BCG

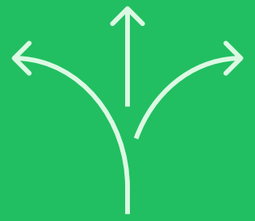
Designing Factories That Are Built for the Future

AUGUST 2023

Manufacturers face four main challenges that impact their business

Productivity
Optimizing production efficiency

Sustainability
Increasing sustainability and meeting net zero targets



Flexibility
Increasing flexibility of production and resilience

Talent
Augmenting and supporting the workforce

Source: BCG.

Most manufacturers have begun their digitization efforts but with limited success

of executives consider advanced manufacturing technologies such as AI as a must and aim to implement them.

of manufacturers have already started their factory of the future (FoF) journey, with at least one fully implemented AI use case.

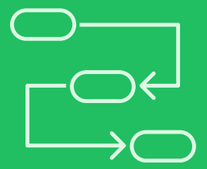
of adopters have successfully achieved their FoF-related targets.

Source: BCG Global Survey on AI in Industrial Operations 2023; n = 1,800.

Successful factory of the future initiatives require a focus on three optimization dimensions and two foundations to realize their full potential

Optimization dimensions

Digitization and automation

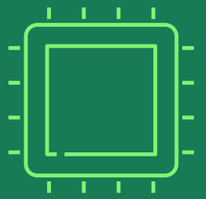


Lean processes

Effective structure

Foundations

People



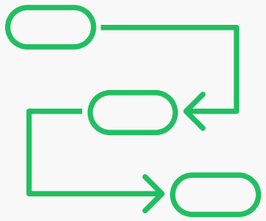
Technology

Source: BCG.

Three optimization dimensions must be considered together to create the factory of the future

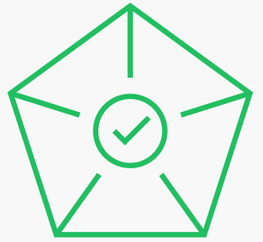
Digitization and automation

Leverage advanced manufacturing technologies to digitize and automate across the entire plant.



Lean processes

Improve process stability through combination of Lean and Industry 4.0 opening new value potentials compared to conventional process improvement.

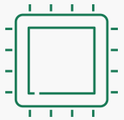


Effective structure

Define optimal plant structure, e.g., through use of digital twins to simulate different layout alternatives.

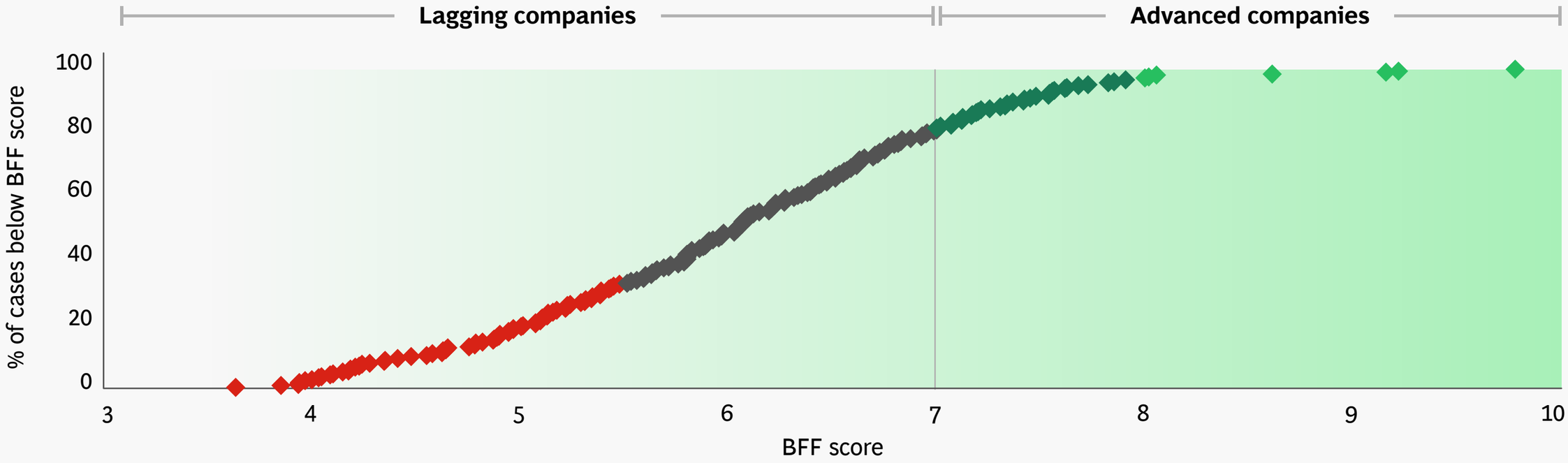
Source: BCG.

The foundational dimensions for factory of the future success directly align with the six key attributes that enable a future-built company

 **People**	1	Align **leadership around a corporate purpose**, particularly sustainable manufacturing.
	2	Develop a clear **people advantage** by attracting, upskilling, and retaining top talent and building the capabilities to drive innovation, operational excellence, and exceptional customer satisfaction.
	3	Institute an operating model to enable **agility and resilience**, making supply chains more responsive and durable to efficiently deliver products.
	4	Establish an **innovation-driven culture** by empowering employees to explore emerging technologies, leverage analytics, and apply advanced solutions to improve operations.
	5	**Embed AI** in the organization to increase transparency, analyze performance, forecast more accurately, and optimize production.
 **Technology**	6	Migrate to **modernized tech platforms**, including scalable infrastructure to leverage the power of manufacturing data and capitalize on advanced technologies such as AI.

Source: BCG Build for the Future Survey 2022; n = 724.

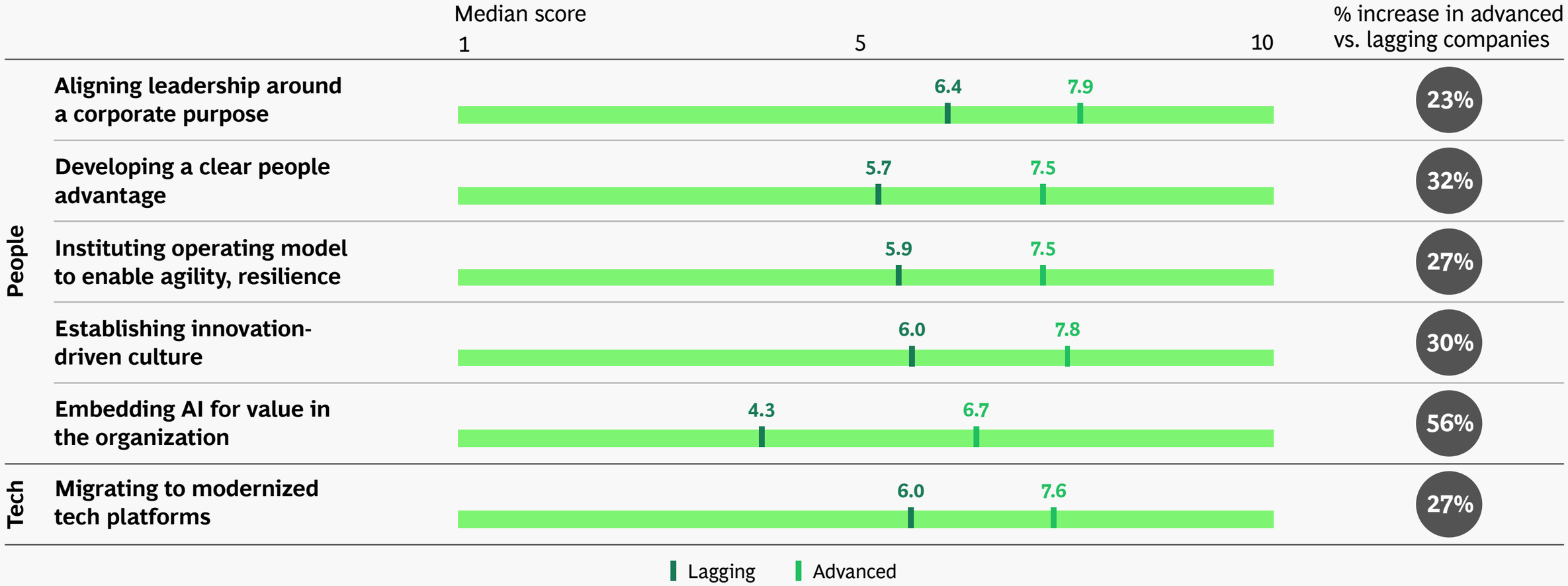
Most manufacturers have significant work ahead; only 16% are scaling their efforts to build for the future, and just 3% are fully future-built



	Stagnating	Emerging	Scaling	Future-built
Manufacturing companies:[1]	32%	49%	16%	3%
All companies:	30%	45%	19%	6%

Source: BCG Build for the Future Survey 2022; n = 724.
Note: Advanced = future-built + scaling; lagging = stagnating + emerging.
[1]Manufacturing-oriented sectors: machine and automation, consumer products, oil and gas, medtech, transport and logistics, biopharma, auto and mobility, hardware and semiconductors, materials and process industries.

Advanced manufacturers excel in all key attributes by a wide margin compared to their peers, especially in embedding AI into their operations



Source: BCG Build for the Future Survey 2022; n = 724.
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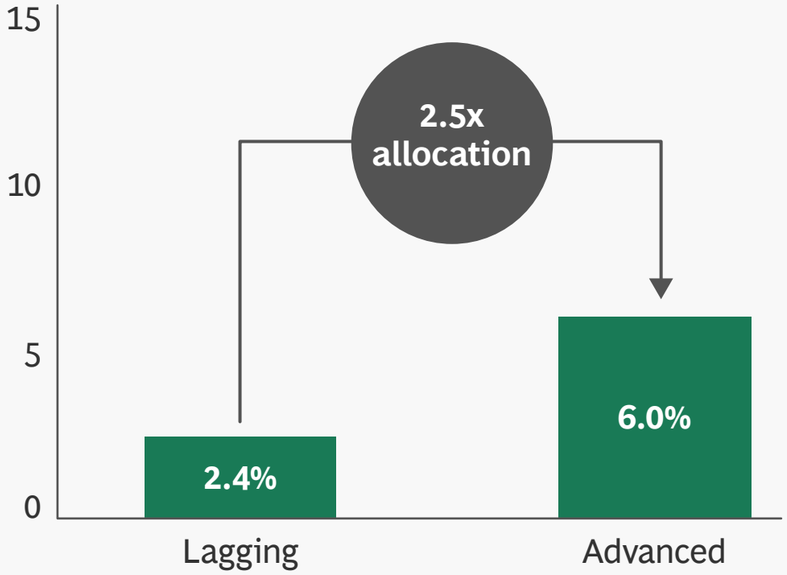
Advanced manufacturers are also prioritizing factory of the future investments to achieve strong digital operations capabilities

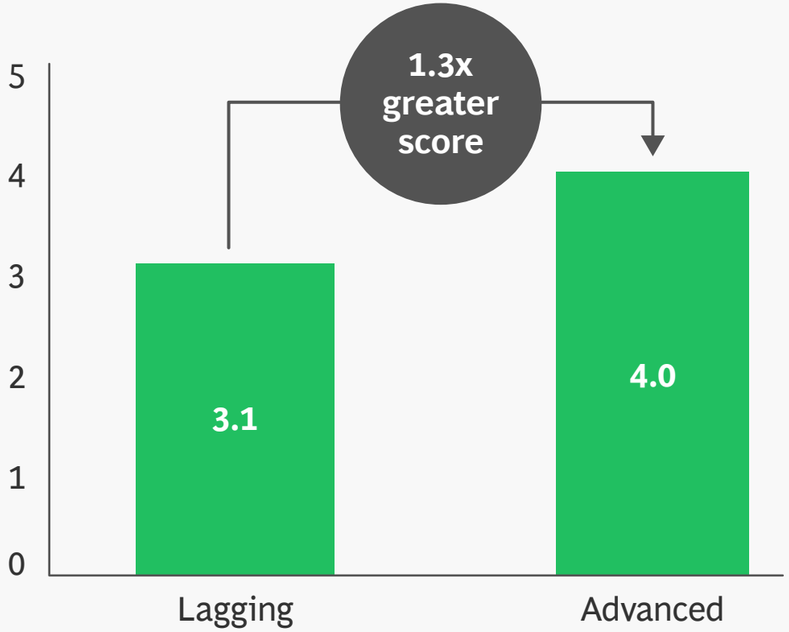
Advanced companies are allocating more of their operational spending toward FoF …

% OF TOTAL CURRENT OPERATION SPENDING ON FOF[1]



… and achieving higher digital operations and manufacturing capability scores

AVERAGE DIGITAL OPERATIONS AND MANUFACTURING CAPABILITY SCORE (OUT OF 5)



Source: BCG Build for the Future Survey 2022; n = 724.

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[1]Industry 4.0-related investment questions in BCG Build for the Future Survey 2022.

Elements of the factory of the future people foundation

Capabilities

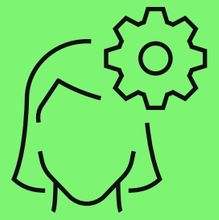
Includes roles such as data scientists and engineers, software developers, and machine-learning engineers to develop and implement new technologies

Governance

The right organizational structure, clear roles and responsibilities, processes, and dedicated KPIs and incentives

Change management and communication

Includes leadership buy-in and engagement at all levels to ensure transformation success



Legal compliance

Comprehensive policies to mitigate risk from technologies such as generative AI

Source: BCG.

Elements of the factory of the future technology foundation

Data sourcing

Systems to capture required data (such as from sensors) and route it to advanced manufacturing solutions

Data processing

Includes the ingestion, pre-processing, storage, distribution, and deletion of data

Data application

Developing, validating, deploying, and serving AI-based algorithms, along with the user interface

Computing

Sufficient computing power, including the determination of on-premise versus cloud computing

Connectivity

Link plants and other assets to share data

Cybersecurity

Identity and access management, detection and response, risk analysis and management, and recovery planning

Source: BCG.

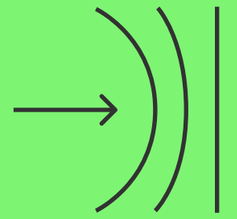
Digitization and automation technologies can dramatically increase efficiency in manufacturing plants

Before

Operators manually handle parts, which are transported from injection molding machines to the next workstation using forklifts.

After

Autonomous mobile robots (AMRs) can pull parts directly from injection molding machines and transport them. Humans supervise the process and focus more on value-creating work.



Impact

Significant reduction in direct logistics labor costs. Investment pays for itself in 18 months.

Source: BCG.

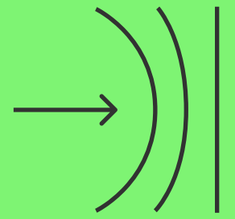
Automated quality control systems can reduce costs and increase manufacturing quality

Before

Operators need to visually inspect parts and components for quality issues. Process is manual, costly, and prone to risk that defects are not identified due to human error.

After

Automated cameras equipped with AI can automatically spot defects. AI algorithms that power the automated inspection process are trained with synthetic data, improving accuracy from day one. Humans can focus on identifying root causes of product defects and potential new quality issues.



Impact

30% reduction in quality inspection costs and decreased risk of delivering defective products to customers.

Source: BCG.

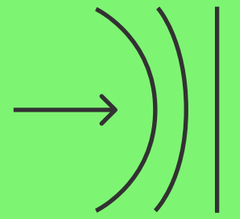
Generative AI can make repairs to plant equipment more proactive, consistent, and cost-effective

Before

Factory equipment repairs require an in-person diagnostic by a technician (or remote support), with uneven repair quality based on the technician's experience level.

After

Machine-learning analytics can identify potential issues with equipment. Generative AI uses the ML insights to automatically provide repair instructions and recommendations for required parts, leading to more reliable repairs. Humans focus more on preventing breakdowns, and repair processes are more efficient.



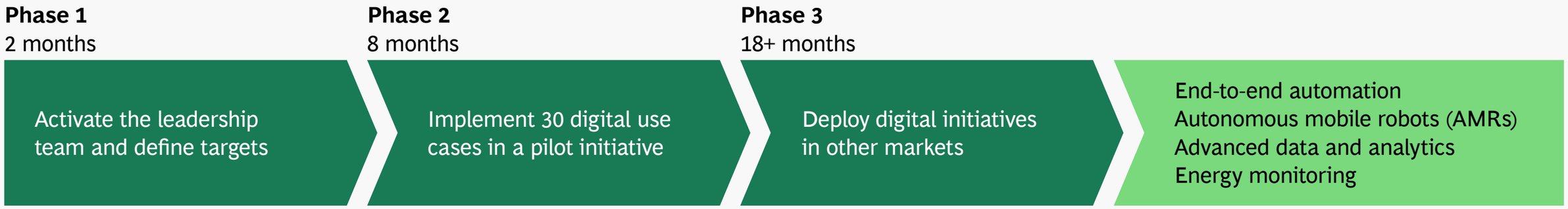
Impact

Reduction in equipment downtime and maintenance costs, along with an increase in plant productivity.

Source: BCG.

One company built a factory of the future as a pilot initiative at a single factory, with plans to scale that model across the enterprise

Digital journey



8%

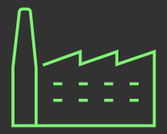
Profit gross margin impact achieved

~$200 million

Total yearly saving impact

Source: BCG.

Five key steps in the process to building the factory of the future



Applications

People

Technology

1

Diagnose

Analyze status quo and identify gaps and opportunities.

2

Design

Design target picture, strategy, and roadmap.

3

Engineer

Engineer solutions and develop measures to close gaps.

4

Implement

Implement solution pilots and measures and validate impact.

5

Scale

Roll out proven solutions and measures.

Source: BCG.