost productivity simultaneously lead to sustainability improvements.

While sustainability and resilience rank behind productivity, they are nonetheless top priorities for a significant number of companies, and the efforts being directed in support of them are compelling. It is notable, for example, that 100% of the newly-designated lighthouses are showcasing significant sustainability impact, such as a reduction in energy consumption. As for resilience, lighthouses have marked impressive achievements in this area. Consider Chinese electrical appliance manufacturer Midea. The company faced supply chain disruption and variability, along with the need to deliver more diverse products to a more fragmented customer base. By deploying an end-to-end supply chain control tower, Midea's Hefei site boosted its resilience with increased transparency on the supply risks while achieving a 56% reduction in delivery lead time. Meanwhile, Johnson & Johnson's consumer health site in Bangkok likewise deployed an end-to-end collaborative supply chain control tower to address a lack of end-to-end visibility on supply risks and inventories due to a lack of integration with suppliers and customers. The control tower bolstered supply chain resilience, supporting 13% revenue growth through the COVID-19 pandemic while reducing inventory by 25%.

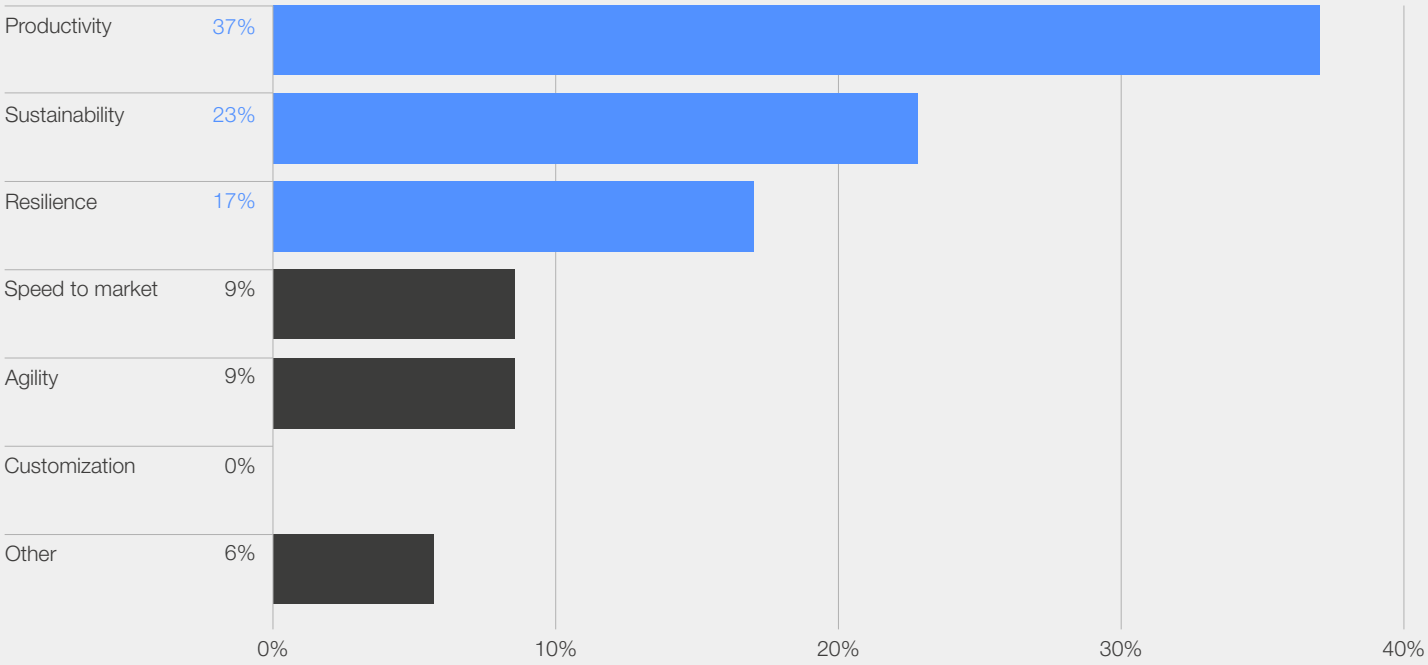
Over two-thirds of respondents (67%) believe that scaling the Fourth Industrial Revolution is highly important for achieving these top three priorities. The next chapter of the Fourth Industrial Revolution, then, will chronicle the stories of successful scaling. As that chapter begins, those who seek to have a hand in writing it will benefit from understanding how companies have thus far achieved success. Understanding the challenges they have faced – and the enablers that have helped overcome them – will prove essential.

FIGURE 16

Approximately 80% of respondents consider productivity, sustainability and resilience as top priorities, and two-thirds consider scaling Fourth Industrial Revolution technologies to be crucial to achieving these top priorities.

Ranking of top strategic priority within next 12 months[1]

% of respondents



80%

Of respondents see **productivity, sustainability or resilience as their top priority**

67%

of respondents acknowledged that **scaling Fourth Industrial Revolution technologies is highly important** to achieve not only productivity but also sustainability or resilience priorities

Key illustrations:

- 100% of **newly designated** lighthouses are showcasing significant sustainability impact (e.g., energy consumption reduction)
- To reinforce its resilience, Midea's Hefei site deployed an **end-to-end supply chain control tower** managing both domestic and oversea order fulfilment processes. Midea achieved a 56% reduction of delivery lead time, while increasing visibility on supply interruption risks.

Notes: 1 Ranking of the most cited, first priority for all companies (e.g. 37% of companies see productivity as their first priority, 23% see sustainability, etc.).
Source: World Economic Forum Global Lighthouse Network, 2022

2.2 Scaling reality check: revealing the truth

Regardless of expressed confidence levels at the outset of the Fourth Industrial Revolution, looking at the current status of scaling progress provides a crucial reality check. Among non-lighthouse companies, an average of only 7% of their production networks are considered advanced in using Fourth Industrial Revolution technologies. This is where the performance gap begins to emerge clearly for lighthouses, which, on average, consider 20% of their production networks to be Fourth Industrial Revolution-advanced. These numbers reveal two intriguing insights. First, they make clear that scaling is a challenging journey for everyone. Second, even for frontrunners, it isn't simple. This is no surprise, considering the various headwinds that impede progress. Part of the challenge is scope, i.e. large, complex manufacturing footprints with hundreds of sites and suppliers in the network, along with thousands of people who must be engaged in the digital transformation journey, requiring relentless capability-building. Another challenge is the lack of standardization of high-impact use cases. Finally, technological infrastructure is evolving at high pace, hampering standardization efforts.

A second figure clarifies that lighthouses are doing something different and pulling well ahead of their competitors. Although most are confident, only lighthouses are ahead of plan. When asked about their rate of progress in scaling Fourth Industrial Revolution technologies across multiple locations, lighthouses were found to be leading by a wide margin. While nearly half of non-lighthouses believe they are behind schedule relative to their production-network-scaling plans, more than two-thirds of lighthouses report being on track. The biggest differentiator, however, is that one in five lighthouse companies is **ahead of plan**. No other organization interviewed claimed this distinction.

Lighthouse organizations have been establishing more realistic time horizons than their non-lighthouse competitors when it comes to scaling across their production networks. When asked how long they estimate it will take to achieve Fourth Industrial Revolution scaling across more than half of their networks, all non-lighthouses responded with a timeline of fewer than three years, with 80% setting an ambitious time horizon of 24 months or less. By contrast, only 62% of lighthouses are as optimistic, and 15% think it could take even longer than three years.

These data suggest two key takeaways. The first is that lighthouses appear more aware and realistic about the time horizons for scaling their production networks. The second is that even though they tend to forecast longer time horizons, lighthouses are scaling faster than non-lighthouses – at roughly three times the rate. Numerous examples demonstrate this scaling efficiency. Consider pharmaceutical company Cipla, which has been scaling over 30 digital, automation and analytics use cases to nearly half of its production network – 22 sites out of 47 – over just two years. Meanwhile, heavy equipment manufacturer Sany Heavy Industry is deploying artificial intelligence (AI), industrial internet of things and automation use cases across 43 sites in parallel.

FIGURE 17 | Scaling is progressing faster and more realistically for lighthouse companies

For lighthouse companies, scaling across production network tends to be...

More advanced

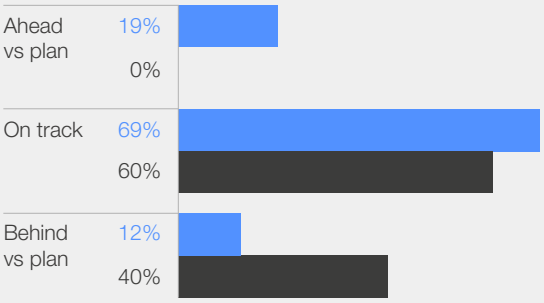
Scaling factor, percentage of the production network considered as advanced in the use of Fourth Industrial Revolution technologies

20%
For lighthouse companies

7%
For non-lighthouse companies

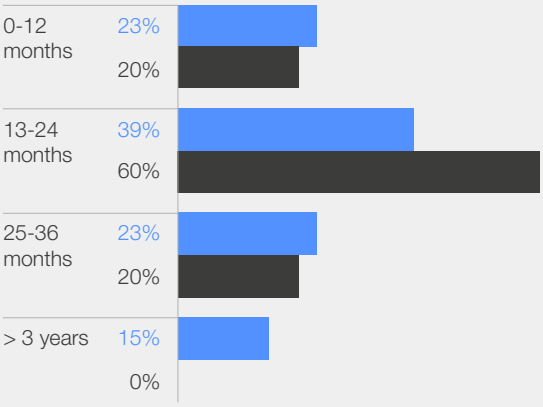
More on track vs plan

Progress rate in scaling Fourth Industrial Revolution technologies across multiple locations, % of respondents



And with more realistic time horizons than for non-lighthouse companies

Time horizon to reach Fourth Industrial Revolution scaling to more than half of the production network, % of respondents



Lighthouse companies | Non-lighthouse companies

Lighthouses examples:

- Pharmaceutical company **Cipla** has been **scaling 30+ digital, automation and analytics use cases to nearly half of its production network** (22 sites out of 47) over a **two-year timeframe.**
- Heavy equipment manufacturer **Sany Heavy Industry** is currently deploying AI, IIoT and automation use cases **across 43 sites in parallel.**
- Beverage company **The Coca-Cola Company** is currently executing a **two year roadmap to replicate key use cases across 17 sites.**

Source: World Economic Forum Global Lighthouse Network, 2022

2.3 Lighthouses are writing the scaling success story

Many companies are held back by various scaling challenges. The global survey was designed to ascertain those challenges and how they affect both lighthouse and non-lighthouse companies. Members of the Global Lighthouse Network have written the opening chapter by overcoming these challenges, but doing so has required a clear recognition of the true obstacles to scaling. It is this gap in recognition that separates lighthouses from other companies.

Lighthouses are aware of what it takes to scale

A range of external forces work against successful scaling across production networks, from the COVID-19 pandemic and supply chain issues to economic factors like inflation. Nearly all respondents believe that such external factors present challenges, yet the major insights emerge upon consideration of perceived **internal** obstacles.

A deeper dive into this analysis, with a focus on internal challenges, provides some compelling contrasts, particularly with regard to the difference between what lighthouses and non-lighthouses consider to be inhibiting progress in scaling. Nearly all respondents – lighthouses (62%) and non-lighthouses (70%) alike – name a lack of resources and capabilities as a major challenge. From there, the differences become apparent.

Firstly, lighthouses more readily acknowledge the criticality of strategy for successful scaling, so when solving problems, they are more conscious and aware that their strategy weaknesses are obstacles. The difference here is stark, with lighthouses identifying lack of strategy as a key challenge nearly three times more often than non-lighthouse companies (27% vs 10%, respectively). The implication is not that lighthouses lack strategy, as this would be paradoxical to the nearly three times

better scaling factor they achieve. It does, however, suggest that lighthouses have a far more realistic awareness of the need for optimal strategy.

Given that only 10% of non-lighthouses name lack of strategy as a key obstacle, it is reasonable to read this as a clear sign of an "awareness gap". It may be that most companies are confused about the true meaning of strategy. For example, implementing Fourth Industrial Revolution technologies may be considered strategy. Whereas such technologies should, in fact, be a lever to achieve a true strategy aligned with business priorities. If there is no properly defined strategy, it stands to reason that strategy weaknesses will not be apparent – thus, a true obstacle would be missed.

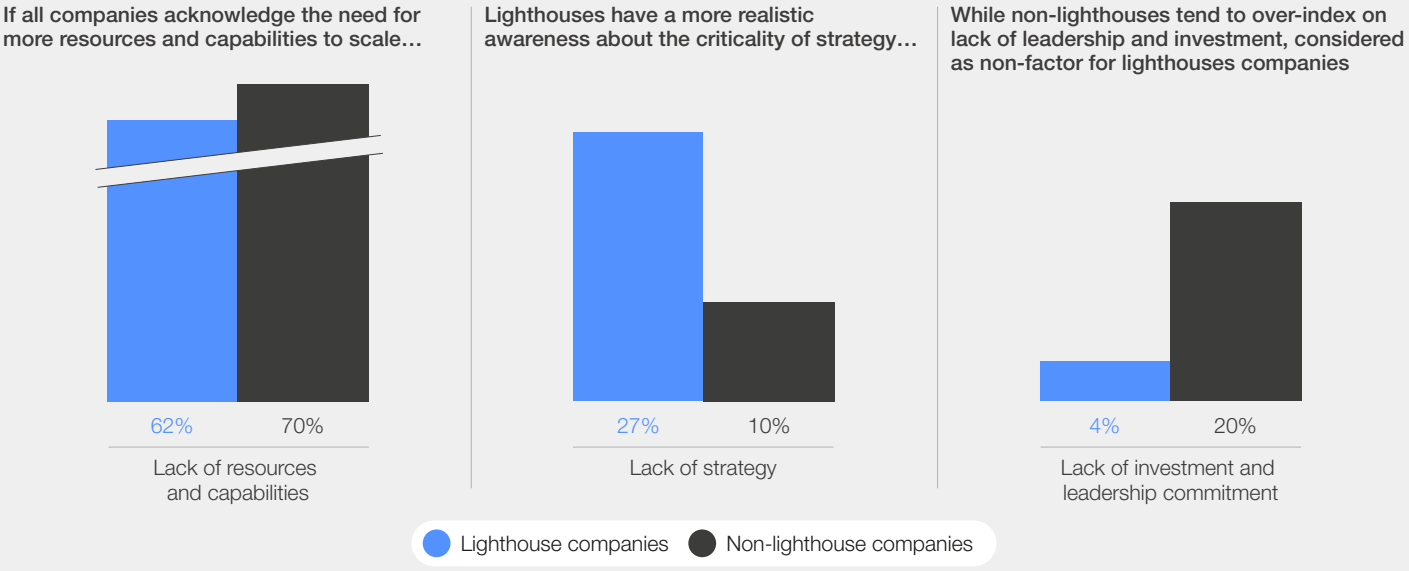
This consideration becomes even more compelling when considering another perception gap: investment and leadership commitment. While 20% of non-lighthouse companies name investment and a lack of leadership commitment as their primary challenge to scaling, only 4% of lighthouses do. Lighthouses cite fewer obstacles related to leadership commitment and investment, which is expected given their greater awareness of the critical importance of strategy and how challenging it is to develop and implement. It is apparent that leadership and commitment work hand-in-glove with a clearly defined strategy.

An intriguing example of leadership can be found at Flex's newly designated lighthouse in Sorocaba, which had each of its Fourth Industrial Revolution initiatives sponsored at regional level. This facilitated accountability and funding while removing roadblocks, paving the way for a successful site transformation. In the case of strategy, Danone's tailored strategy combined corporate-led ambition setting with factory-centric implementation waves. This enabled quick, value-driven scaling across the production network while promoting the adoption of Fourth Industrial Revolution technologies at the local level.

Lighthouses and non-lighthouses have divergent perceptions of what lies at the core of the scaling challenge. This reveals that lighthouse companies are clearer about what it takes to scale and have a clearer recognition of the core challenges. Where they lack skills or strategy, they do so consciously, with awareness of those shortcomings. Non-lighthouse companies, by contrast, have less awareness about the truly critical elements of scaling.

FIGURE 18 **What it takes to scale: perceived obstacles to successful scaling reveal an awareness gap between lighthouse and non-lighthouse companies**

Primary obstacle to successful scaling of Fourth Industrial Revolution technologies
% of respondents[1,2]



Though they agree on the most obvious obstacles, lighthouse and non lighthouse companies tend to perceive differently the core obstacles to successful scaling

This reveals **different levels of awareness on what it takes to scale**

Lighthouse example:

Danone designed a tailored strategy combining **corporate-led ambition setting with factory-centric implementation waves.** It enabled a **quick and value-driven scaling** across production network while **fostering adoption of Fourth Industrial Revolution technologies at local level.**

Notes: 1 Ranking of the most cited obstacles to successful scaling **2** Summing up to 93% for lighthouse companies (7% indicating other obstacles)
Source: World Economic Forum Global Lighthouse Network, 2022

Recognizing key enablers

The awareness gap between lighthouses and non-lighthouses widens further when analysing the perceived key enablers to successful scaling. There are sizeable, notable differences between what lighthouses and non-lighthouses perceive to be the primary contributing enablers – in other words, the secrets to success.

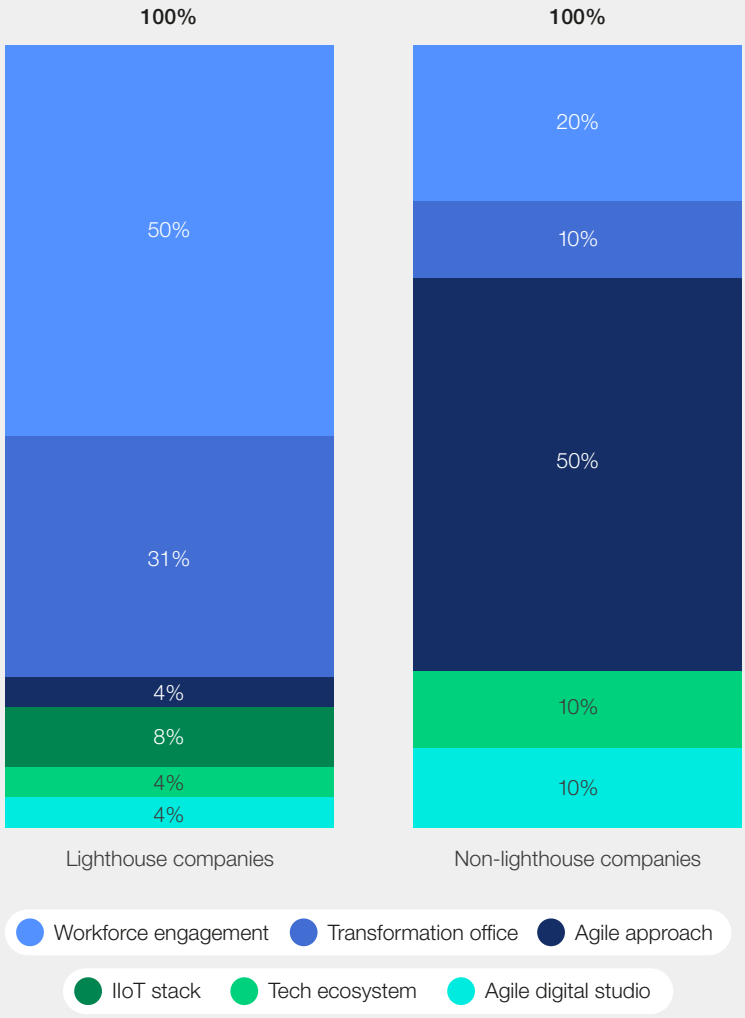
In the case of lighthouses, the key enablers are overwhelmingly people. Workforce engagement is considered the top enabler for 50% of respondents, and 31% consider a transformation office the top enabler. This shows that lighthouses are aware of the importance of ensuring value capture of digital. Five other enablers (agile approach, industrial internet of things stack, tech landscape, agile digital studio, and industrial internet of things academy) are considered considerably lower-impact, representing top enablers for fewer than one-fifth of respondents.

By contrast, among non-lighthouse respondents, there is an outsize emphasis on one factor above all others, with half (50%) listing the agile approach as the top enabler. A combined 22% list either tech landscape or agile digital studio as the primary enabler. Only a combined 30% of non-lighthouse companies put workforce engagement (20%) and transformation office (10%) at the top of their enabler list.

While all of these enablers can play important roles when it comes to scaling, the gap between what lighthouses and non-lighthouses identify as their **top** enabler is telling. Non-lighthouses that want to turbocharge capability building and achieve scaling across production networks have a proven example to follow. Lighthouses have climbed the scaling ladder by investing in people. For those who wish to emulate their success, the imperative is clear: invest in people and the execution engine, immediately.

FIGURE 19 **Perception of what are the critical enablers also confirms an awareness gap between lighthouse and non-lighthouse companies**

Primary contributing enabler to scaling success[1]
% of respondents



Lighthouses are concentrating their focus on two main dimensions:

- **Engaging workforce** in the adoption Fourth Industrial Revolution technologies (50% of respondents)
- **Transformation office** (30% of respondents) to ensure value capture of Fourth Industrial Revolution benefits

Non-lighthouses have a less clear understanding of the critical enablers, despite highlighting mostly agile approach as a key enabler (50% of respondents)

Lighthouse examples

Sri City site of food manufacturer Mondelēz fostered a more transparent and self-governing culture by reskilling 100% of workforce on how to use Fourth Industrial Revolution technologies to better enable decision making at line level, while removing supervision layers

Haier Qingdao set up a dedicated transformation office combining a "digital transformation committee" steered by the general manager, with a Fourth Industrial Revolution research team composed of ~45 people to support best practice exchange and prioritization with a focus on impact and solutions

Note: 1 Ranking of the most cited enablers by all companies
Source: World Economic Forum Global Lighthouse Network, 2022

Scaling waypoints: ready for others to follow

The experience of the lighthouse network companies – the story of the first chapter of the Fourth Industrial Revolution – offers a valuable playbook for companies that look to emulate their success. Lighthouses have always been beacons and aids to navigation. In keeping with this, these leading organizations have established "scaling waypoints" as they have navigated the obstacles to scaling over the past years.

This wayfinding was not without challenge – indeed, lighthouses had to struggle and learn. Many had to work their way out of the pilot phase after being stuck for a time. Through innovation and persistence, however, they progressed. As companies have continued, they have gained the additional perspective afforded by the distance travelled, further deepening their awareness of what it takes to scale. Meanwhile, they have left waypoints in place – offering a "smart follower strategy" – for others to follow.

Non-lighthouse companies now have a choice: they can do their own pathfinding, replicating the trials and errors already overcome by the lighthouses, or they can use the smart follower strategy, learning from the use cases and methodologies of leaders to accelerate their progress by using the scaling waypoints that lighthouses have put in place. To engage a smart follower strategy is to read the waypoints and recognize the three must-haves for success:

1. **Build a clear strategy.** Without clear direction, the breadth of possibilities and the variety of use cases and technologies threaten to mire organizations in pilot purgatory. In contrast, lighthouses show that digital transformation must be designed from customer value back, aligning closely with the company's overall business strategy.

2. **Invest in people.** Without the right resource and capability models, a transformation will soon run out of resources and steam.

3. **Set up the right governance.** Without value assurance and governance – coupled with the right execution engine – companies cannot capture the value they seek or generate real impact. Lighthouses are succeeding at the hardest part: designing and adhering to new standards.

3 Leaders in scaling Fourth Industrial Revolution: case studies

Scaling champions have established the waypoints to be followed by others.

3.1 Danone: A people-led network approach

> Danone prioritized workers' voices, enabling them to shape the approaches at the site level, even as they pursued clear, top-down goals.

How can a company couple top-down strategy with bottom-up, site-level energy? What if the entrepreneurial spirit emerging in specific local sites could be harnessed, amplified and brought to bear across the network globally? Dairy manufacturer Danone faced a challenge scaling Fourth Industrial Revolution technologies, having more than 40 sites, each with different digital maturity and IT/operational technology (OT) architecture, and several minimum viable products (MVP) already deployed locally without network consistency. With hundreds of solutions and providers available, identifying optimal ones was overwhelming. Danone needed to build on successful MVPs to rapidly scale across sites and select a suite of solutions for digital manufacturing, engaging the entire network to ensure adoption. It needed to partner with providers to customize company-wide solutions and accelerate the development, testing and confirmation of solutions for deployment going from months to weeks. This called for a clear strategy and strong governance to successfully execute the digital transformation at scale.

Danone began with top-down identification of the value at stake per site, followed by locally-driven identification of how to unlock it. The starting point for standard solutions was a company-wide catalogue, which could be scaled quickly across all sites. Where custom approaches were needed, however, solution development was facilitated with MVPs and pilots. The chosen solution would be codified into the catalogue, highlighting how to use and extract value from it. As a result of this continuously-enriched catalogue of standard solutions, Danone has avoided individual sites wasting time on solutions that cannot be viably scaled network-wide. A core feature of the approach is that it was value-driven rather than technology driven; that is, it began with considering the existing problems and then locating appropriate technology solutions. Danone encouraged quick scaling of existing, impact-proven solutions. They prioritized global-standard solutions that could be scaled quickly while checking 80% of boxes, rather than doubling down on slower approaches that might aim to check all boxes but would take too long. Things that worked were codified rapidly.

With this approach, Danone prioritized workers' voices, enabling them to shape the approaches at the site level, even as they pursued clear, top-down goals. This helped achieve buy-in, with "hearts and minds" invested. This local focus laid the groundwork for a culture of innovation both at individual sites and, crucially, across the production network – a truly people-led network approach. The key has been the continued upskilling of workers to keep them engaged with the transformation. Over 150 digital leaders have been upskilled, and solution-specific upskilling programmes have reached more than 800 people. Along with the people impact, deployed solutions are on target to capture more than $100 million in impact over two years.

FIGURE 20 **Dairy manufacturer Danone successfully scaled over 40 factories with a clear corporate strategy backed by local implementation capabilities**

Vision: global strategy, local implementation

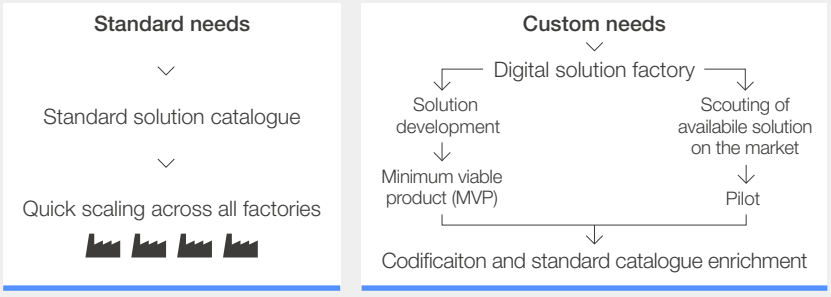
Corporate-led, top-down identification of the value at stake, and cascading into site specific objectives

Bottom up, factory-centric identification of the site needs to unlock the value at stake

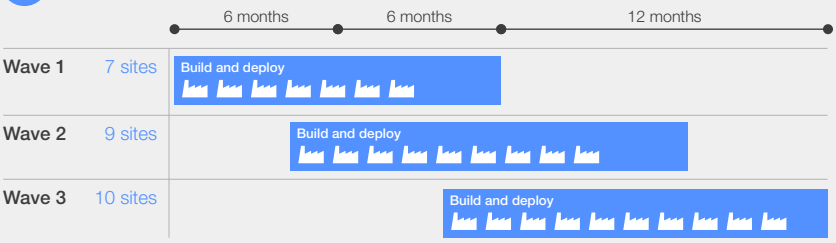
Scaling of solutions implementation at site level achieved by fostering **standardization and collaboration across all sites**

Approach to build and scale solutions

1 **Systematic channeling of the needs** identified towards a **continuously enriched standard catalog of Fourth Industrial Revolution solutions** to accelerate deployment at scale



2 **Exponential scaling across the network**



Impact

€100 million
EBITDA impact

15+
Digital use cases codified into a standard catalogue continuously enriched for quick scaling, and scaled across:

40+
sites with different maturity and IT/OT infrastructure

150+
digital leaders upskilled across network via bootcamps and weekly trainings

Source: World Economic Forum Global Lighthouse Network, 2022

3.2 Cipla: Network-wide transformation using seven key enablers

> Cipla has seen improvements ranging from 20% to 80% in various operations outcomes ranging from people productivity to machine efficiency and quality deviations.

Cipla, an India-based global pharmaceutical manufacturer, has successfully transformed its operations across more than 20 sites in just two years. Cipla's leadership knew it would need to embrace digital to meet its manufacturing goals. It used seven key enablers to achieve this change. Cipla's plan centred on the deployment of digital, automation and analytics solutions to unlock end-to-end cost, productivity and quality leadership across a network of 22 sites in India over two years. The company enacted more than 40 digital and analytics use cases, such as process simulation to improve yield and dynamic planning of manpower staffing. Of these use cases, 18 have been scaled across the entire organization in India, and 28 have been scaled across five or more units.

Much of this success can be tied to network-wide, interconnected agile squads empowered and institutionalized to drive rapid, at-scale deployment of use cases. Likewise, the company enriched its digital capabilities by hiring new talents and upgrading existing talent with an internet of things academy. With more than 30 smart automation applications, Cipla has seen improvements ranging from 20% to 80% in various operations outcomes ranging from people productivity to machine efficiency and quality deviations.

Essential to this transformation has been the development of a future-proof, enterprise-wide data-tech architecture. This enables real-time, data-driven visibility and decision-making. The impact is clear. Whereas initially, less than 20% of operations data had been used for digital- and analytics-enabled decision-making, now more than 90% of that data is used.

FIGURE 21 **Indian pharmaceutical manufacturer, Cipla, is successfully scaling Fourth Industrial Revolution technologies across 22 sites by relying on seven key enablers**

1	**Workforce engagement**	Deployed several initiatives to increase **engagement at all workforce's levels** (e.g. fortnightly townhalls for operators, dedicated learning journeys and intra-network go and see visits for site leaders, etc.)
2	**Transformation office**	Implemented a **dedicated transformation governance** spanning across the company (from chief experience officer to site level)
3	**IIoT Academy**	Built a Digital and Analytics Academy to **source new digital talents and upskill existing ones** (trained 50+ leaders, 110+ translators, 400+ operators via VR, gamified learning and academic collaborations)
4	**IIoT stack**	Deployed a **scalable IIoT tech architecture** set-up with Edge and SCADA connectivity to **push data from 90%+ critical equipment** across the network, to a secure enterprise-wide cloud
5	**Tech ecosystem**	Involved **50+ vendor partners** to support Cipla's fourth industrial revolution journey and established **30+ strategic partnerships** for capabilities
6	**Agile approach**	Deployed **70+ agile squads involving 20+ units** to develop use cases using a MVPs approach structured in two-week sprints
7	**Agile digital studio**	Deployed a **"phygital agile studio"** to drive effective cross-functional collaboration with **colocation of multi-disciplinary teams organized in product squads**

Impact

20-80%+
Improvement in operations outcomes such as people productivity, machine efficiency, quality deviations

90%+
Operations data being used for DNA-enabled decision-making vs starting position of <20%

20+ sites
Underwent a digital transformation in a short span of ~2 years

Source: World Economic Forum Global Lighthouse Network, 2022

3.3 Midea: A strong transformation office to deploy Fourth Industrial Revolution at scale

Companies willing to invest in their people for smart, strategic deployment of Fourth Industrial Revolution solutions and working modes can realize rapid transformation and accelerated scaling of digital. When Chinese electrical appliance manufacturer Midea set out to achieve network-wide transformation, its leadership was clear-eyed on the purposeful investment of resources. Representative of the survey data that suggests lighthouses do not suffer from leadership or investment hurdles, Midea is a solid example of investment and leadership directed towards strategic deployment of digital.

Midea's leadership knew that developing a strong governance model that supported the exchange of best practices and prioritized impact-generating solutions – rather than focusing principally on technology – would be essential to its transformation. This was embodied in its transformation office, which was backed with a powerful investment of $2.5 billion to support its important work.

The transformation programme comprised three essential elements. First, a smart manufacturing academy was charged with designing and developing new solutions. This smart manufacturing institute engaged more than 140 experts and was funded with a $22 million annual budget. Second, a pool of resources was used to implement and achieve impact at scale. This took the form of multiple teams of over 1,000 "virtual engineers" and change agents assembled into a central team to codify best practices to roll out across business units and plants. Third, an effective assessment tool in the form of a digital lean maturity index would enable the company to monitor impact effectiveness across 34 plants under nine business units.

Midea's investment in effective digital transformation – guided by an effective transformation office – has proven its value. The company has quadrupled its profits and boasts five Global Lighthouse Network sites.

FIGURE 22 **Electrical appliance manufacturer Midea built strong governance to execute scaling across its network**

Midea is a Chinese electrical appliance manufacturer employing approximately 150,000 people in China and overseas.
To address the need for shorter lead times while increasing quality, Midea has engaged into digital transformation, currently scaling Fourth Industrial Revolution technologies to 34 sites.

Central academy

Established a Smart Manufacturing Institute composed of 140+ experts, with a $22 million annual budget to develop new techniques for manufacturing, digital, automation, analytics and sustainability

Pooled resources for implementation

Built the teams of 1000+ "virtual" engineers, and change agents, pooled into a central team, codifying best practices (e.g. 500+ best know-how methods) and supporting Fourth Industrial Revolution technologies implementation across all sites

Digital maturity index to monitor impact

Set up a digitalized lean maturity standard to benchmark and monitor the improvement of 34 plants and nine business units

Impact

5	4.3 times	$2.5 billion
World Economic Forum lighthouses	Profit increase since the start of digital transformation	Invested in digital transformation

Source: World Economic Forum Global Lighthouse Network, 2022

3.4 Join the Global Lighthouse Network to write the next chapter

The opening chapter of the Fourth Industrial Revolution is concluded. As manufacturers turn the page and begin the next chapter of the transformation story, the challenge is clear: it is not enough to achieve scaling success at isolated sites or among only part of the production network. To be a lead author of the next chapter, the mandate is to achieve scaling success across the entire organization.

To achieve this, organizations must redouble their commitment to the strategies for responsible growth, working both hard and smart. They must be conscious, aware and realistic about the challenges they face, so they can effectively use the power of key enablers – especially those that invest in people – to improve productivity, sustainability and workforce development as they scale network-wide.

As companies aspire to join the Global Lighthouse Network's leadership ranks, they can use the "smart follower strategy" to turbocharge their scaling. Just as they have since the opening pages of the Fourth Industrial Revolution's first chapter, lighthouses are together writing the global playbook for scaling success.

Call for applications

The Global Lighthouse Network continues to grow and encourages leading organizations to consider applying to join as site or as an end-to-end value chain. All network members – whether newly recognized or existing – are eligible to be considered for designation as sustainability lighthouses. Excited, forward-thinking companies are invited to learn more by emailing LighthouseNetwork@weforum.org.

Contributors

World Economic Forum

Francisco Betti
Head, Advanced Manufacturing and Value Chains; Member, Executive Committee, World Economic Forum

Vincent Desnos
Engagement Manager, McKinsey & Company; Project Fellow, World Economic Forum

Yves Giraud
Senior Expert, McKinsey & Company; Platform Fellow, World Economic Forum

Federico Torti
Initiatives Lead, Advanced Manufacturing and Value Chains

McKinsey & Company

Martin Becker
Senior Associate

Youssef Benkhaira
Senior Associate

Enno de Boer
Senior Partner and Global Head, Operations Technology

The team would like to thank Paul Cumbo of PJC Editorial, external writer and editorial consultant, for drafting this article.

Editing and design

Laurence Denmark
Designer, Studio Miko

Martha Howlett
Editor, Studio Miko

George Messer
Designer, Studio Miko

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org