AlixPartners

JUNE 2025

CHINA AND THE NEXT REVOLUTION IN AUTOMOTIVE MANUFACTURING:

Opportunities and challenges

1. THE CHANGING FACE OF AUTOMOTIVE MANUFACTURING: EVOLUTION AND TRENDS

Over the past century, the automotive industry has undergone a major manufacturing revolution roughly every 40 years. From Ford's introduction of the assembly line to the rise of lean manufacturing, and later the advancement of platformization and modularization, each wave of innovation has profoundly reshaped the industry's landscape.

The ultimate goal of automotive production is to "deliver products that best meet customer needs in the shortest time and at the lowest cost."

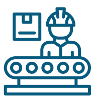
The first three manufacturing revolutions were primarily driven by human-led transformations of production lines, processes, and products, significantly improving efficiency and reducing costs. However, they gave compromise to fully satisfying customer needs—particularly in terms of product diversity.

More than 40 years have passed since the last revolution of platformization and modularization. And today, with the rapid advancement of artificial intelligence (AI) and growing demands from manufacturers for both greater efficiency and product variety, the automotive industry has reached a pivotal moment—both technologically and in the market— a new revolution. This fourth revolution will increasingly be led by AI rather than humans, ultimately paving the way for the realization of the truly unmanned factory.

FIGURE 1: THE EVOLUTION OF AUTOMOTIVE MANUFACTURING

1910s

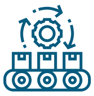
Assembly Line Production



This refers to the traditional method in which car chassis move along a conveyor belt at a fixed speed. Workers positioned on either side of the belt perform their respective assembly tasks.

1950s

Lean Manufacturing



This approach focuses on eliminating waste while improving efficiency and quality. Key characteristics include Just-in-Time (JIT), automation, pull systems (where downstream processes pull work from upstream processes), and continuous improvement (Kaizen).

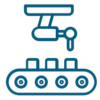
1980s

Modular Manufacturing

This involves building a basic, highly-compatible platform using common structural elements shared across different vehicle models. Individual models are then customized and adjusted based on specific requirements.

2020s BEYOND

Unmanned Factory



This represents a fundamental restructuring of automotive production processes and workflows based on **first principles**.

Instead of human workers, **artificial intelligence** drives flexible production lines and continuous improvement, aiming to achieve a truly unmanned factory.

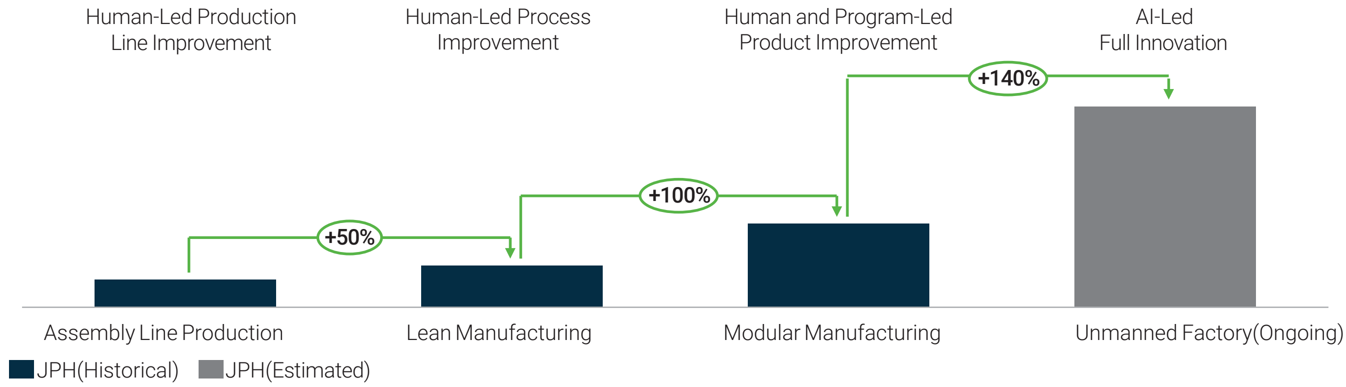
In the future, AI systems will take full control of operational decision-making in unmanned factories, serving as the true central command of production. Programmable bionic robots will handle core tasks such as material transport, machining, and quality inspection, ensuring high precision and autonomy throughout the production process.

At the same time, automated guided vehicles (AGVs), integrated with autonomous driving technologies, will enable efficient material movement, further optimizing production flow and resource allocation. As intelligent systems assume complete authority over production decisions, human involvement in direct factory management will be phased out, ushering in a new era of highly autonomous, unattended, and fully unmanned operations in automotive manufacturing.

In this context, we project that following the completion of the fourth automotive manufacturing revolution, jobs per hour (JPH) will double, first pass yield (FPY) will increase to 95%+, overall operation cost will be significantly reduced even considering the new maintenance cost, new software & IT infrastructure cost—human labor will decrease by ~90%, utility cost will be reduced by 20-40%, and flexibility in production lines will be significantly enhanced.

The unmanned factory will not emerge overnight. Its realization depends on continued improvements to current products and production lines, the maturity and scalability of AI technologies, and the depth of data integration. Based on the level of AI involvement and data integration, we classify unmanned factories into three stages. Currently, some leading automakers have reached the intermediate stage and are steadily advancing toward completion, while others remain in the early stages of implementation.

FIGURE 2: SMART MANUFACTURING PERFORMANCE INDICATORS



Source: AlixPartners analysis

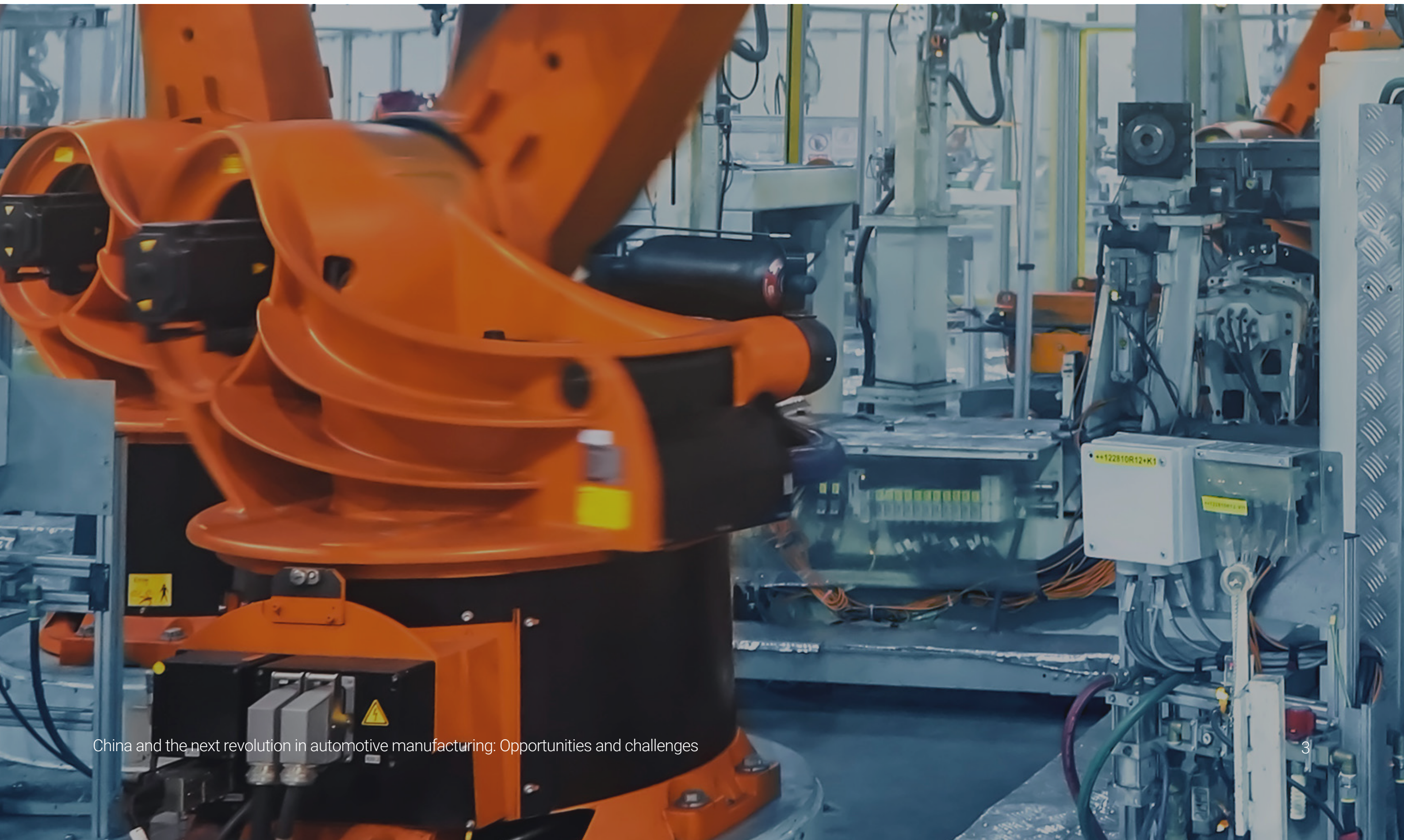
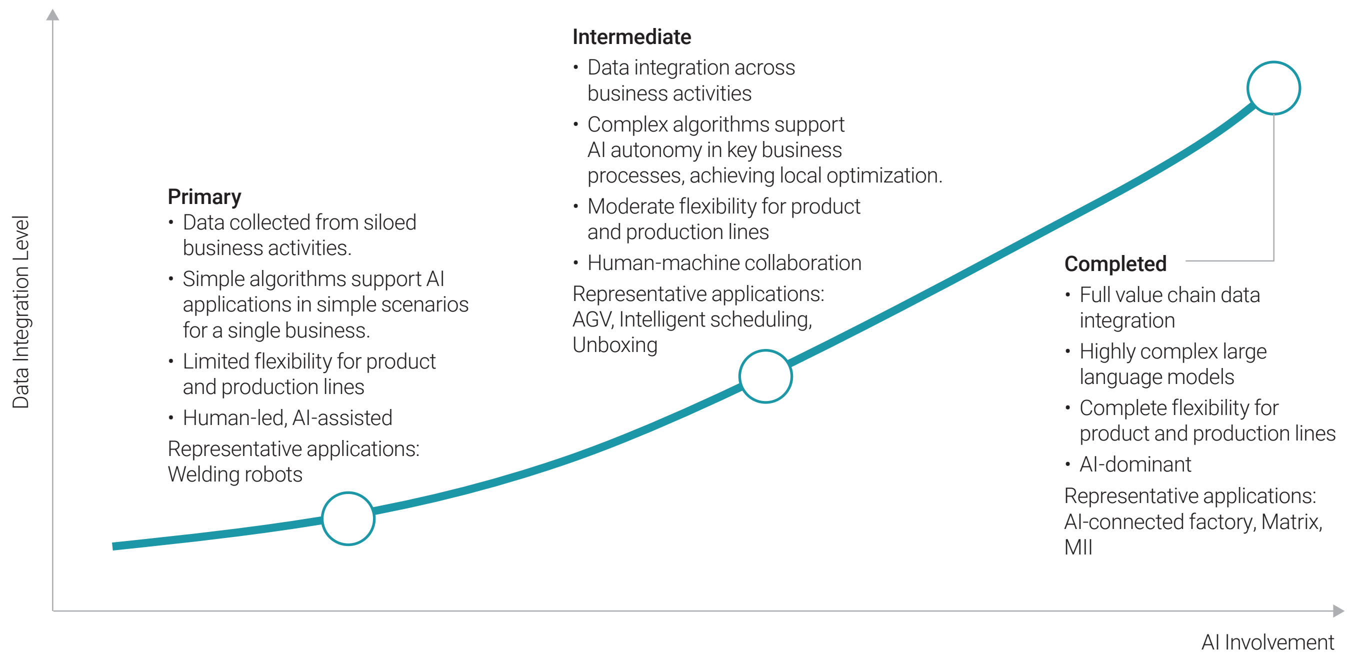


FIGURE 3: THREE DEVELOPMENT STAGES OF ALIXPARTNERS UNMANNED FACTORIES



1. Primary stage

Automakers adopt automation, information technology, and process optimization techniques to standardize core equipment and key business processes. Data sharing is achieved within siloed business units. At this stage, simple algorithmic models are introduced, and AI applications are piloted in isolated, single-scenario use cases. Manufacturing decisions remain primarily driven by human .

2. Intermediate stage

Automakers integrate equipment and systems across departments, enabling data sharing and data mining throughout multiple business functions. Intelligent models and enterprise knowledge bases are established, allowing core business processes to develop autonomous capabilities of **status perception, real-time analysis, autonomous decision-making, precise execution, and continuous optimization**. The hallmark of this stage is **human–machine collaboration**, as seen in technologies like AGVs, digital twin-based scheduling, and automated unboxing.

3. Completed stage

With full value chain data integration and the deployment of advanced large-scale AI models, smart manufacturing systems take over the entire production process. These systems act as autonomous decision-makers, enabling a new manufacturing paradigm: **the unmanned intelligent factory**. This stage is exemplified by models such as **C2M (Customer-to-Manufacturer), AI-connected factories, etc.**

2. "MADE IN CHINA 2.0" AND NEW OPPORTUNITIES

China's automotive industry has steadily built a comprehensive manufacturing and supply chain system through the strategic approach of exchanging market access for technology. With the rise of new energy vehicles (NEVs), China has capitalized on new opportunities and achieved significant breakthroughs. In market scale, export volume, technological sophistication, and brand recognition, it has become a powerful force on the global stage. These accomplishments have been underpinned by the strength of its manufacturing sector. Looking ahead, we believe China's automotive industry will continue to enhance its manufacturing capabilities and seize the new opportunities presented by AI, delivering even greater value to an increasingly diverse and expanding global market.

2.1 DEVELOPMENT PATH OF "MADE IN CHINA 2.0"

From an investment perspective, market players in China are increasingly focusing on AIoT (Artificial Intelligence of Things) and process optimization to drive efficient and flexible production. Their efforts are concentrated in three key areas:

Reconstructing products and production lines:

Designing highly platform-based and modular products helps reduce costs while simplifying the demands on production lines. At the same time, the adoption of concepts such as integrated factories, integrated technologies, and multifunctional production islands is advancing smart manufacturing at the hardware level.

Deploying highly intelligent software applications:

The reconstruction of products and production lines does not come at the expense of product diversity. Moving beyond traditional lean manufacturing methods, highly intelligent software now dynamically reconfigures and modifies production lines, effectively replacing human decision-making.

Integrating data and building end-to-end large language models:

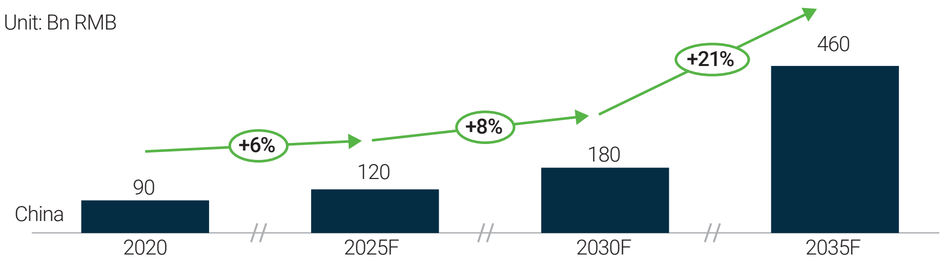
To enable fully autonomous operations, companies must integrate data across production, equipment, and supply chains. By training end-to-end large language models, they can develop proprietary AI "brains" to power their unmanned factories.

2.2 INVESTMENT SCALE OF "MADE IN CHINA 2.0"

In terms of investment scale, smart manufacturing in China's automotive industry is still in its early "pilot" stage. However, both application and investment are expected to accelerate significantly in the coming years. Focusing solely on use case related investment, the total amount is projected to reach approximately RMB 180 billion by 2030 and around RMB 460 billion by 2035.

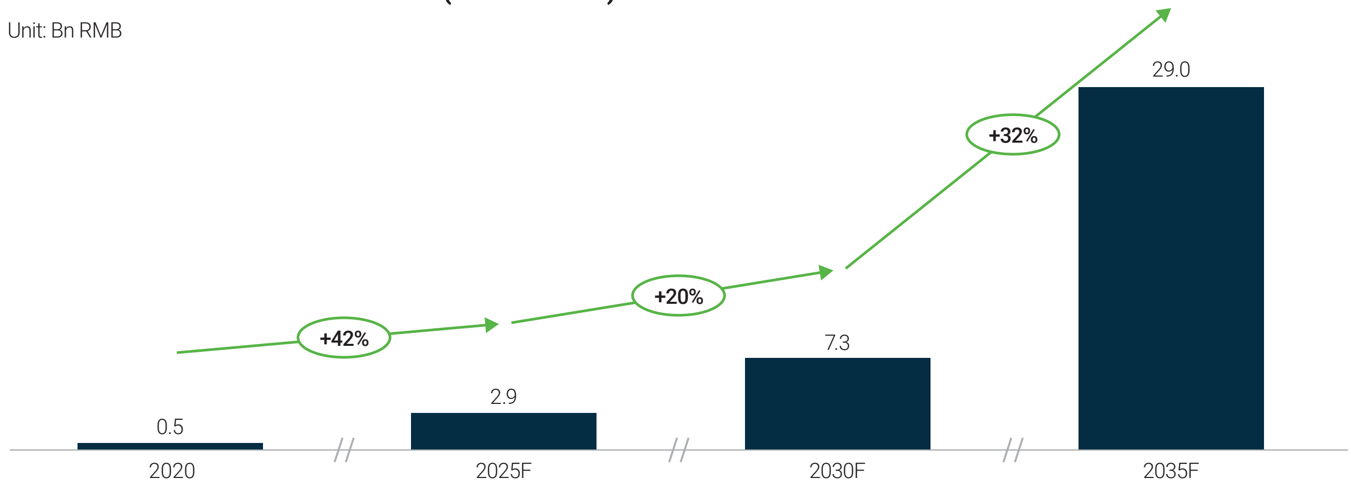
If the shared infrastructure investment is considered, like cloud, network and computing power, the related investment will be significantly higher. The infrastructure investment is projected to reach RMB 7.3 billion in 2030 and RMB 29 billion in 2035.

FIGURE 4: INVESTMENT SCALE OF USE CASE RELATED SMART MANUFACTURING OF CHINESE AUTOMOTIVE INDUSTRY (2020-2035F)



Source: AlixPartners analysis

FIGURE 5: INVESTMENT SCALE OF SHARED INFRASTRUCTURE OF SMART MANUFACTURING OF CHINESE AUTOMOTIVE INDUSTRY (2020-2035F)



Source: AlixPartners analysis

Investment in smart manufacturing in China is unfolding in several phases, progressively advancing in both breadth and depth.

2020–2025: Pilot phase—Leading companies pilot smart manufacturing in new production lines/factories

Constrained by legacy assets and the significant capital required for smart manufacturing, leading automakers are using new product development as a catalyst to build new intelligent factories. For example, one automaker completed a fully connected 5G digital intelligent factory in 2021 to support its new product launch. In this facility, the automation rate reaches 95%, with industrial robots executing most standard tasks through unmanned operations. All elements, processes, and systems within the factory are interconnected, enabling multidimensional data integration and supporting the application of AI-driven technologies such as Product Data Management (PDM), AI-based quality inspection, and intelligent scheduling.

2025–2030: The promotion phase—Large-scale upgrading and renovation of existing factories

Given the typical 10-year depreciation cycle of automotive production lines, the last wave of large-scale upgrades and construction occurred around 2017–2018. A second investment peak is expected around 2027–2028. Meanwhile, ongoing advancements in autonomous driving will further accelerate production line updates.

During this phase, transformation will follow a **software-first, hardware-later** approach to maximize early returns. Automakers will first deploy mature software solutions—such as intelligent scheduling and visual error prevention—on existing lines. Gradually, these lines will be reorganized and human labor replaced by industrial robots.

2030–2035: The deepening phase—Toward 100% unmanned factories

As embodied intelligence (general-purpose humanoid robots) matures, the range of tasks they can handle will expand, enabling them to replace human workers in increasingly complex operations. Simultaneously, growth in computing power and advances in algorithms will allow for the development of more sophisticated models capable of addressing intricate production challenges and achieving system-wide optimization.

This evolution will pave the way for **100% unmanned factories**. However, it's important to note that the pace of progress in general-purpose robotics and the reliability of supporting algorithms and computing power remain uncertain. As such, while theoretically feasible, the realization of fully unmanned factories by this stage may still face practical limitations.

3. RESPONDING TO CHALLENGES OF "MADE IN CHINA 2.0" IN THE NEW AUTOMOTIVE MANUFACTURING REVOLUTION

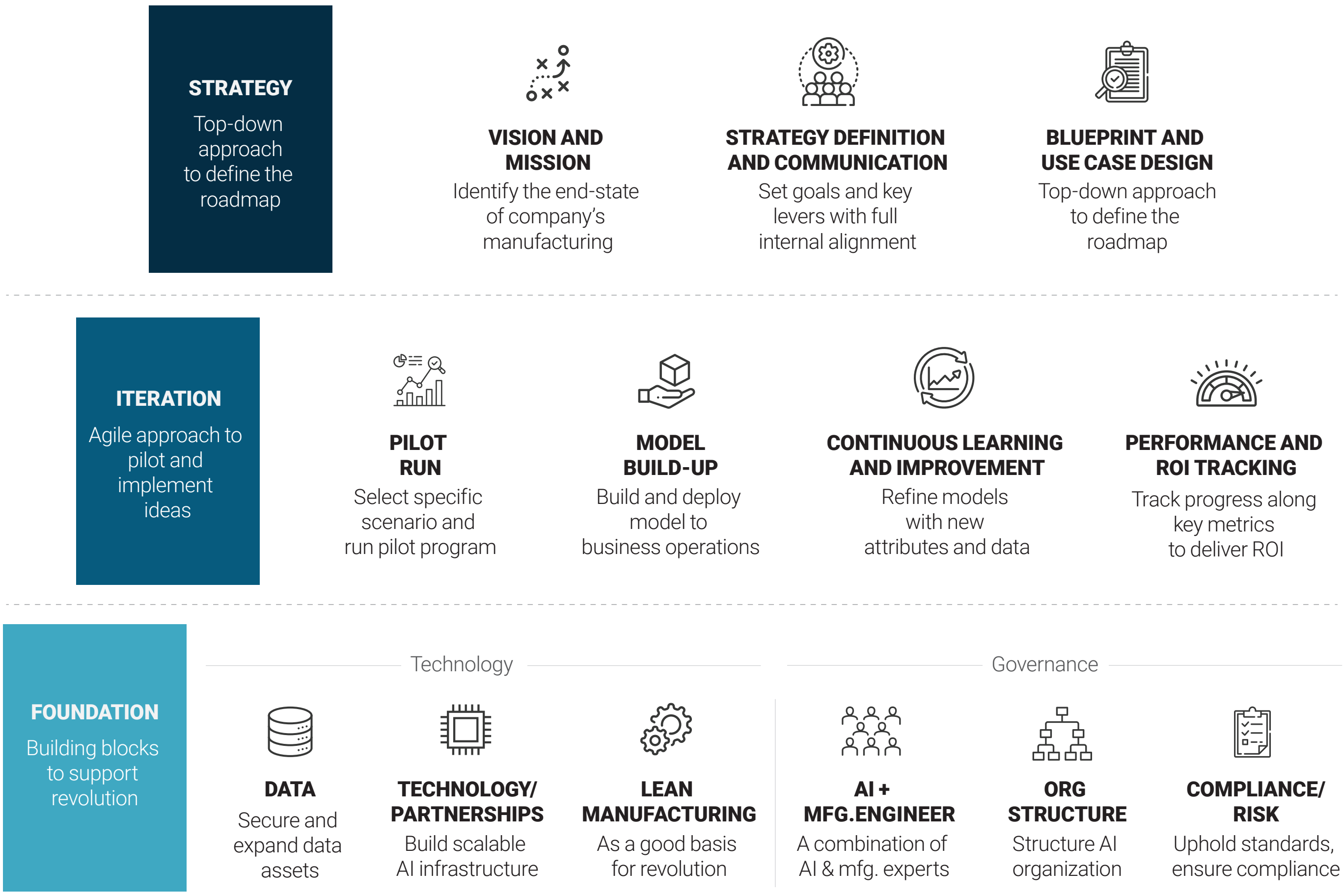
We have found that Chinese automotive companies face the following challenges when confronted with the new round of manufacturing revolution:

1 Investment uncertainty	Many companies—particularly at the senior management level—lack confidence in the "black box" nature of AI and have an unclear understanding of their own organization's AI progress. This often results in the absence of a well-defined roadmap for developing AI infrastructure or deploying AI use cases. Additionally, companies frequently pursue AI solutions without clearly identifying specific business pain points or scenarios. For instance, vague requests like "AI to write feasibility reports" are made without breaking tasks into actionable steps, such as data collection and analysis.
2 Returns uncertainty	AI delivers benefits across multiple dimensions—cost reduction, quality improvement, efficiency gains, and greater flexibility—but it is difficult to consolidate these into a single return-on-investment (ROI) metric. Moreover, limited internal capabilities make it difficult for some companies to gather the foundational data needed to calculate returns. Compounding the issue, the scope and depth of AI solutions vary widely, leading to highly inconsistent outcomes. This makes it difficult for companies of different sizes and maturity levels to benchmark or learn from one another's experiences.
3 Infrastructure supply risks (e.g. computing power)	Geopolitical tensions—particularly U.S. restrictions on advanced chip exports and AI software platforms like CUDA—pose significant risks to infrastructure supply. China's domestic chip ecosystems (e.g., Huawei Ascend, Cambricon MLU) are still maturing, contributing to a widening gap in high-end computing capabilities (with demand growing at ~175% annually). Additionally, extended software adaptation cycles (up to 18 months) and a shortage of inference-optimized chips further complicate deployment. The evolving nature of AI technology also causes structural shifts in computing demands, adding to the complexity.
4 AI model and data adaptability	General-purpose AI models often fail to meet the nuanced needs of specific business functions and may contain algorithmic biases that lead to unfair or inaccurate outcomes. Effective algorithm training is heavily dependent on data volume and quality—areas where many companies fall short. Consequently, companies must first build robust data infrastructure before AI applications can be meaningfully deployed.
5 Talent mismatch	Smart manufacturing requires a workforce skilled in multiple disciplines, such as AI and manufacturing or automation and software development. However, traditional manufacturing engineers frequently lack the digital and analytical skills necessary to support AI-driven transformation.

To address these challenges, AlixPartners can provide a Smart Manufacturing Implementation Framework to support the next manufacturing revolution towards "unmanned factory":

- First, a top-down approach is essential to develop an effective AI-driven smart manufacturing strategy. This requires a unified, high-level understanding of the next wave of manufacturing transformation, with strategic direction and use-case selection guided from the top.
- Second, companies should move away from the traditional approach of establishing benefits upfront, executing accordingly, and conducting final acceptance checks. Instead, they should adopt rapid model-building and iterative optimization to translate vision into reality through agile implementation.
- Last but not least, strong internal technical and organizational support is crucial. Data must be available and **usable**, infrastructure must be **robust and accessible**, and solid external partnerships must be established. Companies should form dedicated AI teams and implement comprehensive risk management and compliance frameworks to ensure the successful deployment of smart manufacturing initiatives.

FIGURE 6: ALIXPARTNERS' SMART MANUFACTURING IMPLEMENTATION FRAMEWORK



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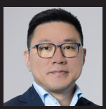

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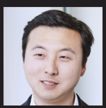

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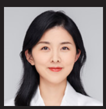

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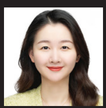

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ABOUT US

For more than 40 years, AlixPartners has helped businesses around the world respond quickly and decisively to their most critical challenges – circumstances as diverse as urgent performance improvement, accelerated transformation, complex restructuring and risk mitigation.

These are the moments when everything is on the line – a sudden shift in the market, an unexpected performance decline, a time-sensitive deal, a fork-in-the-road decision. But it's not what we do that makes a difference, it's how we do it.

Tackling situations when time is of the essence is part of our DNA – so we adopt an action-oriented approach at all times. We work in small, highly qualified teams with specific industry and functional expertise, and we operate at pace, moving quickly from analysis to implementation. We stand shoulder to shoulder with our clients until the job is done, and only measure our success in terms of the results we deliver.

Our approach enables us to help our clients confront and overcome truly future-defining challenges. We partner with you to make the right decisions and take the right actions. And we are right by your side. When it really matters.