BCG + ACMA

Bolts, Bytes and Bots

Reimagining next-gen auto component manufacturing in India

February 2026

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BCG

Boston Consulting Group partners with leaders in business and society to tackle their most important challenges and capture their greatest opportunities. BCG was the pioneer in business strategy when it was founded in 1963. Today, we work closely with clients to embrace a transformational approach aimed at benefiting all stakeholders – empowering organizations to grow, build sustainable competitive advantage, and drive positive societal impact. Our diverse, global teams bring deep industry and functional expertise with a range of perspectives that question the status quo and spark change. BCG delivers solutions through leading-edge management consulting, technology and design, and corporate and digital ventures. We work in a uniquely collaborative model across the firm and throughout all levels of the client organization, fueled by the goal of helping our clients thrive and enabling them to make the world a better place.

ACMA

Set up in 1959, the Automotive Component Manufacturers Association of India (ACMA) is the apex industry body representing India's auto component sector. With a distinguished membership of over 1,100 manufacturers, ACMA's members collectively contribute to over 85% of the industry's total turnover, playing a pivotal role in India's emergence as a global automotive manufacturing hub.

ACMA's mission is anchored in driving sustainable growth, technological advancement, and employment generation. Through its unwavering focus on R&D, quality excellence, innovation, and skilling, ACMA ensures that India remains at the forefront of the global auto component value chain.

The Association empowers its members through policy advocacy, market intelligence, capacity building, and international partnerships, while fostering gender diversity, sustainability, and equitable growth across the ecosystem.

ACMA plays a catalytic role in trade promotion, technology enhancement, and quality improvement, actively:

- Showcasing Indian capabilities at global trade fairs and business delegations abroad;
- Publishing insightful policy reports and industry studies;
- Driving manufacturing excellence through cluster programs such as Asset Turnover Improvement, Uptime Improvement, Zero Defect Quality, and Sustainable Manufacturing.

ACMA is well-represented across key Government committees, councils, and advisory panels, and has forged MoUs with counterpart associations in countries including France, Germany, Japan, South Korea, Taiwan, Turkey, the UK, and the USA, fostering trade cooperation and technology exchange.

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Summary

India's auto component sector is at a pivotal point in its growth journey. The industry has expanded at ~14% CAGR between FY20 and FY25, reaching $80 Bn in size in FY25, and aspires to grow to $200 Bn by 2030. This growth is increasingly outward-looking. Exports have risen by ~1.5X, from approximately $15 Bn in FY19 to ~$23 Bn in FY25, with an ambition to reach $100 Bn by FY30. The sector has also transitioned from a $2.5 Bn trade deficit in FY19 to a ~$450 Mn surplus in FY25, underscoring a step-change in global competitiveness, deeper integration into global supply chains, participation in higher-value, more demanding Original Equipment Manufacturer (OEM) programs and building capabilities for an electric future. To achieve its growth targets, the sector should explore stepping beyond traditional processes and adding digital, automation, and advanced analytics layers. For India's auto component sector, this is becoming an important enabler of competitiveness.

1. Global lay of the land

Why auto component factories are evolving: New pressures, new priorities

Global manufacturers are facing operational and competitive pressures that are reshaping how factories must run. Together, the following forces are accelerating the case for digital and automation, helping manufacturers unlock more from existing assets and operate with greater reliability and resilience:

- **Zero-defect output becoming the norm, precipitating the need** for stronger real-time control and traceability.
- **Higher asset uptime** (for enhanced throughput) demands better maintenance and faster issue closure.
- **Compressed NPD cycles leading to shrinking** concept-to-launch timelines, from 3-5 years earlier to 18-24 months, raising the bar on speed.
- **Sustainability pressure is rising** as EU's Climate Laws have set ~55% GHG reduction target by 2030, thereby accelerating manufacturing decarbonization across OEMs and suppliers.
- **Talent constraints are intensifying** amid rising churn, intensifying skill gaps and employee costs.

The art of the possible: Mapping the transformation from visibility to automation

Companies are not moving through digital maturity in a single linear path as progress is highly contingent upon product complexity, workforce profile, and capital constraints. While the typical journey and implemented use-cases involve moving from foundational visibility (L1, L2) and predictive insights (L3), to closed-loop optimization (L4) and finally towards fully automated workflows (L5), companies often evolve differently, with greenfield facilities directly leapfrogging to higher levels.

What good looks like: Global success stories

The experience of manufacturers across the globe provides evidence that Smart Factory, when implemented right, translates into measurable outcomes. Typically, 10–20% productivity uplift, 5–10% cost improvement, 20–30% quality improvement, and 20–40% faster time to market have been achieved.

2. Indian auto component sector: At the cusp of transformation

Inflection point – Why Smart Factory is emerging as a strategic priority?

Earlier, keeping lines largely manual was the smart choice in India. It offered low cost, high flexibility, and was suitable for a complex portfolio; Smart Factory was a nice to have and made sense primarily for a few very high-volume lines with clear payback. The industry, however, now faces five macro trends that make Smart Factory both viable and imperative. Together, these trends expose the growing inadequacy of traditional factories that must be addressed:

1. **Export ambitions are growing:** ~$100 Bn in exports by FY30 can only be delivered by fulfilling rising OEM expectations on quality, delivery, and responsiveness. India currently accounts for ~2% of global auto component trade vs ~12% for Mainland China, indicating meaningful headroom for expansion.
2. **ICE and EV programs are witnessing simultaneous growth:** Suppliers must deliver growing volumes of Internal Combustion Engine (ICE) programs while investing for Electric Vehicle (EV) with lower utilizations for the first few years. This will inevitably require sweating existing assets and improving productivity and throughput to create headroom and investible surplus for longer payback investments.
3. **Workforce churn is eroding experience-curve benefits:** Faster attrition is resetting shopfloor know-how, raising variability in output and quality without digital support and interventions.
4. **Scale is increasing additional complexity:** A larger vehicle base (toward ~50–55 Mn by 2030) translates into more variants, programs, and changeovers – hard to manage without digital visibility, flexible lines, and better control.
5. **Cost pressures are persisting in volatile environment:** Input costs are becoming more volatile while output prices remain sticky. Winners must find new ways to drive efficiency and reduce waste.

Mindset shift has occurred: From sporadic, small-scale pilots to a structural, scalable value lever

Evidence shows that digital interventions create value in distinctly Indian ways – they establish a truthful, system-generated baseline by exposing hidden losses, help newer plants match mature-site performance, assist in controlling costs (enabled by frugal Indian sensor innovations), improve the utilization of existing capacity, and increasingly become a key "need to have" as OEM requirements raise the bar on traceability and audit-ready data. This does not mean that we have transformed. But a clear shift is now evident – **the question is no longer "If" Smart Factory can work, but "how" to implement it and extract business value.**

From experiments to enterprise: The journey so far and prevailing impediments

An industry wide BCG-ACMA survey, across the auto component players with 60 respondents and in-depth conversations with leaders and shopfloor workers reveal valuable insights into the journey the industry has traversed, highlighting key achievements, factors that flip the odds of successful digital implementation, and key challenges.

There is now encouraging evidence that Smart Factories are becoming increasingly real, even in the Indian auto component space.

India's Digital Manufacturing Flywheel has started moving

Indian innovation at shopfloor is making digital adoption cost-effective: Companies are cross-leveraging sensors (ex. visual sensors to estimate weight of RM consumed) to reduce costs.

Adoption has decisively moved beyond "idea stage" into execution: 2/3rd of companies are already in pilot, scale-up or fully integrated stages.

Tech adoption is steadily moving up the stack: More than 2/3rd of the companies have deployed IoT sensors, with ~20% moving towards AI predictive analytics, digital twins or additive manufacturing.

Most companies have started seeing measurable and meaningful outcomes: ~60% companies report moderate-to-transformational impact from digital initiatives.

Scale is already in-scope and the "scaling dividend" is real: Companies in scale-up stage are experiencing moderate to strong impact with 2.1x higher frequency vs early explorers.

What the survey surfaced is clear. The odds that digital intervention will deliver significant returns flips when companies:

- Build a clean data foundation
- Ensure clear top-down sponsorship to convert pilot wins into repeatable, scaled impact
- Execute a consistent, phased rollout of initiatives
- Build an interconnected tech stack architecture as initiatives move from pilots to scale

However, some constraints restrict the move from pilots to scale:

1. **True impact potential is hidden in unclear metric and faulty baseline:** Investments stay episodic and fragmented in the absence of true baseline and top-down sponsorship that makes value pools explicit.
2. **Data remains fragmented, inconsistent, and siloed:** Data isn't clean at source and definitions vary across business functions, forcing manual reconciliation and weakening transparency and scale-up.
3. **Limited in-house know-how for digital intervention:** Firms have strong operational expertise but lack the digital execution muscle to deploy, debug, and sustain digital interventions, creating external dependencies.
4. **Constraints of legacy equipment and integration:** Mixed-age assets and incompatible interfaces make end-to-end (E2E) integration difficult.
5. **Fragmented vendor ecosystem is hard to navigate:** Vendors typically provide point solutions which work in isolation, but limit interoperability and E2E scale.
6. **Loss of momentum and uneven roll-out discipline driven by internal resistance to change:** Teams revert to familiar manual routines, delaying sustained adoption when frontline trust and incentives don't align.

The bottom line is that the momentum is real. As pilots demonstrate value, the next step is to reinforce foundations and build a repeatable scale engine for enterprise-wide transformation.

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3. Gearing up for success: From ambition to execution

Companies in India are at different starting points on the Smart Factory journey. For those yet to begin, the time is opportune – proof points and road maps are clearer today, and early wins can be fast-tracked through targeted pilots and selected use cases. Like any other investment, these initiatives should compete on clear payback and ROI, mindful of constraints on capital, capability, and talent. Selecting the right lighthouse and ensuring the adoption of pilot is critical to ensuring early success. Three actions that can help companies get off the ground include – (1) Digitize manual data heavy processes first (2) Select shopfloor champion and empower them to drive adoption and (3) Target the biggest leakages (downtime, yield, scrap).

For companies already in the pilot phase, the next step is to double down and create a fully integrated 2-3 year road map to scale adoption via a structured approach to ensure momentum is not lost.

Making smart factory solutions work

To support Smart Factory transformation, India's auto component sector now needs a structured, repeatable approach that turns digital ambition into day-to-day shopfloor execution. We outline six proven levers that together form a practical roadmap to implement and further scale Smart Factory. These are grounded in lessons from India's Smart Factory vanguards and strengthened by BCG's experience in implementing these solutions across the auto and manufacturing sectors.

Exhibit: Our holistic approach to address barriers to scale for Smart Factory transformation

1 Top-down direction and sponsorship

Clear ambition, leadership pull, and resourcing to drive alignment, **resolve change resistance**, and push **through impact ambiguity**

2 Enterprise data backbone

Unified, structured platform to ensure clean system-captured data at source, connect siloed org functions, and establish one version of truth

3 Digitally capable talent pool

Role-linked skilling to build digital execution capability, beyond core ops strength to **address digital capability gaps**

4 Fit-for-purpose digital architecture

Modular, right-sized systems designed to match shopfloor complexity and **integrate easily with legacy equipment**

5 Scalable vendor and solution ecosystem

Collaborate and co-build with proven tech partners having deep experience in auto to reduce deployment risk and navigate a **fragmented vendor landscape**

6 Change delivery and Value led scale

Governed **rollout engine with playbooks, routines, and KPI tracking** to sustain momentum and ensure outcome-linked scale **overcoming change resistance and pilot fatigue**

Smart Factory transformation isn't a solo journey – it needs ecosystem orchestration: while companies remain at the core and drive execution inside the plant, industry bodies enable coordination and shared infrastructure, and policy support de-risks investment and bridges capability gaps.

Evidence from Indian companies: Levers deployed and impact delivered

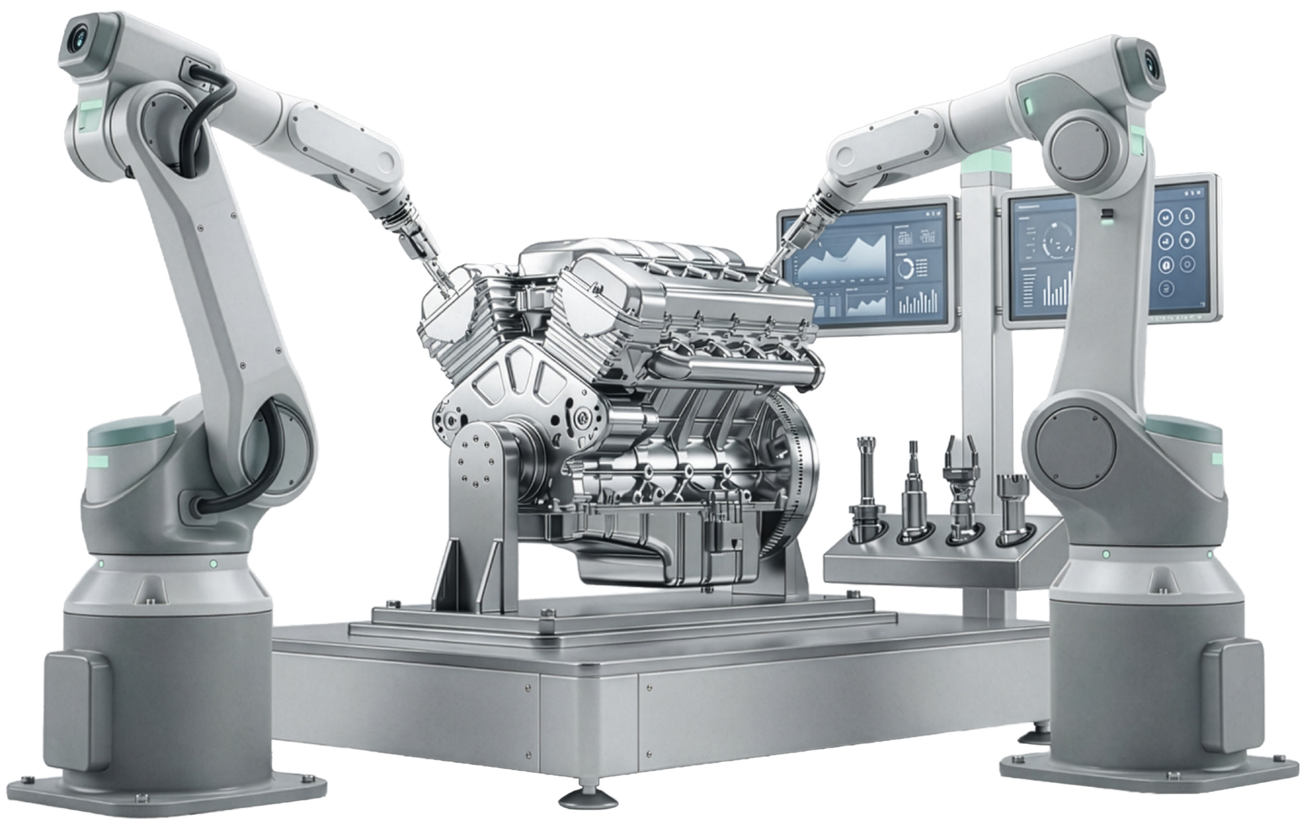
Across interviews and plant visits, it is encouraging to see Indian auto component peers applying parts of the 6 solution levers in practice – moving beyond generic pilots to targeted fixes that unlock scale.

Collectively, these actions are directly addressing the recurring blockers and delivering quantifiable impact. Measurable results include 10-15% uplift in OEE, ~30% reduction in specific direct material costs and ~30% reduction in manpower intensity in specific tasks and sustained digital adoption and scale up. These examples reflect true value that can be unlocked if solutions are implemented with the right execution approach and long term scaling intent.

2030 Industry North Star: Five bold digital aspirations

Buyers are raising expectations, while India targets ~$200 Bn industry scale and ~$100 Bn exports by 2030 amid other macro drivers. Meeting this ambition requires a step-change in how plants run, anchored in a set of five bold and achievable digital aspirations (2030) that convert intent into measurable gains:

1. Move 80%+ suppliers to scaling / fully integrated digital maturity stage.
2. Go paperless, digitize entire shopfloor, with 100% critical data captured digitally at source.
3. Target 1.5X workforce productivity to decouple industry growth from headcount.
4. Create shared industry assets – common platforms, standards, use cases, and a partner ecosystem.
5. Deliver measurable shopfloor outcomes (zero defect, OEE improvements and NPD speed) with 80%+ digitally mature suppliers targeting near-zero defects, ~15% OEE uplift, and ~25% faster NPD cycles.



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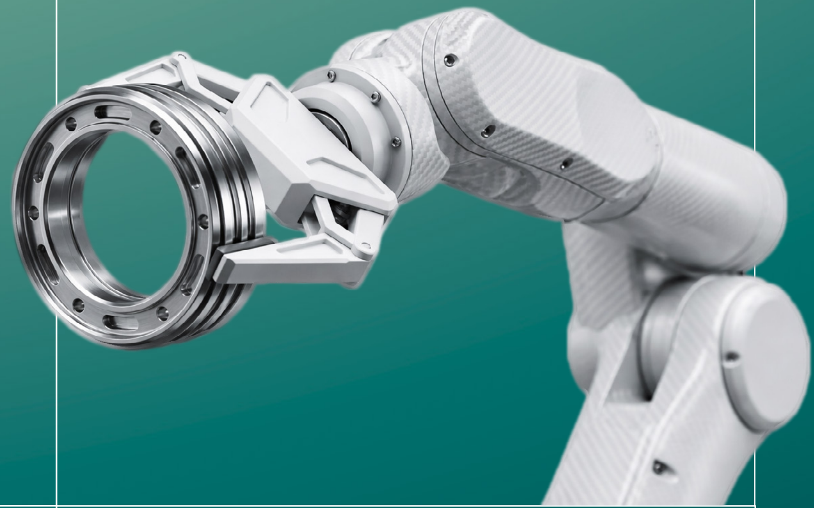

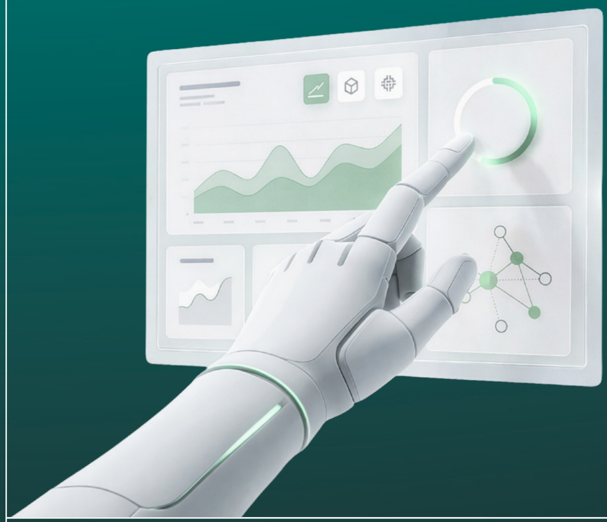

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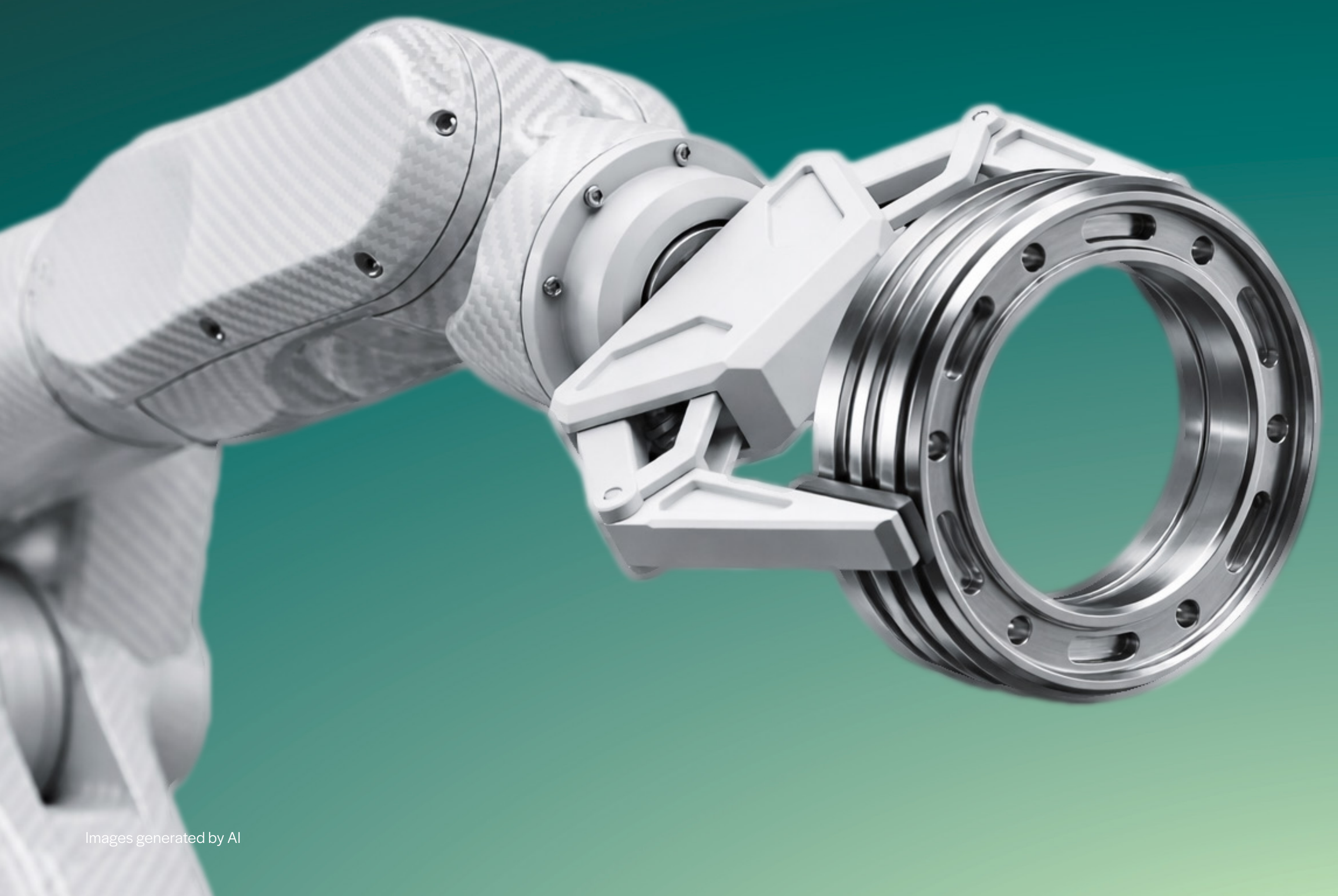
01.

Global lay of the land



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Making the factories within the auto component industry "Smarter" envisions a shift from digitizing individual processes to redesigning how factories operate End-to-End (E2E). It integrates people, data, and intelligent automation to deliver higher productivity, consistent quality, faster response, and greater operational resilience.

The shift is no longer experimental. **Advances in computing power, artificial intelligence, automation flexibility, and falling technology costs are enabling manufacturers globally to scale these capabilities** across entire factories, setting the context for why auto component manufacturing is now evolving.

While this report focuses on smart factories – an essential and high-impact lever – this alone is not sufficient. Sustained transformation will require complementary advances in quality systems, supply chain interventions, new product development and testing, and cross-sector stakeholder coordination.

1.1 Why auto component factories are evolving: New pressures, New Priorities

Manufacturers worldwide are confronting a convergence of structural, technological, and competitive pressures that is accelerating the adoption of digital and advanced manufacturing solutions. This urgency is particularly pronounced in the automotive sector where complexity, quality expectations, and faster time-to-market requirements are rising simultaneously.

Across the automotive value chain, several forces are reshaping how factories must operate:

"0" defect tolerance becoming norm

Zero-defect finished products are increasingly becoming non-negotiable by OEMs, requiring continuous monitoring, real time control and traceability at every stage of production.

<2% target unplanned downtime

High asset reliability is critical and requires minimizing unplanned downtime. This is driving demand for predictive maintenance to improve equipment availability, extend asset life, and stabilize output.

18-24 Months new normal NPD timeline for OEMs

Speed to market has emerged as a critical competitive differentiator. Chinese OEMs are now launching new vehicle models in as little as 18-24 months versus traditional automakers who often take 3-5 years.

55% reduction in EU GHG emissions by 2030

Sustainability pressure is rising. The EU Climate Law targets ~55% lower Green House Gases (GHG) emissions by 2030, pushing OEMs and auto component suppliers to decarbonize manufacturing.

Rising Churn Eroding Skill Depth

Talent constraints are intensifying. Rising employee costs and experience churn are reducing skill depth and putting sustained pressure on productivity and operational continuity.

Collectively, these pressures are creating strong tailwinds for digitalization and automation. Manufacturers are increasingly turning to advanced technologies to extract greater value from existing assets, strengthen margin management, and build operational resilience in an increasingly volatile and uncertain environment.

1.2 The art of the possible: Mapping the transformation from visibility to automation

The Smart Factory journey spans a broad set of use cases. The framework below captures this landscape by showcasing how representative use cases across each of the factory processes evolve from foundational digital enablement to advanced automation. **Together, these use cases illustrate the range of interventions that are shaping modern automotive manufacturing today**. Typically, manufacturers start with the basics – visibility, traceability, and simple analytics. As capabilities mature, they build cross-system integration and advanced analytics, enabling predictive insights and higher levels of automation.

Global lay of the land | India: At the cusp of transformation | Gearing up for success

In practice, however, transformation does not always follow a single linear path. Companies progress differently based on starting conditions, product complexity, workforce profile, and capital constraints. Progress may also vary widely across different processes depending on the elements most important to each. For instance, a company may be at L5 in quality and process controls but only L2 in workforce augmentation. In some cases, greenfield sites may leapfrog directly to more advanced automation.

Exhibit 1: Factory Process digital maturity model

Maturity →

Factory Process Flow ↓

Themes	L1: Foundational	L2: Enabled	L3: Intelligent	L4: Self Optimizing	L5: Automated
	Basic digital enablement	Cross-system visibility	Predictive, AI/ML based insight	Closed-loop digital optimization	Fully automated workflows / robotics
Customer connected supply and Agile product dev planning	↗ Digital **demand capture and basic forecasting**	↗ OEM integration **and real time order visibility** ↗ Digital **D&E data mgmt.**	↗ Simulation based **demand / capacity planning** ↗ Real-time **cost simulation for NPD**	↗ **Digital Prototype** ↗ Virtual manufacturing feasibility	↗ AI-supported **generative design** ↗ **Digital twin enabled rapid design** and OEM collaboration
Real time operations control and visibility	↗ Basic **OEE digitization** ↗ Digital **KPI tracking**	↗ **Unified plant cockpit,** cross-line **benchmarking**	↗ **Predictive anomaly detection,** deviation alerts	↗ **Operations digital twin** (throughput simulation, layout optimization)	↗ Automated operations with robotics / AMR
Zero defect Quality and process control	↗ Inline **QC sensors**	↗ **Unit level traceability** (DMC/ RFID) ↗ **Central quality data** lake	↗ **AI RCA** and golden-batch ↗ **Quality correlation engine**	↗ **Self-correcting quality loop**	↗ **Robotic QC**
Smart maintenance and reliability	↗ **Machine condition monitoring**	↗ **Integrated maintenance** cockpit	↗ **Predictive maintenance** (AI/ML)	↗ Intelligent **maintenance scheduling**	↗ **Robotic inspection and intervention**
Workforce augmentation and digital enablement	↗ **Digital SOPs** / mobile access	↗ Connected worker: **real-time KPIs**	↗ **AR guidance** for production QC and maintenance	↗ **VR immersive training** ↗ Smart **knowledge navigator**	↗ **Autonomous operator assist** systems (human-machine co-pilot)
Sustainability and Energy Management	↗ **Energy monitoring dashboards**		↗ Predictive **load and consumption analytics**	↗ **Energy Digital Twin** (furnace/HT optimization)	↗ **Autonomous energy/load management** (future state)

Source: BCG Analysis

We can **derive significant learnings from our Asian peers like Japan and China,** where manufacturing realities are often more comparable to India than in Western markets (e.g., process footprints, supply chain structures and labour economics). Manufacturers there, both in automotive and beyond, are already translating Smart Factory maturity into real progress, demonstrating what it takes to move from visibility to fully automated workflows.

Key learnings stand out. **Japan demonstrates how to modernize while solving for legacy equipment – optimizing older machines while layering in digital capabilities. China, meanwhile, shows how to scale by proving value in lighthouse plants, codifying playbooks, and rolling them out rapidly across the network.** India can adapt, taking inspiration from what has worked and tailoring local realities to scale impact and compete globally.

1. A Japan based food manufacturer is pursuing digital renewal for its legacy plant, parallelly building foundational use cases and higher complexity automation

The manufacturer, with a 110-year-old "mother plant" (the birthplace of the group's business), is pursuing a long-term renewal plan to address aging facilities. To improve efficiency it advanced smart packaging by capturing equipment data (mostly legacy), replacing paper with smartphone shopfloor inputs, and enabling dashboards/real-time monitoring for faster issue identification and continuous improvement (L2). Parallelly, it introduced an Automated Guided Vehicle (AGV) automation system to streamline operations (L5).

2. A Chinese battery manufacturer replicated smart factories at scale, rapidly leapfrogging to AI-led operations and higher levels of automation at new facilities

The battery manufacturer built a Smart Factory baseline in 2021, leveraging AI, advanced analytics, and edge/cloud computing (L3–L4). It then put that playbook into a greenfield lighthouse in 2022, deepening AI, IoT, and flexible automation. Evidence of this deeper implementation includes an energy-management system fed by >40,000 sensors and ~80% automated pack lines (L5), with intent to replicate across its production network.

3. Another Chinese construction equipment manufacturer built a lighthouse-led playbook and replicated end-to-end Smart Factory capabilities across its network

The manufacturer uses lighthouse sites as capability accelerators proving what works in one flagship factory, codifying it into a playbook, and rolling it out across the network. At the lighthouse, it built unit-level traceability via a product "ID card" (L2), a "factory brain" to orchestrate end-to-end production (L2–L3) and scaled IoT with thousands of sensors and networked robots (L2–L3). It then added advanced automation, including AI-enabled robots with 3D visualization for cutting/sorting and automation across core processes (L5). The company states that these technological and technical solutions were promoted across 45 other factories.

4. A well-known Japanese industrial automation and electronics manufacturer followed a near linear transformation path – from visibility to optimization and automation

The manufacturer set out to improve line utilization while maintaining consistent high quality. It started with visibility (L2) by deploying on-site data visualization to track assembly line status and coordinate transfers and staffing, reducing lead time by 10%. Building on that foundation, it moved into quality innovation (L3–L4) by automatically analyzing process/inspection data to detect and predict defects and feed improvements back to equipment. In parallel, it strengthened traceability/error-proofing (L2).

Overall, these examples highlight how top manufacturers advance Smart Factory maturity through multiple pathways – deploying different capabilities at different speeds and achieving varied levels of maturity across functions, rather than following a single, linear roadmap albeit within the contours of the process digital maturity model.

1.3 What good looks like: Global success stories

Industry experience demonstrates that digital and advanced manufacturing interventions can deliver substantial and measurable impact. Leading adopters have achieved **10-20% increase in productivity, 5-10% improvement in cost structures, 20-30% improvements in output quality, and 20-40% faster time to market**, significantly increasing flexibility and effective capacity.

Exhibit 2: Smart Factory intervention presents key benefits for manufacturers

Several global manufacturers have demonstrated how Smart Factory use cases translate into tangible and real-world impact. By scaling digital, automation, and advanced analytics across operations they have achieved measurable improvements. This is evident in the increase in productivity, quality, and flexibility illustrating how next-gen manufacturing moves beyond pilots to deliver value.

We next share 2 examples of players in the automotive industry who have realized outsized value by embedding Smart Factory principles in their daily operations.

Case study 1

Rebuilding cost competitiveness through intelligent automation

Global supplier of vehicle interiors and Electric Vehicle (EV) components

Automated (Level-5) in manufacturing operations and quality control, Intelligent (Level-3) in maintenance

Challenges

A leading European supplier of vehicle interiors and EV components was under mounting pressure from structurally high labor costs which were eroding its global competitiveness and threatening its margins and scalability. The mandate was clear – to reduce manufacturing expenses without compromising quality, flexibility, or speed.

Levers implemented, and how

The company embarked on a bold transformation journey which began with converting an existing facility into a lighthouse plant by achieving Level-5 automation across manufacturing options and quality control. The journey began with a one-year pilot to prove the business case before scaling. Core levers included:

- **Cloud-based data** consolidation across the factory, creating a single source of truth and enabling predictive analytics.
- **Digitization** to create real-time visibility across operations and the supply chain.
- **Full automation** of material flows using Automated Guided Vehicles (AGVs) and advanced robotics.
- **AI-enabled quality detection**, reducing defects and manual checks.
- Flexible assembly lines and inventory relocation to a dedicated "dark factory".

Two critical challenges emerged. First, legacy system integration posed a technical challenge due to heterogeneous machine data from different equipment brands and formats. This was resolved by standardizing data models and interfaces. Second, cultural and skill gaps emerged as the workforce transitioned to a highly automated environment. This was addressed through structured training and upskilling. With proven success, the model was rolled out enterprise-wide, deploying 30+ use cases across automation, digital operations, and advanced analytics.

Tangible impact achieved

The transformation delivered substantial financial and operational benefits, including:

- 8–10% improvement in gross margin.
- €190 Mn in annual savings, positioning the plant as a benchmark for future-ready manufacturing.

Beyond pilots, at-scale digitally enabled operations also strengthen core production conditions, improving safety, ergonomics, and workforce capability; enhancing resource efficiency and sustainability; and accelerating innovation through simulation, virtual validation, and rapid experimentation.

These capabilities are increasingly central to meeting rising OEM expectations, positioning manufacturers as competitive and future-ready players within the global automotive ecosystem.

While the two examples highlight outsized value in automotive manufacturing, Smart Factory leaders across other sectors have demonstrated even greater scale and maturity of deployment. In particular, electronics manufacturing has operationalized automation, digital control towers, and advanced analytics across vast factory networks. The following page covers a deep-dive into a leading electronics manufacturer as one of the most scaled and best-in-class smart factory deployments globally.

Case study 2

Reinventing tyre development through autonomous, digital-first NPD

Global automobile tyre manufacturer

Autonomous (Level-4) New Product Development (NPD) process

Challenges

The world's leading tyre manufacturer wanted to significantly reduce product development time to meet OEM timelines (of faster time-to-market and frequent model launches) while engineering a tyre capable of withstanding extreme power, torque, aerodynamic loads and very high speeds.

Levers implemented, and how

While the manufacturer had a history of leveraging basic digital tools and computing technologies, including mathematical models for tyre performance for the last 30+ years, its new ambition required a step change.

- **Deep digital simulations and virtual testing** to mirror real-world conditions and engage OEMs with these simulations from the earliest research stages. This enabled faster lock-in of specifications and replaced traditional trial-and-error methods, enabling faster iteration and more precise performance tuning.
- **AI enabled design process** – data from previous simulations fed into AI models that could then predict tyre behavior and optimal design parameters instantly.
- **Additive manufacturing for tyre mold components** further augmented the design process which leads to faster development of prototypes.

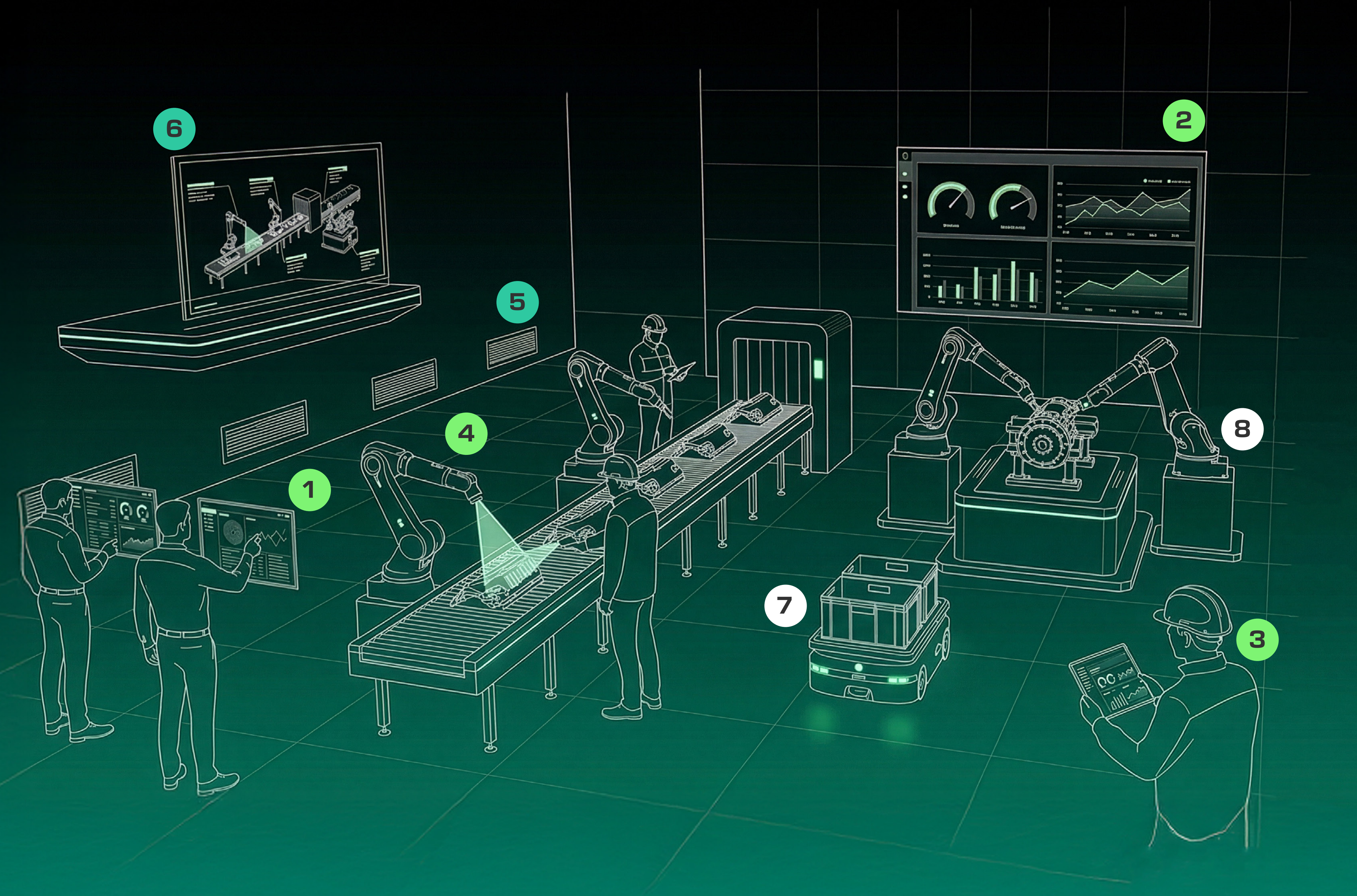
The overall digital transformation was not without challenges – achieving internal and OEM trust in simulations (that it actually mirrors real-world) was a key bottleneck. The manufacturer overcame the accuracy/trust hurdle by acquiring best-in-class tech companies in the field of simulation. They first demonstrated performance in motorsport and gradually rolled out tech to road-tyre projects when it became an accepted norm. Another key issue was cultural and skill transformation – longtime tyre engineers were accustomed to rely on physical testing. Transition was carried out by educating and demonstrating results internally.

Tangible impact achieved

The digitized approach to product development has yielded tangible, quantified improvements:

- Faster time to market: development cycle completed in just 15 months (compared to 24-30 months earlier).
- 20–30% reduction in physical prototypes reducing development costs and Research and Development (R&D) related emission.

View of the future –
Smart Factory setup at scale



Transformation Focus

A leading Taiwanese electronics manufacturer undertook a bold ambition, not only to automate tasks, but to architect an intelligent production ecosystem to unlock higher industrial value and operational scalability across its global manufacturing network.

They implemented end-to-end systems across L1 to L5 digital maturity, enabling real-time visibility into operations and product quality, while improving throughput through a unified data infrastructure, real-time KPI dashboards, and AI-enabled, digitally powered robotics, among other interventions.

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Impact Achieved

20–30% improvement in cycle time

25% reduction in error rates

15% reduction in operations cost

Level 1 & 2

1 Consistent & unified data infrastructure

Connects plants, platform services, apps to a shared cloud, helping bridge physical and virtual worlds

2 Real time KPI / performance boards

Pulls key metrics from MES, SFC, and automation systems to speed issue detection and response

3 Digital paperless SOPs

Integrates SOP management with optional station level SFC data collection

4 End-to-end product traceability

Barcode/QR scanning captures serial and batch IDs, production location/date, line info for quality tracking and documentation

Level 3 & 4

5 Real time thermal & airflow optimization

To identify hotspots and optimize cooling for stable opns and energy efficiency

6 Digital twins

Used to plan and simulate automated production lines to virtually test processes before deployment

Level 5

7 Automated material movement via AGVs

Optimizes automated internal material movement with dynamic routing for easier logistics

8 AI powered robotic arms

Integrate precise socket pose estimation and real-time motion planning, enabling highly accurate, collision-free operations

Foundation & Learnings

The transformation hinged on simultaneous actions across 3 elements:

1. **Technology:** Digital twin-based simulation to reality to speed up deployment and reduce physical trial and error.
2. **People:** Upskilling engineers through hands-on training in digital interventions such as digitized performance tracking, digital SOPs, digital simulation, and AI-powered robotics.
3. **Partnerships:** Collaborative long-term partnerships with technology vendors to co-develop and deploy scalable automation.

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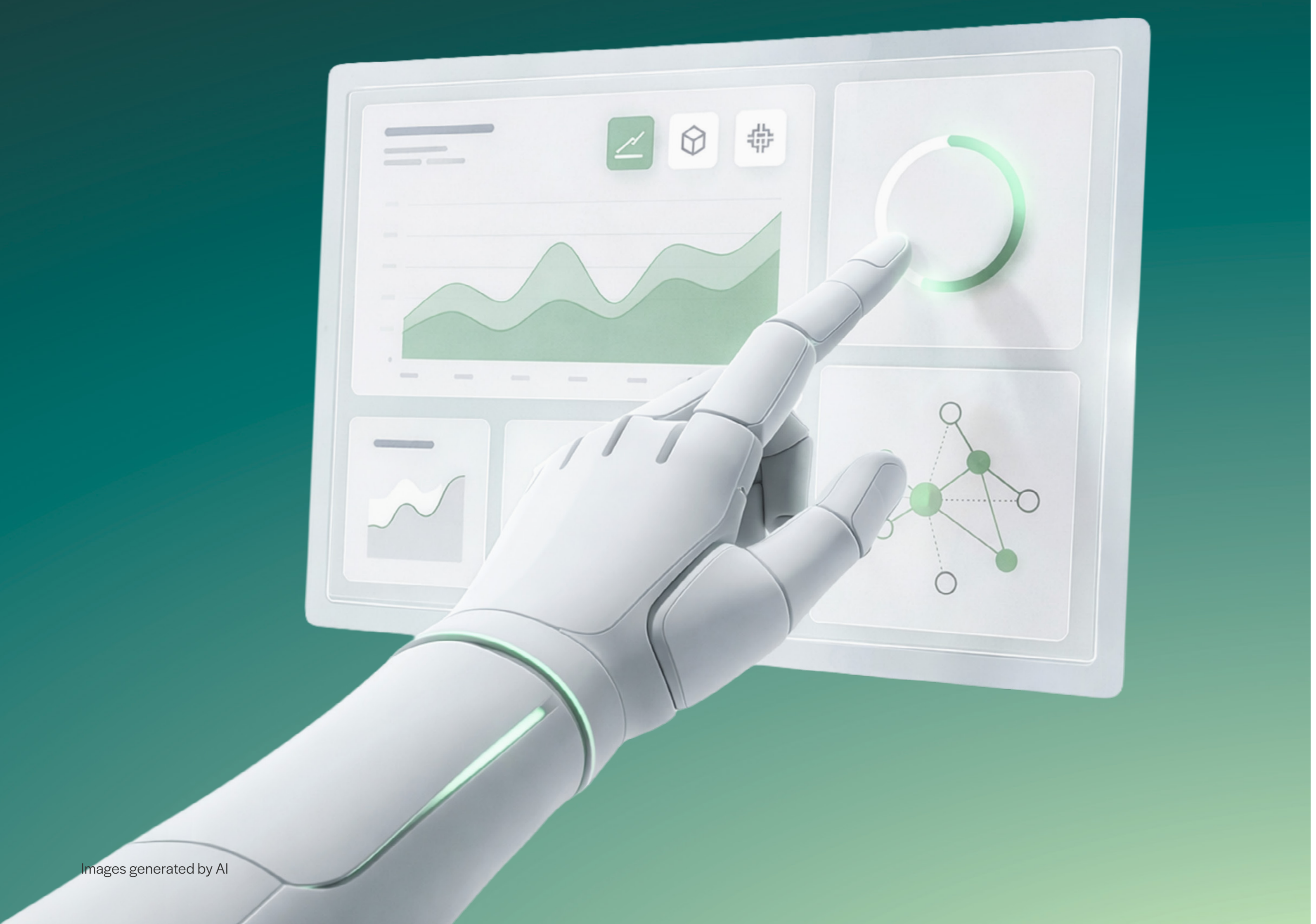
02.

Indian auto component sector: At the cusp of transformation



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India's auto component sector must be read in its own context – Smart Factory in India has not been held back by intent, but by structure. Historically, the ecosystem ran at a smaller scale with smaller units, benefited from abundant manpower, and skewed towards build-to-print work with no R&D or design value addition. As a result, margins continue to be thin, making every investment a tough Return on Investment (ROI) test.

Further, the Indian automotive market has been relatively insular, i.e., largely serving domestic demand. Thus, most "digital" aspects of the machines / OEM solutions weren't designed for Indian shopfloor realities, so adoption stayed pragmatic and selective, more "prove-it" than big-bang.

Those **constraints are now shifting – scale is building, labor economics and customer expectations are changing, and OEM offerings are becoming more India-ready. That combination is pushing the industry to an inflection point,** where Smart Factory interventions shift from acting as optional pilots to a necessary lever.

2.1 Inflection point – Why Smart Factory is emerging as a strategic priority?

In the past, Smart Factory was often viewed as optional. 4–5 years ago, except for a very few high-volume lines, automation or digital was seen as a discretionary intervention with only a limited payback. Rather, manual lines that kept costs low and flexibility high, to serve a complex India portfolio, were considered as the smart thing to do.

However, as the **contours of the Indian auto component industry are changing, shaped by five macro trends**, the adoption of Smart Factory principles is becoming critical. These 5 macro trends expose gaps with traditional factories that must be addressed for India to compete and lead globally.

1. India's export ambitions are growing

In our report last year, we captured how India's export momentum is being matched by a clear ambition for step-change. Auto component exports have grown **1.5x from ~$15 Bn (FY19) to ~$23 Bn (FY25)**, with an outlook of **$100 Bn by FY30.** The sector has moved from a **$2.5 Bn deficit to a ~$450 Mn surplus**, yet India captures only **~2% of global trade versus China's ~12%**, highlighting both the headroom and the capability bar to capture it.

Exhibit 3: Indian auto component sector aspires to grow exports at a CAGR of ~35%

ACMA X BCG's survey of procurement leaders across global OEMs and Tier-1s shows strong openness to sourcing from India, with **80% expressing willingness**. This openness, however, depends on suppliers' ability to deliver **faster NPD, closer engineering collaboration, consistent zero-defect quality, and reliable, shorter lead times**. Most of these imperatives can be directly addressed by digital interventions.

Exhibit 4: Key areas of improvement sought by CPOs, most of which can be addressed via digital interventions

% CPOs that believe India has room to improve in

Technology	Engineering	Local Presence	Quality
86%	36%	59%	49%

Key areas of improvement:

Technology	Engineering	Local Presence	Quality
✓ Improve development cycles/lead times	✓ Improve tooling and prototyping speed and capabilities	✓ Build greater speed and reliability in TAT	✓ Drive stronger quality control, reduce quality led rejections (e.g, manual inspections, dimensional inaccuracy, corrosion, RM quality
✓ Improve speed to adapt to new technology and innovations – make R&D a strategic priority	✓ Improve OEM collaboration; scale skilled engineering capacity	↗ Invest in supply chain / WH near OEMs given long shipping routes	✓ Drive greater consistency across batches (addressing process gaps, automation)
		✓ Invest to improve on-site engineering, sales and support presence	

✓ Areas where digital intervention can have impact

2. ICE and EV program growing simultaneously creating pressure on balance sheet

India is a rare market where vehicle volumes are rising rapidly with sustained Internal Combustion Engine (ICE) demand growth alongside rapid EV adoption. Total EV registrations across vehicle categories rose from **~1.43 lakh (FY21)** to **~17.84 lakh (FY25)**, taking EV penetration in new registrations from ~0.8% to ~7.3%. During the same period, ICE registrations grew from **~173.8 lakh (FY21) to ~225.87 lakh (FY25)**; about **~7% CAGR**, indicating that ICE volumes are nowhere close to their peak.

This two-speed expansion is unusual versus major markets where ICE demand is shrinking while EV demand is rising. For instance, in the EU, petrol registrations fell ~20.5% and diesel ~28% in the first two months of 2025.

The implication for auto component suppliers is a dual investment squeeze – they must scale ICE-linked supply to meet current and future programs while simultaneously investing in EV capabilities, programs, and platforms to stay relevant in the future. Moreover, global demand for classic ICE components remains meaningful even as markets consolidate, creating a last-person-standing opportunity for India.

Therefore, **unless ICE lines deliver more output without physically expanding, suppliers will be forced to choose between investing in additional ICE capacity** with limited future visibility or risking under-delivery against current OEM demand.

3. Workforce churn is eroding shopfloor experience

Across major automotives, demographics are already tightening the talent pipeline. Globally, **~25% of automotive employees are expected to retire** over the next decade, even as the industry's skill needs are shifting toward new technologies.

India is seeing the same experience leakage through churn. Automotive **attrition has been increasing, rising to ~12.4% in 2024 (vs 11.1% in 2023)**. This is amplified on the shop floor where tenure is increasingly short. Over **43% of temporary/contract workers exit within a year**, making experience highly perishable in labor pools.

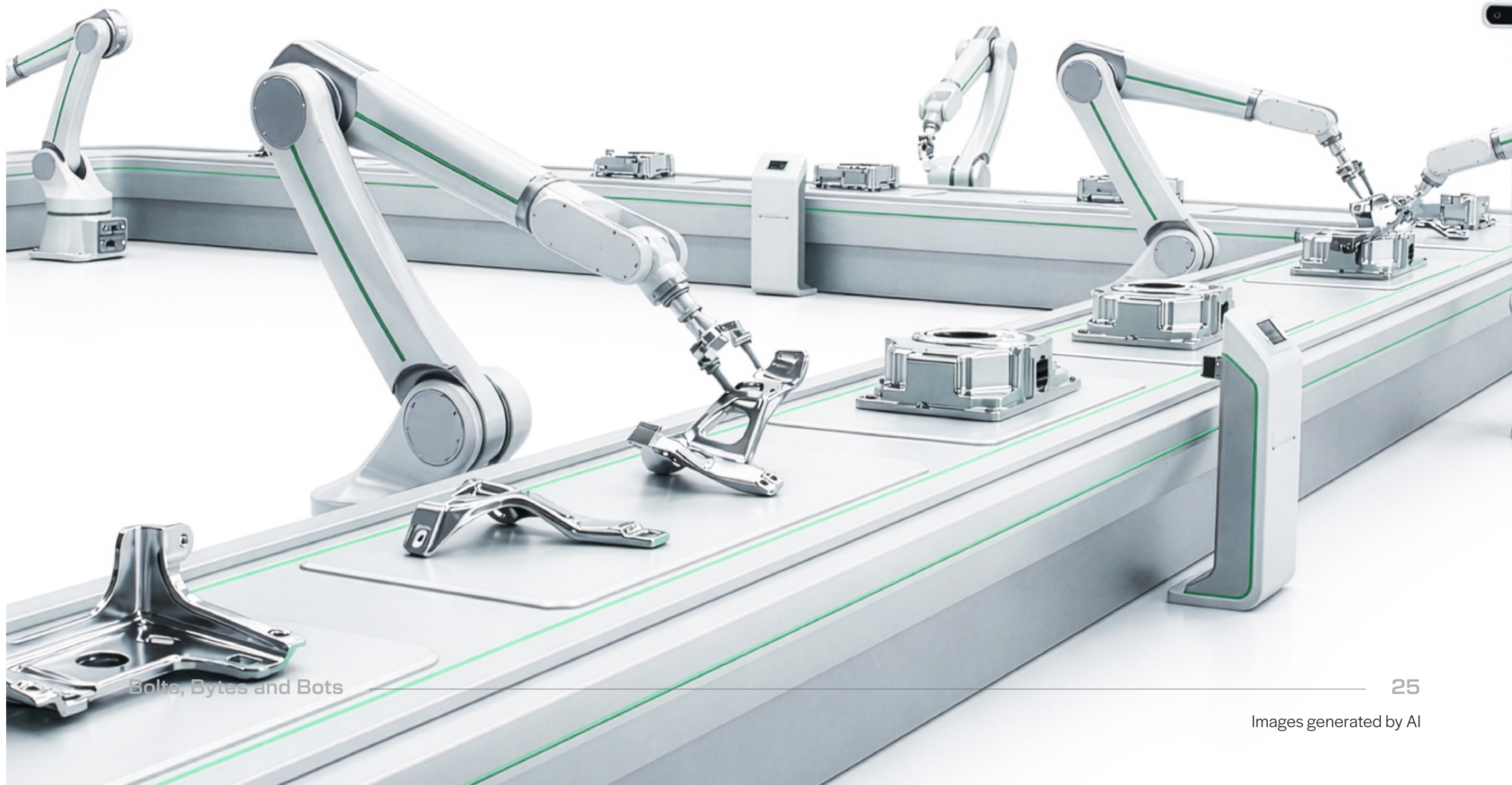
With experience cycling out faster than it can be rebuilt, capability does not compound organically; plants become reliant on a few operators, time-to-competency keeps resetting, and shift-to-shift output and quality become harder to stabilize unless process knowledge is embedded into systems.

4. The expanding definition of "scale"

India's manufacturing base is expected to scale sharply over the next decade. Annual vehicle production is expected to rise from **~30-35 Mn units in 2024-25 to ~50–55 Mn by 2030** (and ~90–100 Mn by 2037), which directly lifts **volume, variety, and cadence expectations for auto component plants**.

This implies scale for auto component manufacturers not just in terms of output but in the number of product families, programs, and changeovers. Many suppliers have added new assembly lines and products to keep pace. **These expansions mean that a single factory now produces a far wider array of parts (thousands of Stock Keeping Units (SKUs) with multiple variants)** and serves more vehicle programs than ever.

The net effect is that scale in today's context is about volume as well as unmatched complexity. Multiple product lines, variant-specific workflows, and interdependent process flows have become the norm in these supersized operations. Inevitably, **this will stretch traditional management to a breaking point, making the old ways of running a plant untenable.** In short, scaling up without scaling digital visibility and data-driven decision-making leads to systemic cracks.



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5. Cost pressures are persisting in a volatile environment

Auto component manufacturers face sustained pressure to improve cost competitiveness, even as input prices and logistics costs remain volatile. **With industry operating margins expected to stay range-bound at ~11–12%, manufacturers must find new ways to drive efficiency and reduce waste,** especially where pass-through mechanisms are limited.

External shocks add a second layer of pressure. For instance, freight rates rose in FY24 due to Red Sea disruptions. Broader manufacturing sentiment also reflects this squeeze: nearly 60% of firms reported higher production costs as a share of sales, driven by raw materials, wages, utility/energy, scrap prices, and logistics.

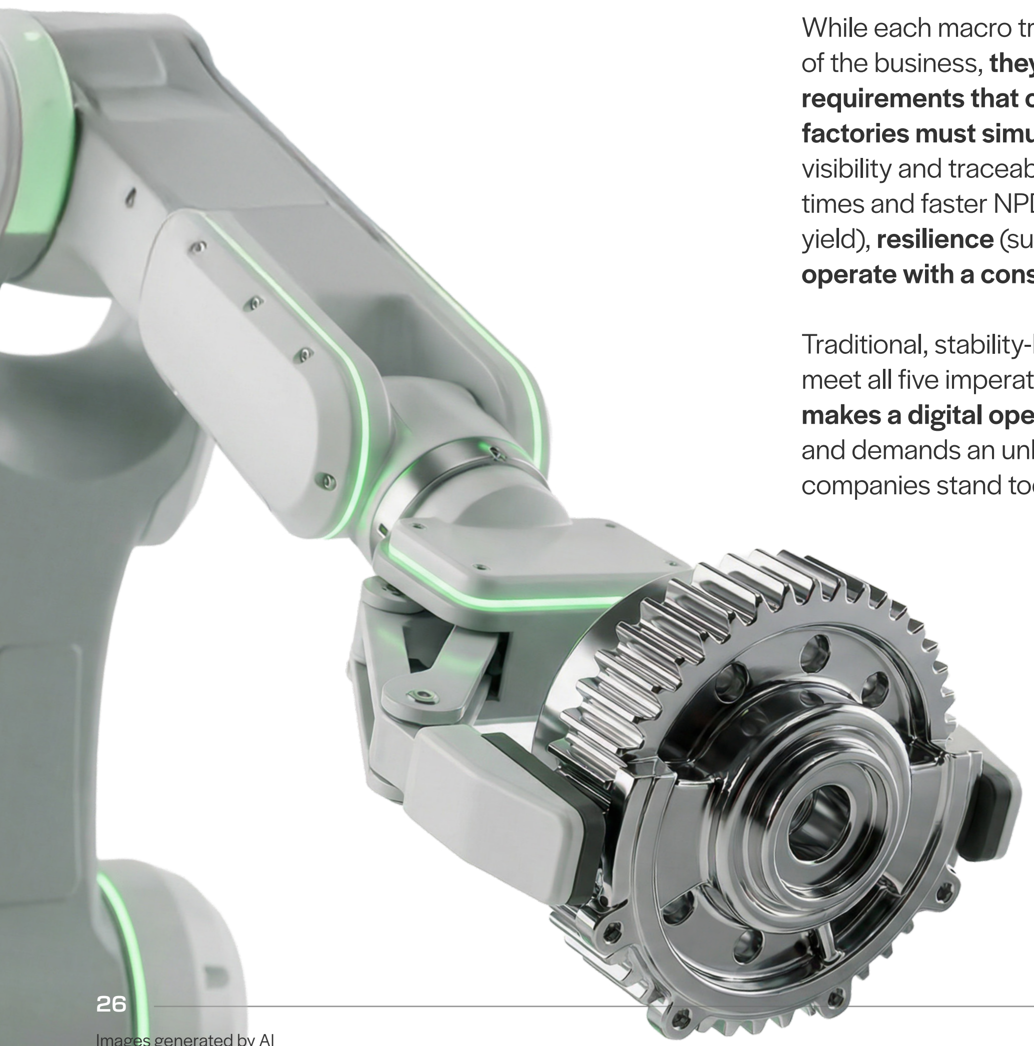
In parallel, global buyer selection still explicitly weighs cost (alongside quality and engineering/tech). Thus, suppliers can't assume that an increase in price will protect profitability.

The trends shaping auto components manufacturing in India are breaking the way traditional factories plan, run, and improve their daily operations:

1. **Losses remain invisible** because manual management and limited visibility leave micro-stoppages, speed loss, scrap, and rework unmeasured until margins erode.
2. Execution fails under **changeover complexity** because shared ICE and EV lines require frequent routing, setting, and inspection changes that manual scheduling cannot control.
3. Reliability remains reactive because stretched legacy assets lack downtime analytics and predictive maintenance, so **repeat failures and recurring root causes destabilize throughput.**
4. **Capability becomes person-dependent** because churn removes the know-how and paper-based training slows ramp-ups and resets standard work.
5. **Speed to launch becomes constrained** because compressed timelines outpace toolroom, prototyping, and engineering capacity across new programs.
6. **Improvements struggle to prove ROI** clearly because demand swings and logistics volatility destabilize baselines, pushing plants toward buffers, expediting, and firefighting.

While each macro trend stresses a different corner of the business, **they all converge on operational requirements that can be solved via digital initiatives: factories must simultaneously deliver trust** (quality, visibility and traceability), **speed** (short production lead-times and faster NPD), **productivity** (higher OEE and yield), **resilience** (supply-chain robustness), and learn to **operate with a constantly churning workforce**.

Traditional, stability-biased factories are not built to meet all five imperatives at once. This **convergence makes a digital operating backbone non-negotiable** and demands an unbiased assessment of where Indian companies stand today.



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Mindset shift has occurred: From sporadic, small-scale pilots to a structural, scalable value lever

What smart factory used to mean		Why it was a mismatch with Indian manufacturing realities
Technology-first programs (to showcase), problems identified later	→	High cost-competition meant showcasing technological superiority not priority
Designed for high wages + stable processes (such as Germany & Japan) → automation pays back	→	Manual heavy + high product mix → flexibility matters
Predictable demand, workforce stability, planned capex cycles	→	Demand volatility, high attrition, capex is constrained (MSMEs account for ~70% of the sector)
ROI from higher automation intensity (robots = value), not information flows	→	Low capex tolerance
Large, multi-year automation investments make sense	→	Small, modular investments with fast payback preferred

True to its form, the Indian ecosystem is using frugal innovation to break earlier assumptions, and companies now see Smart Factory interventions as strong value levers.

1. Smart Factory revealed uncomfortable truths and made value fundable

MES/SCADA and traceability dashboards exposed inflated manual Overall Equipment Effectiveness (OEE) and hidden losses (micro-stops, rework, downtime), turning guesswork into measurable, fundable actions.

A leading automotive belts and hoses manufacturer implemented MES integrated with SAP supported by barcode-based traceability, in-line sensors and automated machine data capture across a production line. Once manual reporting was replaced with system-generated data, the plant discovered that an assumed **~80% OEE was actually ~69%**, revealing hidden losses.

OEE fell from ~80% to 69% revealing "true" baseline **and reached 82% after targeted actions** from reliable data

50% reduction in rejections followed once true performance losses were made visible

2. Digital tools enabled young plants to match mature site performance

Digital tools began to tackle core execution problems by capturing real-time process data to reduce variability, locking standard work to reduce dependence on individual experience.

At an automotive fasteners and precision components, the a young plant's workforce matched the more mature site's performance after deploying E2E digital traceability, QR route cards and inline QC. The plant head and functional leaders credited the performance parity to digital controls.

Reduced dependence on star operators through enforced digital standard work

3. Indian frugality and innovation made sensorization more cost effective while driving strong impact

Indian manufacturers are demonstrating how Smart Factory does not require heavy, high-cost deployments, but can be powered by frugal, shopfloor-led innovation that is tightly linked to data and process understanding.

A large sheet metal component manufacturer implemented an **innovative welding wire consumption tracking mechanism** using length detection, converting consumption into grams per part to **precisely control material wastage.** This was complemented by **real-time quality** and **throughput tracking** to systematically optimize weld gas consumption, progressively lowering CO_2-to-argon ratios through data-driven experiments.

Simple length detection sensor innovatively used to capture consumption and track against benchmark

30% reduction in specific material cost achieved through these data-led innovations

4. Digital efficiency gains improved the utilization of existing plant capacity

By improving visibility into throughput, losses, and bottlenecks digital interventions are helping plants use existing capacity more effectively. This enables manufacturers to simplify shift structures and support incremental growth without adding new assets.

At a driveline and powertrain components supplier, Smart Factory based performance monitoring was deployed across most production lines, with real-time visibility into hourly production, losses, and Andon alerts.

3 >> 2 shifts enabled on select processes through productivity improvements

150+ crore of new business absorbed using existing capacity, with **no incremental capex**

5. OEM requirements made a stronger case for digital readiness

Buyers raised the bar on traceability, audit-ready data, and predictable lead times, thereby nudging suppliers to prioritize digital capabilities. This improved critical operating metrics and, in turn, accelerated broader adoption across the supply base.

A leading sheet metal component supplier implemented supplier and customer-SAP links and an Audit Cloud where they upload micrograph, 3D scan reports for audits on demand.

Shifted OEM audits and JIT/JIS delivery from episodic coordination to a built-in, always-ready operational capability

The evidence is clear, Smart Factory has moved from optional pilot to a core competitiveness lever. Digital interventions have exposed real baselines, unlocked fundable productivity gains, stabilized manual high-mix plants, and become a buyer prerequisite.

Hence the

question today is not "if" but "how".

2.3 From experiments to enterprise: The journey so far

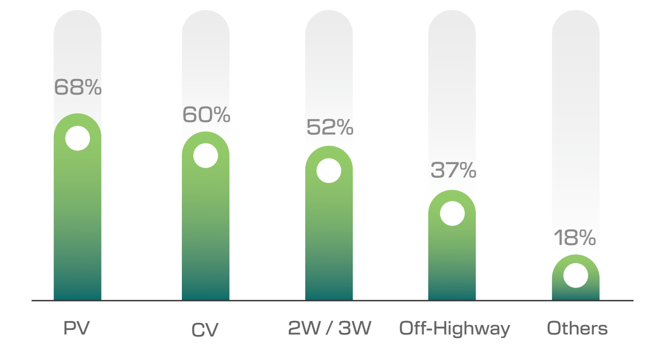
The flywheel has started moving

This year, ACMA X BCG jointly ran a survey and undertook detailed discussions with CXOs and business leaders of the auto component industry to take stock of Smart Factory adoption and understand the factors that were impeding enterprise-wide transformation. **The good news is that India's auto component manufacturers have moved meaningfully beyond the "idea stage" on Smart Factory into execution – pilots and scale-up.**

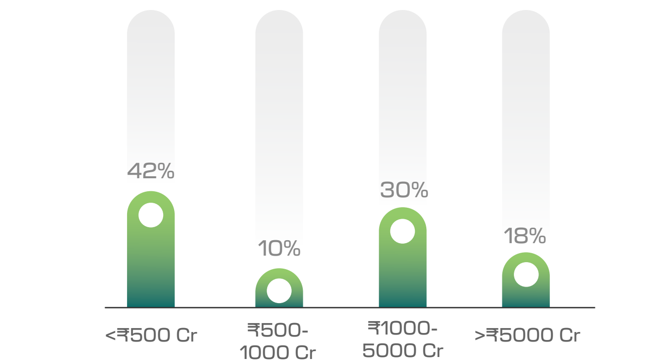
The survey captured responses from 60 auto component manufacturers across a diverse spectrum, spanning revenue bands, end-customer segments, domestic/export orientations, and plant footprints, providing a balanced view and representation across operating models and maturity levels.

60 unique responses received on the survey

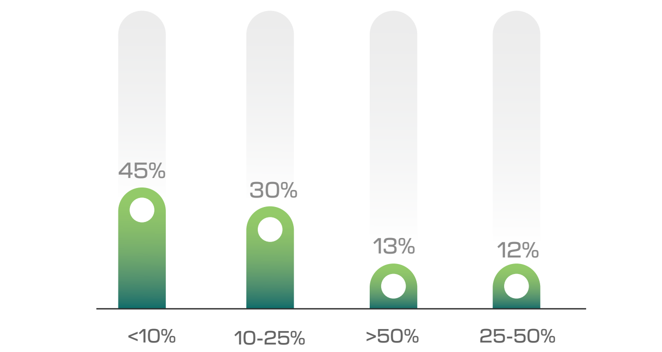
Broad end-customer coverage: Responses span auto comp players which serve all types of end markets



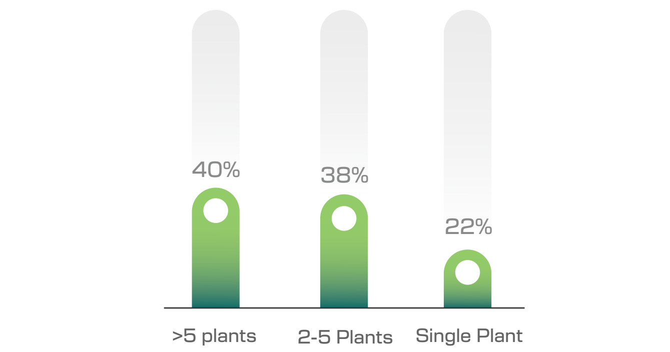
Across revenue segments: Coverage spans both emerging and scaled manufacturers



Across export orientation: The base includes both domestic-focused and export-led suppliers



Across Single-Site and Multi-Plant Footprints: Captures site-level adoption journeys and the realities of replicating solutions

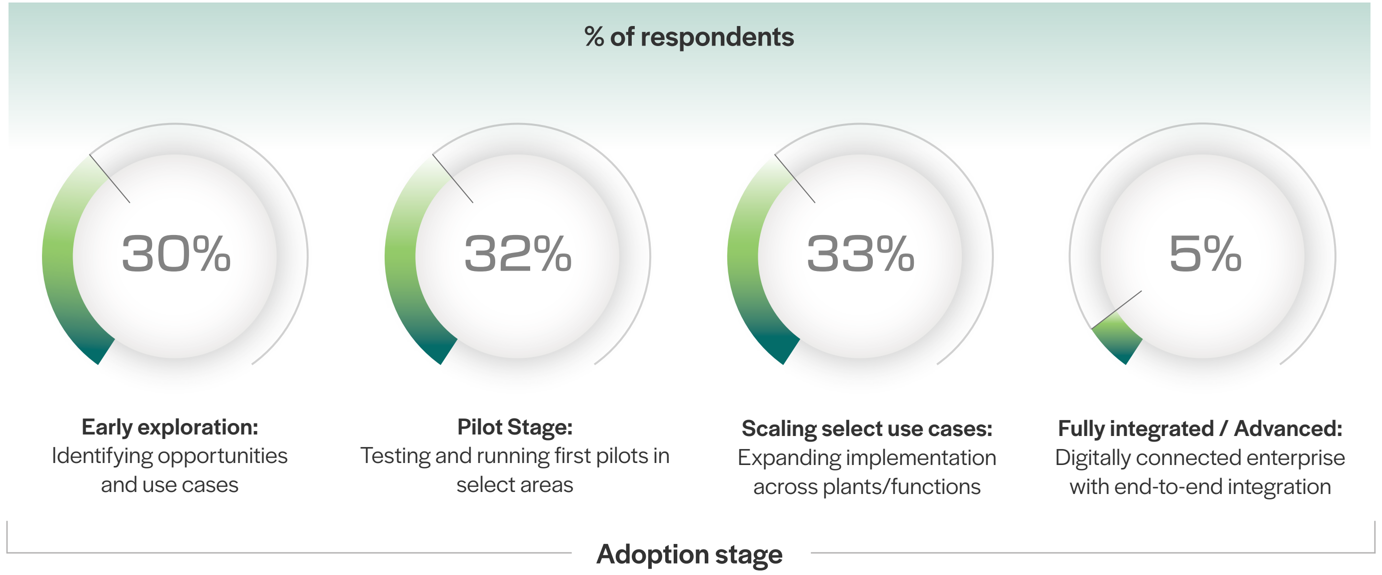


Key Takeaways:

1. More than 2/3rd of the sector is already at pilot stage or beyond, and more than 1/3rd is scaling digital initiatives.

Greenshoots are more than visible and adoption has clearly moved beyond ideation signaling that Smart Factory is beginning to institutionalize rather than remain within the realm of isolated trials.

Smart Factory maturity spans early exploration to end-to-end integration

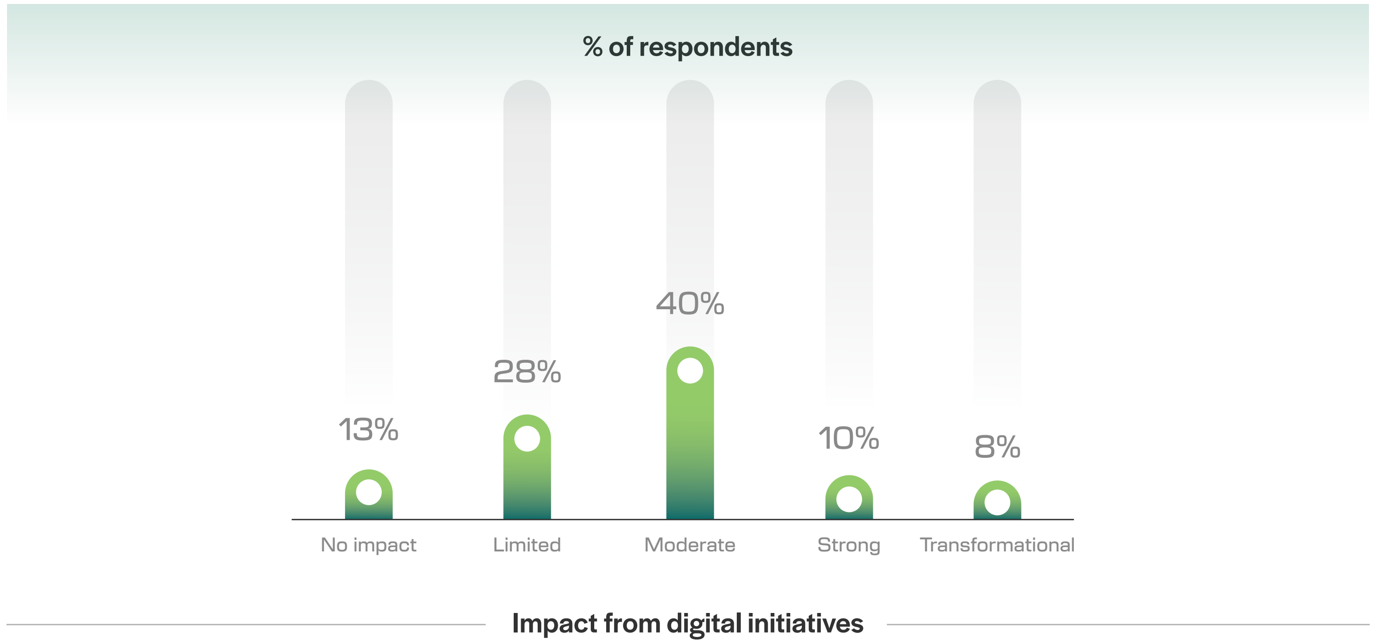


2. Most companies have started to see meaningful and measurable impact.

~60% of the companies report moderate-to-transformational impact. The nature of this impact is also consistent across discussions. Digital interventions are creating a cleaner picture of truth by replacing manual reporting with system-generated data, further converting that transparency into better decisions and faster issue resolution as losses and bottlenecks become visible and actionable.

This enables cross-functional collaboration around a single version of performance across operations, quality, maintenance, and planning and, where scaled, translates into hard economic outcomes through quality, cost reduction, and capacity unlock.

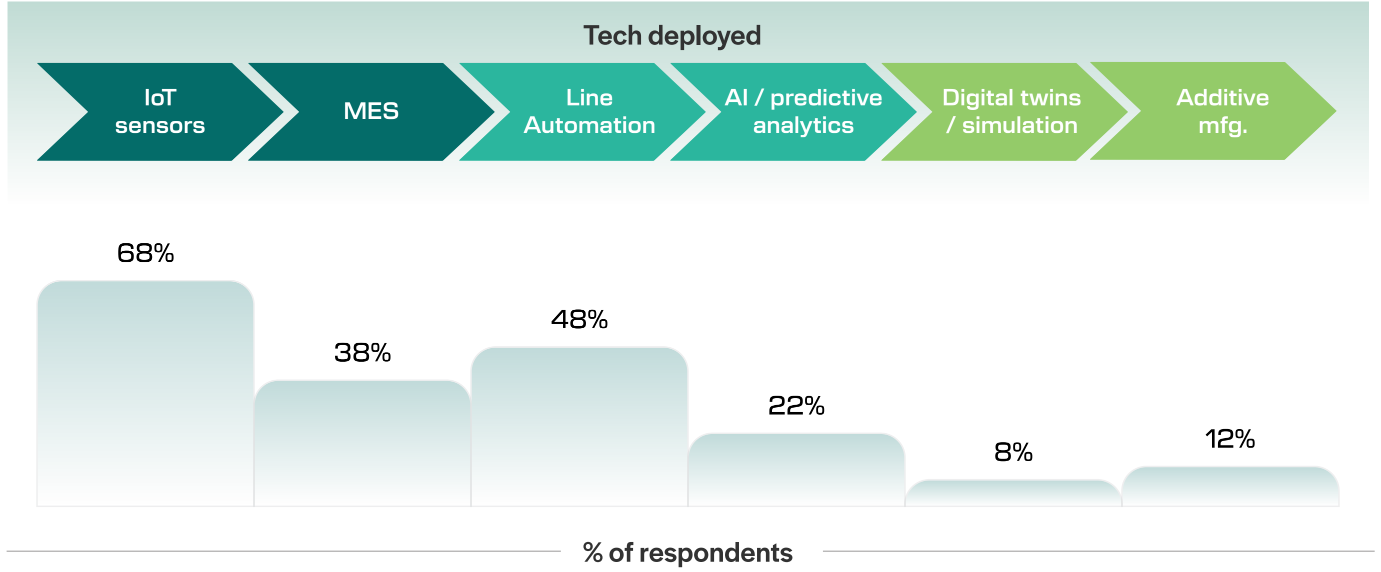
Companies have started to see measurable impact



3. Tech adoption is steadily moving up the stack: More than 2/3rd of the companies have deployed IoT sensors and are now treading towards advanced use cases.

Adoption is progressing from foundational layers like connected machines and automation to more advanced ones. ~20% companies have already started deploying digital twins and additive manufacturing; early proof that the ecosystem is beginning to move beyond connectivity into next-generation manufacturing capabilities.

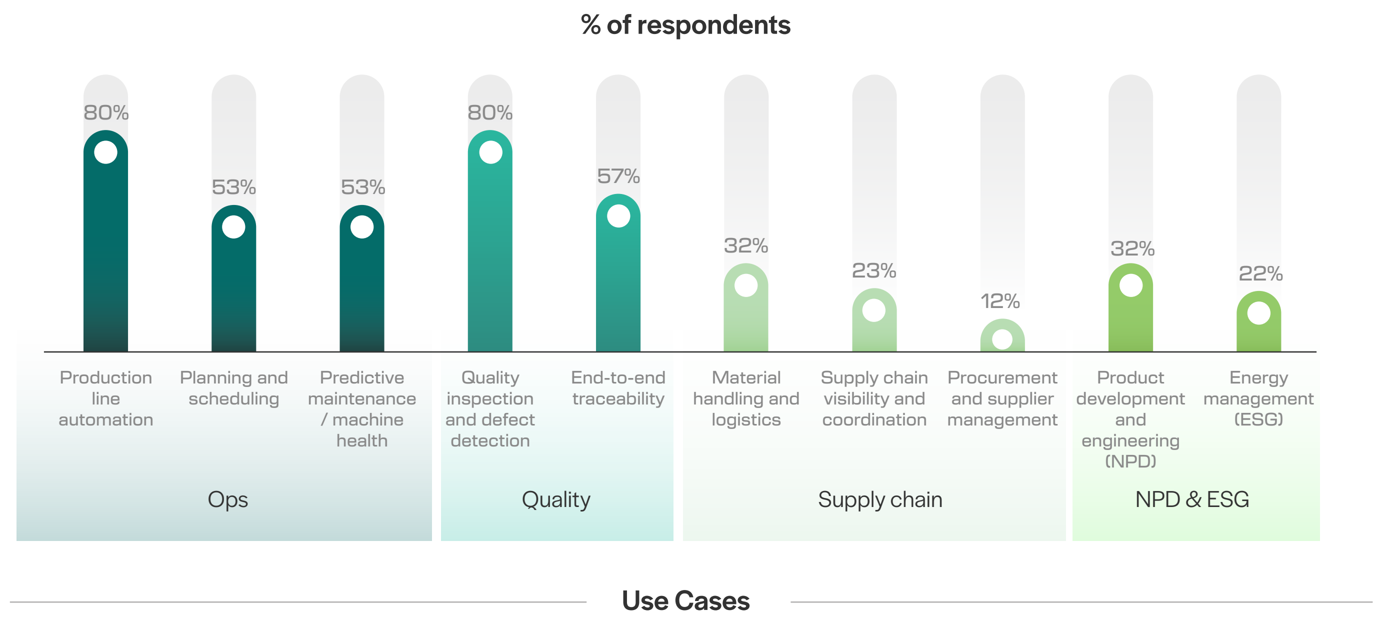
Tech adoption is moving up the stack as companies mature



4. Operations and quality are emerging as clear front-runners in priorities for digital adoption, where belief in impact is strongest.

~80% of the companies want to cover operations and quality interventions as immediate priority, with strong momentum towards extending digital capabilities across the value chain. Supply chain visibility, NPD, and ESG are emerging as natural adjacencies, pointing to a more integrated, E2E digital transformation over time.

Operations and quality emerge as immediate use case priorities



What flips the odds of success and helps realize greater value

1. Building data backbone is pivotal before advanced use case deployment

Companies currently in the scaling stage are 3X more likely to have implemented IOT sensors / connected machines compared to companies in the early exploration phase. 90% of all respondents in the scale-up stage have implemented IOT/ connected machines and are now moving towards the implementation of AI / predictive analytics (35%) and line automation (65%).

Plant leaders reinforce that reliable data drives advanced analytics. System truth must come first. Once connectivity is established, higher-order use cases become viable and scalable. Standardized data and controls enable replication at scale.

At a large automotive Thermal and HVAC systems manufacturer, foundational IoT connectivity and online monitoring of critical equipment parameters enabled the deployment of an AI engine based on data to trigger alerts / actions and performance analytics to proactively identify issues. OEE improved from ~76% to ~82% once reliable data streams enabled faster detection and resolution of breakdown and quality issues.

> **Once MES strengthened data visibility, the true baseline became clear – legacy OEE of ~80% came down to a truer ~69%. With interventions, we elevated it back to ~82%**
>
> –Automotive belts and hoses manufacturer

> **Aspiration is to bring all data onto a common platform with a single dashboard. Defining the problem correctly solves ~30–40% of the challenge, and having the right data solves the remaining**
>
> –Driveline and transmission systems supplier

2. Clear top-down sponsorship converts pilot wins into repeatable, scaled impact

Top-down sponsorship is critical to get pilots off the ground, ensuring resources, attention, and ownership to iterate until tangible impact is visible. Bringing together technology, people, and vendors in a live operating environment of a pilot is complex, and without continued senior-level focus, many pilots lose momentum and fail to deliver tangible outcomes.

Importantly, success at the pilot stage does not automatically translate into scale. Pilots help demonstrate feasibility and localized ROI in controlled settings, but scaling requires conviction and explicit commitment from the top leadership team. Unless leaders believe that early success can be replicated across lines or plants, organizations remain stuck in pilot mode and rarely unlock the full impact potential of digital transformation.

> **ROI wasn't clear initially, so we started small with a limited-scope PoC. Once performance became credible, top leadership backed us to scale beyond trials – expanding the effort and bringing in a dedicated team**
>
> –Driveline and transmission systems supplier

> **Pilots help validate value however, the strongest ROI is realized with scale when enabled by clear leadership sponsorship. Once scaled, deployments can deliver payback in ~1–1.5 years**
>
> –Sheet metal component supplier

> **Over the past 2–3 years, digital transformation has become a strategic focus among the top three organizational priorities, alongside capacity expansion and production planning**
>
> –Automotive braking systems manufacturer

3. Consistent, phased rollout of initiatives drive sustained impact

Digital success is rarely the result of one large leap. Companies that see sustained impact tend to follow a disciplined, phased journey, taking consistent steps over time. The emphasis is on starting with the basics, learning quickly, and scaling deliberately where value is proven.

In practice, this journey typically unfolds in stages. Companies begin by establishing accurate data baselines and putting foundational architectures in place, so performance is visible and trusted. They then launch a small set of high-impact pilots or lighthouse initiatives, focused on the most critical pain points. As these initiatives mature, leaders track impact closely, build confidence in the results, and double down on areas where value is clearly demonstrated.

> **Initial POC was done with a small team and scale. When reasonable performance was achieved, then bigger teams were enrolled**
>
> –Driveline and transmission systems supplier

> **We drive module-based investments through multiple small bets. Full automation At once is risky and may not result in intended outcomes**
>
> –Automotive thermal and HVAC systems supplier

4. Interconnected tech stack architecture amplifies impact at scale

As companies progress and mature along their digital journey, the fitness of their digital architecture becomes increasingly critical. What is sufficient for early experiments must be consciously evolved to support future growth, reuse, and integration as initiatives scale. An interconnected tech stack enables capabilities to be built in layers – linking data sources, execution systems, and analytics in a coherent way that allows impact to compound over time as new use cases are added.

To enable this, solutions need to be developed against a clear reference architecture, with well-defined layers and standardized integration patterns. This ensures that each new deployment builds on existing foundations and strengthens the overall ecosystem. As pilots move into broader rollout, the architecture itself becomes a multiplier, amplifying value creation across the organization.

> **As digital initiatives started scaling, SAP, TOC, legacy SCADA, and MES all needed to talk to each other. Stitching these layers together became critical**
>
> –Automotive belts and hoses manufacturer

> **As our systems became connected, improvement moved from isolated fixes to standardized routines across productivity, quality, cost, delivery, and automation — enabling impact at scale**
>
> –Auto sheet-metal component supplier

Bumps in the journey: Practical challenges seen in implementation

Exhibit 5: Six key themes emerge as challenges for auto comp sector in digital scale-up

1. True impact potential is hidden under unclear metrics and faulty baselines

ROI ambiguity delays decisions and keeps digital deployment stuck in pilots

Difficult to articulate payback; OEM customers demand quality/traceability but rarely compensate for additional digital costs

–Automotive fasteners and precision components manufacturer

2. Data remains fragmented, inconsistent and siloed

No single source of truth for planning data

Capacity and RM planning are still managed in Excel, and there is no plant-wide data architecture

–Automotive braking systems manufacturer

3. Limited inhouse know-how for digital intervention

Limited digital talent slows deployment, debugging, scaling efforts

When MES is down, they are dependent on service providers; no in-house troubleshooting capability

–Automotive belts and hoses manufacturer

4. Constraints of legacy equipment and integration

Legacy machines raise retrofit costs and complicate integration

Many machines lack basic PLCs; retrofitting or adding 3rd-party sensors is costly and not always technically clean

–Automotive belts and hoses manufacturer components manufacturer

5. Fragmented vendor ecosystem is hard to navigate

Fragmented vendors limit interoperability and end-to-end scale

The ecosystem isn't ready or equipped – no single player can translate a business problem into an end-to-end solution

–Automotive thermal and HVAC systems supplier components manufacturer

6. Loss of momentum and uneven roll-out discipline driven by internal resistance to change

Adoption slows when workers don't yet trust systems and incentives

Culture and change management are crucial to making digital adoption stick – shifting the mindset from policing to decision-led empowerment

–Driveline and transmission systems supplier

Smart Factory adoption is held back by a chain of constraints that compound as plants move from pilots to scale.

1. It typically starts when **true impact is hidden under unclear metrics and faulty baselines** – making value hard to evidence and investments harder to sustain.

2. This is closely followed by **data challenges – data is fragmented, not clean at source**, and definitions vary across functions (e.g., committed vs actuals; Ops vs IT metrics). Moreover, teams end up manually massaging numbers, making transparency difficult and slowing scale-up. **This often translates into ROI ambiguity.** For instance, a large rubber and hose components manufacturer shared that even with ~10% OEE improvement and ~50% reduction in rejection rate, MES payback remained ~6 years. This high ROI timeline is because it is largely an ongoing OpEx spend and many benefits don't immediately translate into cash savings; however, extending MES to decision enablement and autonomous flows can deliver quicker ROI through CapEx avoidance.

As a result, such investments are often deferred to years when revenue/profitability are strong. Digital intervention takes a backseat as it doesn't "excite" the management enough.

3. These foundational gaps constrain execution. Most companies have strong operations expertise, but face **limited in-house digital know-how** to deploy, debug, and sustain solutions on the shop floor creating dependence on external support and slowing iteration.

4. Even with intent, **legacy equipment and integration challenges** become the practical tipping point – mixed-age assets and incompatible interfaces make E2E workflows hard to industrialize.

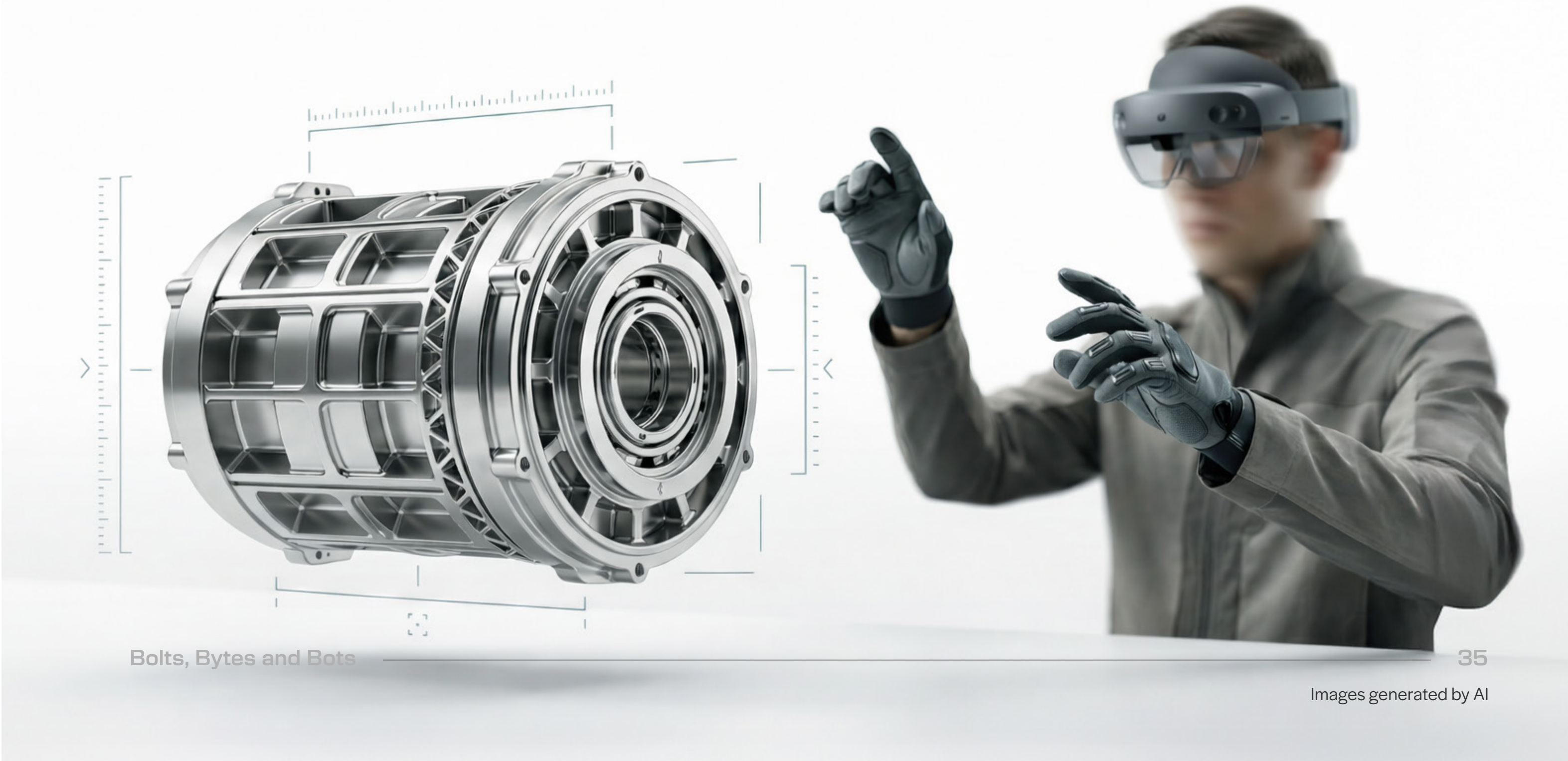
5. The pace is further constrained by a **fragmented vendor ecosystem that is challenging to navigate**, where point solutions may work in isolation, but interoperability needs significant configuration and governance.

6. Finally, **adoption stalls when firms face loss of momentum driven by resistance to change** as frontline teams prefer and revert to familiar routines and adoption remains inconsistent across lines and plants.

While these 6 challenges represent common themes across the industry, the intensity and nature of barriers vary meaningfully by company – depending on export exposure, scale, and digital starting point. For example,

- **Companies with low exports (i.e., <10% export sales) are 2X more likely to cite high investment cost as a barrier** versus companies with higher export sales. This suggests **greater sensitivity to ambiguous impact potential / unclear ROI**, often driven by faulty baselines and unclear metrics.
- **In contrast, high-export firms** often face legacy integration and limited digital know-how as constraints, reflecting more stringent traceability, compliance, and process complexity requirements.

These differences reinforce the need for tailored pathways to digital adoption, calibrated to each company's ambition and constraints.



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03.

Gearing up for success: From ambition to execution

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The momentum for Smart Factory in India's auto component sector is real – pilots are underway, early value is visible, and leadership commitment is growing. But the real opportunity lies ahead, moving from isolated experiments to enterprise-wide, multi-plant transformation that can meaningfully shift cost, quality, and responsiveness at scale.

3.1: Making Smart Factory solutions work

Companies across the Indian auto component sector are approaching Smart Factory from different starting points. While more than two-thirds of the sector is already at pilot stage or beyond, the remaining one-third is in the exploration phase and looking to soon start their journey. For companies that have not yet begun, the time is opportune – use cases are better understood, execution playbooks are clearer, and practical learnings from early adopters are now available.

Although there are enough proof points of value already available in our ecosystem, Smart Factory initiatives should be treated like any other business investment, competing against other priorities with clear visibility of payback and ROI. This is particularly important for many small and mid-sized players navigating constraints on capital, capability, and talent.

For one-third of the sector looking to embark on this journey, the most practical path is to begin in a focused manner and expand progressively as value is realized. We suggest a simple three-point guide to identify and implement pilots that can accrue value and strengthen confidence to scale:

- Identify areas where data capture remains manual and prioritize digitizing these first.
- Identify and empower shopfloor champions who can drive the adoption of new initiatives and ways of working.
- Prioritize operational areas with significant value leakages (e.g., downtime, yield loss, scrap, rework).

By assessing these three dimensions, companies can significantly improve their ability to select digital initiatives that are expected to yield results in their context, fund further journey and get started on the digital maturity curve.

For companies that have already experienced impact from pilots and POCs, the priority now is to translate these into institutional capabilities and a repeatable scale engine. This transformation calls for a clear capability blueprint, covering both foundations and scale enablers. Our holistic approach outlines six key levers to address the most persistent barriers and form a practical roadmap to implement and scale Smart Factory. These levers are grounded in lessons from India's Smart Factory vanguards and BCG's extensive experience implementing these solutions across auto and other sectors.

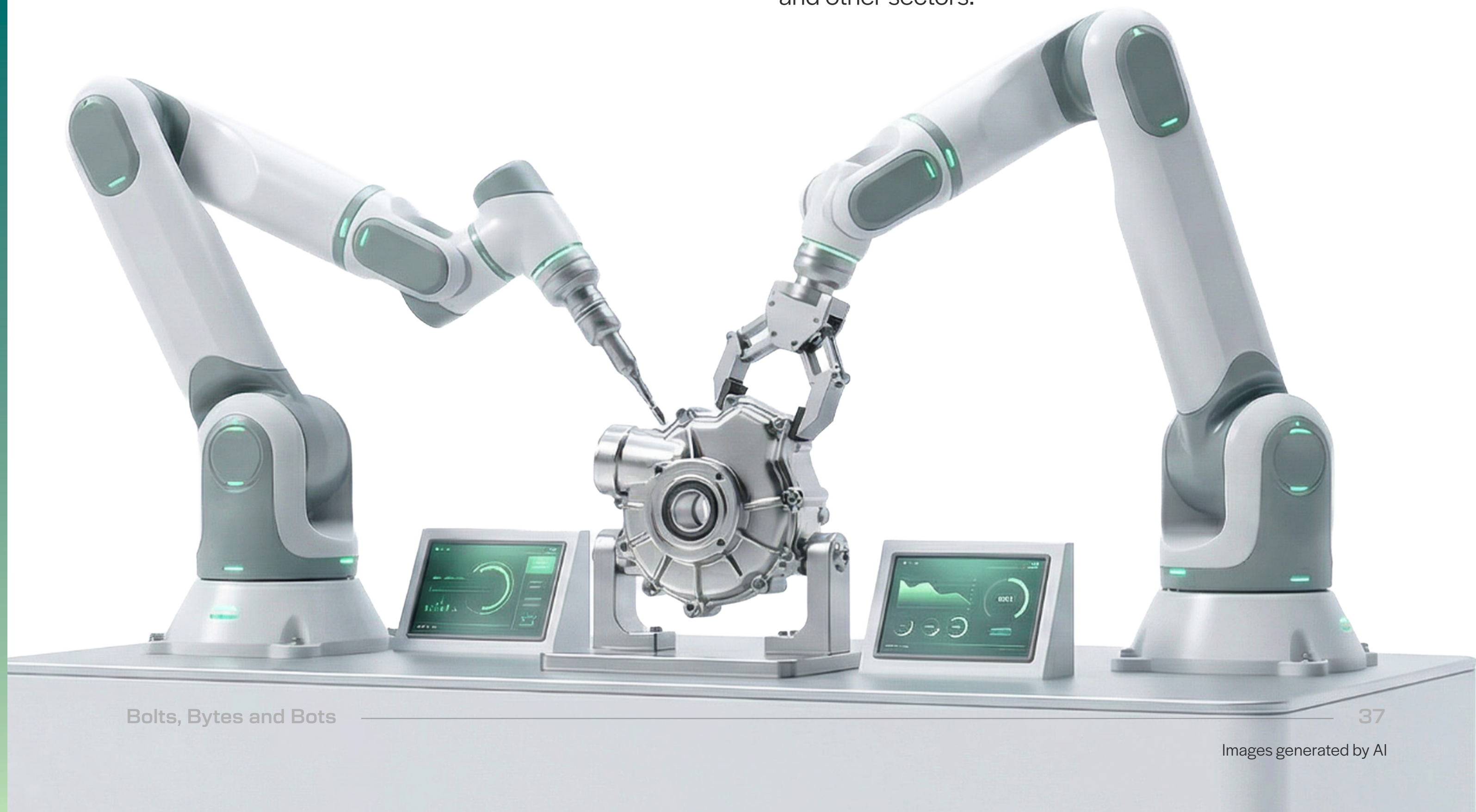

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Exhibit 6: Our holistic approach to address barriers to scale Smart Factory transformation

1

Top-down direction and sponsorship

Clear ambition, leadership pull, and resourcing to drive alignment, **resolve change resistance**, and push **through impact ambiguity**

2 Enterprise data backbone

Unified, structured platform to ensure clean system-captured data at source, connect siloed org functions, and establish one version of truth

3 Digitally capable talent pool

Role-linked skilling to build digital execution capability, beyond core ops strength to **address digital capability gaps**

4 Fit-for-purpose digital architecture

Modular, right-sized systems designed to match shopfloor complexity and **integrate easily with legacy equipment**

5 Scalable vendor and solution ecosystem

Collaborate and co-build with proven tech partners having deep experience in auto to reduce deployment risk and navigate a **fragmented vendor landscape**

6 Change delivery and Value led scale

Governed **rollout engine with playbooks, routines, and KPI tracking** to sustain momentum and ensure outcome-linked scale **overcoming change resistance and pilot fatigue**

Global lay of the land | India: At the cusp of transformation | Gearing up for success

1. Top-down direction and sponsorship

Scaling digital adoption starts with clarity and leadership pull. Companies that progress fastest treat Smart Factory as a business transformation, not an IT initiative – with clear ambition, visible sponsorship, and consistent decision-making from the top. This directly **addresses two recurring challenges we see – one is internal resistance to change and two is the lack of confidence on where digital will create impact.**

In practice, companies that succeed do a few things well:

- Leaders set a clear **3–5 year digital ambition roadmap**, explicitly linked to business outcomes such as quality, productivity, and delivery.
- Run **regular leadership steering forums** to prioritize use cases, allocate resources, and remove blockers.
- **Consolidate the ownership of digital initiatives** into a central team, rather than leaving efforts fragmented across plants or functions.

A case in point is a leading global auto component manufacturer that institutionalized digital manufacturing through board-mandated sponsorship. The company centrally pooled its Smart Factory expertise into a dedicated "connected manufacturing" unit, headed by a senior executive reporting into the board member responsible for manufacturing. Crucially, digital initiatives were explicitly tied to productivity, machine availability, and quality outcomes, not technology for its own sake, thereby enabling the company to scale solutions and deliver ~25% productivity improvement worldwide.

Industry bodies can further strengthen this leadership pull by running an annual digital maturity assessment (similar to the survey conducted this year), enabling companies to benchmark themselves against peers, track progress year-on-year, and shape ambition based on industry's best practices. This can help CXOs move from intent to conviction and maintain focus over the full transformation horizon.

Moreover, policy support in the form of accelerated depreciation or other tax incentives for specific Smart Factory assets can reinforce leadership commitment and help shape the industry's ambition.

2. Enterprise data as a backbone

A single, trusted view of data is a non-negotiable prerequisite for scaling Smart Factory. Many companies struggle to make progress not because they lack technology, but because data is manually scrubbed, inconsistently defined, and fragmented across systems. This lever directly addresses two challenges: **establishing a clean, shared performance baseline so teams don't stall thinking they're already "good enough" and resolving legacy integration gaps** by connecting disparate systems into a single data backbone.

In practice, companies that unlock scale invest deliberately in fixing the data foundation:

- Replace manual reporting and post-facto corrections with **automated data capture at source.**
- Establish **a single source of truth for all data in the organization** by building a **common data layer or platform** that all use cases draw from, rather than multiple disconnected tools.
- Set up a dedicated data Quality Assurance (QA) function to validate data quality, definitions, and integrity on an ongoing basis.

Industry bodies can support this shift by working with Bureau of Indian Standards and machine OEMs to promote common data interface standards for auto component machinery, helping companies capture shopfloor data into a single platform and reduce fragmentation across systems.

Even with legacy, older equipment, proven solutions can still enable robust data capture and a reliable data backbone.

We observed a clear gradient of solutioning by machine type and connectivity readiness. Typically, ~50–60% of machines in India can be addressed via software-based approaches with minimal one-time spend, while a smaller subset, often 15+ years old or largely mechanical, requires materially costlier L3/L4 interventions. These together enable an enterprise-wide source of truth for better performance and decision-making.

Exhibit 7: Digital interventions across different cost & complexity levels help enable a robust data backbone

Cost and complexity: Low → High

Typical fix	% of machines where applicable (as % of all legacy)	Type of machine where fix applicable	Average spend	Capabilities needed
L1 **Software based approach →** iterate to auto discover tags using OPC server	50-60%	Machines that lack standard data dictionary, nomenclature, language (but PLC and sensors exists)	**1-1.5 lakhs** (OPC server – one time cost)	1. Instrumentation engineering 2. Process technician
L2 **Gateway-controller PLC setup →** Gateway PLC taps into data from legacy PLCs	25-30%	OEM support not available to harmonize data flow and controls across system (but old PLC, sensors exist)	**2.5-3 lakhs** (for master PLC on every 8-10 m/c)	Capabilities listed above + 1. Control systems engineering 2. Electrical maintenance
L3 **Physical rewiring of sensors and actuators** to tap into signals (analog / digital / relay)	~15%	Typically 15+ year old machines that lack connectivity standards like OPC	**2-3 lakhs** (for sensors / actuators on every machine)	Capabilities listed above + 1. Control system integrator 2. Panel / wiring setup design and build 3. Sensor / actuator build
L4 **E2E identification and build of input / output signals,** sensors and connection to **PLC**	5-10%	Mechanical machines (e.g. legacy lathes) with no control systems	**7-8 lakhs** (per machine)	Capabilities listed above + 1. Entire machine design and build teams

Each fix must be supported by foundational (1) Data QA and (2) Stable network connectivity backup

3. Digitally capable talent pool

Companies that progress the fastest recognize that **Smart Factory is not driven by external tools alone, but by internal teams that can translate digital capabilities into operational outcomes.** Most auto component companies have strong teams to manage process operations but lack people who can translate digital tools into day-to-day production improvement. This creates dependence on vendors, slows response, and prevents scale. Building a digitally capable talent pool directly **addresses the challenge of limited internal digital capability.**

The secret to success is to marry digital capabilities with already existing strong operational expertise. Companies that build this capability do a few things deliberately:

- **Set up a dedicated OT / digital function** within operations with clear ownership for deploying and sustaining digital solutions on the shopfloor, but ensuring that the team works closely with operations.
- Establish a **horizontal Centre of Excellence (CoE)** to codify learnings, standardize approaches, and support the scaling of solutions across lines and plants.
- Run **targeted upskilling programs for operations teams,** covering areas such as sensors, robotics, automation systems, and digital platforms used in the plant.

A skills-through-execution approach is visible in an Indian auto sheet-metal components supplier where capability building was anchored directly in machine and process OEM involvement. Rather than running generic training programs, the company worked closely with supplier teams to train its engineers on the required process standards and equipment capabilities. This expertise was then systematically cascaded into shopfloor routines and daily execution, translating OEM expectations into internal capability.

Industry coordination can significantly amplify these efforts. **Relevant industry bodies can act as a convening and scaling platform,** enabling experienced CoEs from larger companies to support Tier-2 and smaller firms through structured advisory and commercial models.

Policy support can further accelerate talent development at scale. Models such as **Tamil Nadu's TANSAM and Singapore's government-backed Advanced Manufacturing Centre for Innovation (ACMOI)** demonstrate how public investment in shared labs, curriculum development, and industry-linked training programs can rapidly expand the pool of Smart Factory-ready talent available to manufacturers.

4. Fit-for-purpose digital architecture

Even with clean data and capable partners, many digital **programs fail at scale because the architecture choice is inadequate.** The issue is rarely intent. Rather, its because companies lack the know-how to design and deploy architectures that are aligned with shopfloor complexity without either over-engineering or locking themselves into brittle systems. This lever directly addresses **legacy integration challenges** and **high cost driven by poor architectural choices.**

Companies that get this right don't just "choose modular systems", they **change how architecture decisions are made.** The truth is that modularity works only when guided by an upfront architectural blueprint. Without that, "best-of-breed" quickly becomes fragmented. Hence companies should:

- **Start with a reference architecture,** defining clear layers (connectivity, execution, analytics) before selecting tools.
- **Centralize the ownership of architecture design** in a small core team that sets standards and approves deviations while **allowing plants or lines the freedom to deploy within those guardrails.**
- **Establish separate development, testing and production environment and mandate compatibility with existing systems as a procurement criterion,** shifting the burden of integration to suppliers.

Policy support is particularly important in this layer. Governments can accelerate adoption by promoting open interoperability standards (such as OPC-UA for machine to machine and UNS for machine to cloud) and discouraging proprietary lock-in through procurement norms and incentive design. Clear guidance on interoperable architecture helps ensure that investments made today remain usable as plants digitize further.

5. Scalable vendor and solution ecosystem

Scaling Smart Factory is often constrained less by the availability of solutions and more by the complexity of choosing and managing the right partners. **The market is crowded with startups and providers. Identifying the right fit is itself a skill, requiring an assessment of domain understanding, integration capability, customization needs, and the true cost of ownership.**

Building a scalable vendor and solution ecosystem directly addresses a persistent challenge, i.e., **navigating a fragmented vendor base while managing integration and execution risk during scale-up.**

Companies that scale successfully approach vendor engagement differently:

- Shift from **transactional buying to long-term partnerships** with repeated experience in the auto component context.
- Prioritize a small **set of strong, integration-ready partners** to reduce execution risk.

Industry coordination can materially lower the effort and risk for individual companies for building a trusted vendor ecosystem:

- Maintaining a **repository of referenceable vendors** with prior industry deployments to enable faster and safer partner selection.
- Organizing **smart factory supplier fairs** to connect manufacturers with proven technology providers.
- Facilitating **consortium pricing or co-development** with vendors for common building blocks (e.g., connectivity kits, MES modules).

Policy support can further reinforce this ecosystem by creating an **accredited vendor registry under NSIC/ MeitY**, helping build vendor capability at scale and reducing adoption risk, particularly for MSMEs.

6. Change delivery and value led scale

Once the foundations are in place, the real challenge is sustaining momentum and scaling impact. Many digital initiatives lose steam not because they fail technically, but because execution weakens after the first few wins. **Making digital work at scale requires a disciplined change-delivery engine that keeps initiatives tied to business value and drives repeatable rollout across lines and plants. This element directly addresses a key challenge – internal resistance to change.**

Companies that succeed focus deliberately on how change is driven and owned:

- **Align incentives and performance management** by updating Key Performance Indicators (KPIs) and reward systems.
- **While vision is set at the top, execution ownership must be shifted downward**, ensuring that shopfloor teams are involved early in solution design, piloting, and rollout, building buy-in rather than imposing change.

Industry coordination can reinforce this shift through cross-industry partnerships, bringing together OEMs, large Tier-1s, multilateral agencies, and training institutions, to mobilize funding, skills, and shared change-management programs. Such partnerships can help companies institutionalize change capabilities that would be difficult to build independently.

It is evident that driving scaled transformation is not a solo effort – it requires orchestration across the ecosystem. While companies lead execution within the four walls of the plant, responsible for building internal capabilities, deploying technology, and embedding new ways of working, lasting impact is achieved when industry bodies step in to coordinate, share learnings, and enable common infrastructure, and when policy support helps de-risk investment or fill capability gaps.

Exhibit 8: Solution map | Priority levers across stakeholders

Scaled transformation requires the ecosystem to work together – companies sit at the epicentre, enabled by industry collaboration and policy support

FoF element	Actions internal to companies (CXO imperatives)	Actions requiring cross industry collaboration	Actions requiring policy enablement
Top-down direction sponsorship	1. Set **3-5 Y digital ambition linked to business outcomes** with regular steering forums	1. **Track progress annually** (industry maturity assessment) to inspire ambition	1. Financial incentive (**accelerated depreciation, tax break)** for digitalization to reinforce leadership commitment
Enterprise data backbone	2. **Digitize data capture at source** and establish single source of truth – enabled by **data Quality Assurance (QA) function**	2. Collaborate on data interface standards with Bureau of Indian Standards & machine OEMs	
Digitally capable talent pool	3. Setup **dedicated OT team**, Centre of Excellence (COE) and upskilling programs	3. **Enable Knowledge Transfer from experienced Centre of Excellence to tier-2 / MSME** via structured commercial model	2. Introduce "smart manufacturing" **curriculum in Industrial training institutes tailored to auto industry**
Fit-for-purpose digital architecture	4. **Centralize design and governance of architecture**, with separate production and test environment		3. **Endorse interoperability standards** (OPC-UA for machine to machine and UNS for machine to cloud)
Scalable vendor and solution ecosystem	5. Collaborate on **long-term, repeat partnerships with integration ready** vendors	4. Maintain a **repository of referenceable vendors** and negotiate consortium pricing for common stacks	4. Create **accredited vendor registry** under NSIC /MeiTY
Change delivery and value led scale	6. **Link incentives** and KPI to digital outcomes and push ownership to shopfloor	5. Facilitate cross industry partnerships (**OEMs, large Tier 1s, multilateral agencies**) for shared change management	

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3.2 Evidence from Indian companies: Levers deployed and impact delivered

Across interviews and plant visits, it is encouraging to see **Indian auto component peers applying parts of the 6 solution levers in practice –** moving beyond generic pilots to targeted fixes that unlock scale.

These moves are translating into visible, measurable improvements in cost efficiency, workforce productivity, and shopfloor performance.

Exhibit 9: Solutions are already in play and Indian auto component players are seeing visible, measurable impact

Transformation lever	Company profile	What they did (levers employed)	What they did (levers employed)	Primary impact realized
		Operating actions	Digital tools / enablers	
Top-down direction sponsorship	Automotive belts and hoses manufacturer	↗ Set a clear 2030 ambition to launch the transformation journey: 1. 3X productivity (from ~33 lakh equivalent output to ~1 crore) 2. Zero-error organization (from % levels to parts per million levels) 3. Shorter prodn. lead times (from ~2 weeks to ~48 hours) ↗ Phased scale-up agenda focused on – expanding MES across lines/plants; applying AI to product validation/NPD; using analytics for network & inventory optimization	↗ SAP-integrated MES deployed on 1/15 lines with barcode-based controls, inline sensor data capture, and end-to-end traceability with real-time inventory status ↗ Deployed Warehouse Management System (WMS) with barcode-enabled processes to manage raw material storage, and inventory accuracy	**~13%** Actual OEE uplift **~50%** Line rejections reduced **80% → 69% → 82%** True baseline emerged and targeted action yielded results
Enterprise data backbone	Sheet metal component supplier	↗ Defined a single pane data model spanning product data (production, material consumption, quality) and process data (OEE, maintenance, SPC) **Example:** Digitized wire-consumption capture at source helped standardize consumption data, enable part-level value attribution ↗ Scaled the model machine, line and section-wise with standard alerts and action routines	↗ IoT/data platform layer to ingest shopfloor/product/process data ↗ Connected ERP to IoT to enable real-time financial reporting of daily operating costs and profits (vs. aggregated reporting), improving accuracy and enabling faster course correction	**~30%** reduction in material cost
Digitally capable talent pool	Leading Indian battery manufacturer	↗ Built a cross-functional IT/OT Ops Excellence team with clearly defined roles & ownership (e.g., data science, CI, BI, PMO, OT admins) under a Program Head to ensure alignment & avoid silos ↗ Strengthened shopfloor problem-solving via mandatory rotations and structured capability building (Six Sigma, MES/IoT, PowerBI) ↗ Refreshed training content quarterly based on bottlenecks identified, led by a CI project manager to sustain ROI	↗ Captured brainstorming notes as audio transcripts & converted them into action logs using GenAI ↗ Shared action logs on the IoT platform to enable knowledge transfer and continuity amid attrition/role transfers ↗ Used VR-based training modules to standardize training and refresh cycles ↗ Set up real-time performance management dashboards to improve cadence of reviews	**30-40%** redn in manpower intensity **~30%** capacity increase
	Sheet metal component supplier	↗ Built a locally hired talent pool to create a steady workforce base and reduce disruption from churn ↗ Implemented a centralized training syllabus & cross-functional rotations to build holistic shopfloor capability; assigned newly identified Kaizens as "capstone" projects for new hires ↗ Leveraged OEM led on-site training for knowledge transfer, complemented by partnerships with local universities and ITIs for internships / live projects	↗ Built dashboards on the IoT platform to track Kaizen impact and enable ongoing performance measurement/impact assessment ↗ Digitized PM/JH checklists to standardize routines, improve adherence, and build operator capability	**~16%** JH[1] time recovery **~12%** KK[2] time improvement 1. Jishu Hozen; 2. Kobetsu Kaizen
Fit-for-purpose digital architecture	Leading Indian battery manufacturer	↗ Unified namespace & asset framework to apply standard naming for all machines and substations across sites and lines, enabling plug-and-play scaling of reporting and analytics ↗ Defined which workloads run where – used the cloud/central enterprise systems for heavy AI training using large datasets, while keeping day-to-day critical shopfloor workflows on-prem	↗ Hybrid edge–cloud architecture enabled central AI training and model refresh using enterprise data ↗ Gateway PLCs / IPCs provided a cost-efficient bridge to bring legacy and mixed-OEM equipment onto a common data layer, enabling standardized data capture and integration	**76** legacy machines connected **6-7%** Increase in production
Change delivery & value led scale	Driveline and transmission systems supplier	↗ Involved shopfloor right from the planning phase, ensuring use cases and digital resources were grounded in shopfloor priorities and realities ↗ Ensured sustained adoption through continuous shopfloor feedback loops, positioned as decision support for ongoing improvements	↗ Visualized the end-state of data and dashboard very early in process with the help of vendor – resulting in generating upfront buy-in	**Sustained digital adoption and scale-up since 2010 –** across various initiatives (ERP, SCADA, IOT across 2 plants)

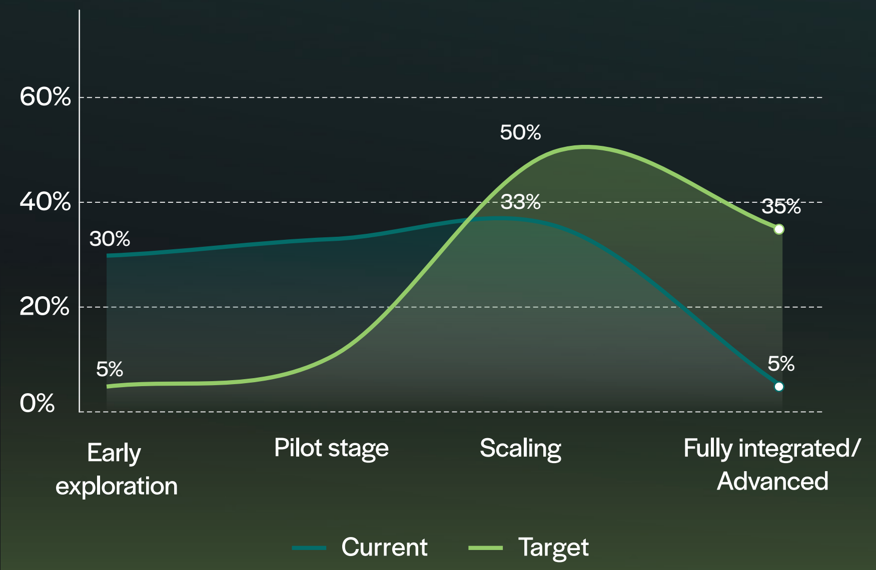
3.3 2030 Industry North Star: Five bold digital aspirations

Smart factory is no longer a factory-level efficiency program; it is a sector-level growth enabler. Buyer / CPO asks are raising the bar on traceability, data, predictable lead times, and cost competitiveness; and macro shifts are amplifying the urgency. India's auto component industry is targeting $200 Bn in overall size and $100 Bn in exports by 2030, at a time when the industry must simultaneously manage ICE-EV coexistence, workforce churn, rising scale, and tighter global expectations.

This will require a step-change in how factories operate. Digital adoption at scale is central to this shift. To translate growth ambition into execution reality, the industry must commit to a set of bold, measurable digital aspirations.

01

Move 80%+ companies to scaling and fully integrated digital maturity stage



Make digital the default way of running plants, not a set of isolated pilots

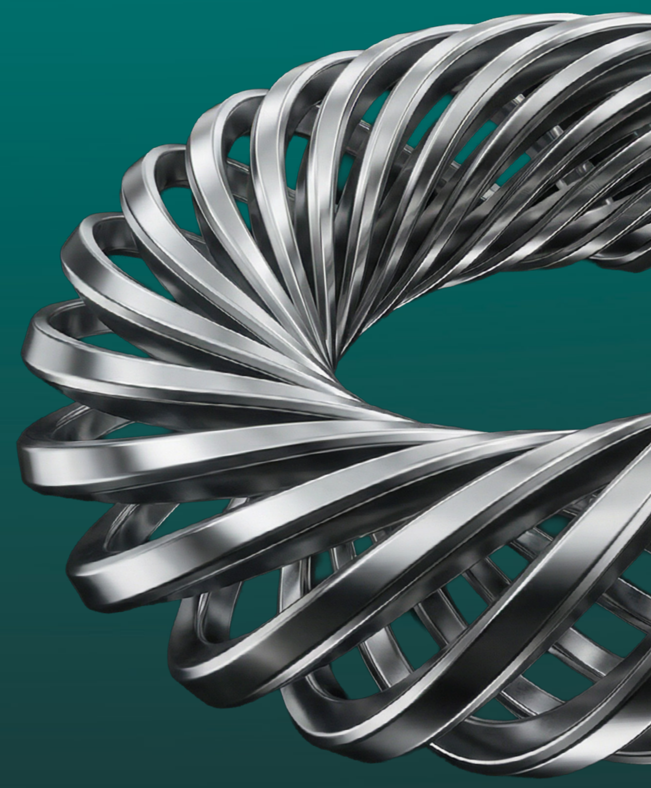
02

Data purity at source: paper-less, manual edit free data capture

100%

Digital capture of shopfloor data

Create a single, trusted operational data foundation enabling real-time decisions at the line



03

1.5x workforce productivity

50%

Improvement in output per worker

Shift growth from headcount-led to capability-led through digital ways of working

04

Create shared industry assets

Build dedicated **"smart factory" resources** (referenced vendors, reusable solutions, IP) and an **expertise bench** through industry collaboration

Complement digitization with shared ecosystem enablers that reduce cost and complexity

05

Measurable shopfloor outcomes–"0" defect, OEE improvements, NPD speed

30% Co's to deliver near-zero defects

~15% OEE uplift

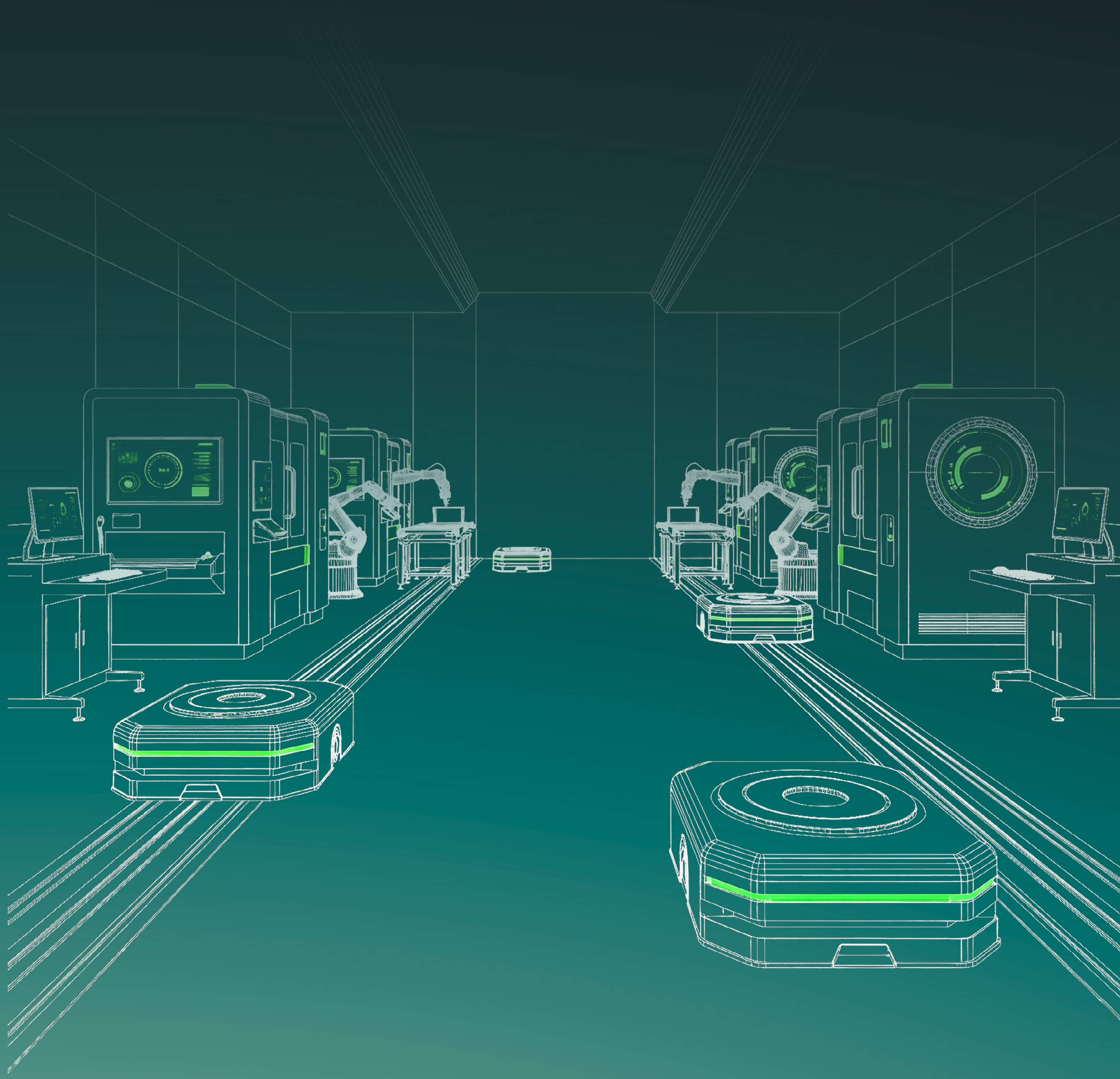
~25% Faster NPD cycles

Translate digital adoption into visible outcomes that matter to OEMs and exports

Images generated by AI

India's auto component sector is one of the country's strongest industrial success stories – **contributing 2.3% to India's national GDP, 25% to national manufacturing GDP, and employing over 50 lakh people.** Building on this scale and capability base, the industry has also crossed an important competitiveness milestone by moving from a trade deficit to a **~USD 450 Mn trade surplus**, reflecting rising localisation and export strength.

Now, the sector is at a clear inflection point: the next decade offers a rare opportunity to usher in a new era of smart factory that blends global technology with India's deep shopfloor manufacturing prowess and a pragmatic, frugal innovation mindset. To deliver the 2030 ambition, digital enablement must move beyond pilots and become a core way of running factories, consistent across lines, plants, and suppliers, turning India's scale into a durable advantage in quality, productivity, and speed-to-market. **If the ecosystem acts in sync, smart factory can define India's next chapter of global competitiveness.**



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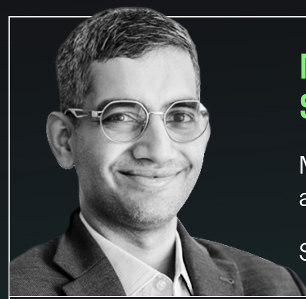

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