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AI Enablement on the Way to Smart Manufacturing

Deloitte Survey on AI Adoption in Manufacturing

Overview

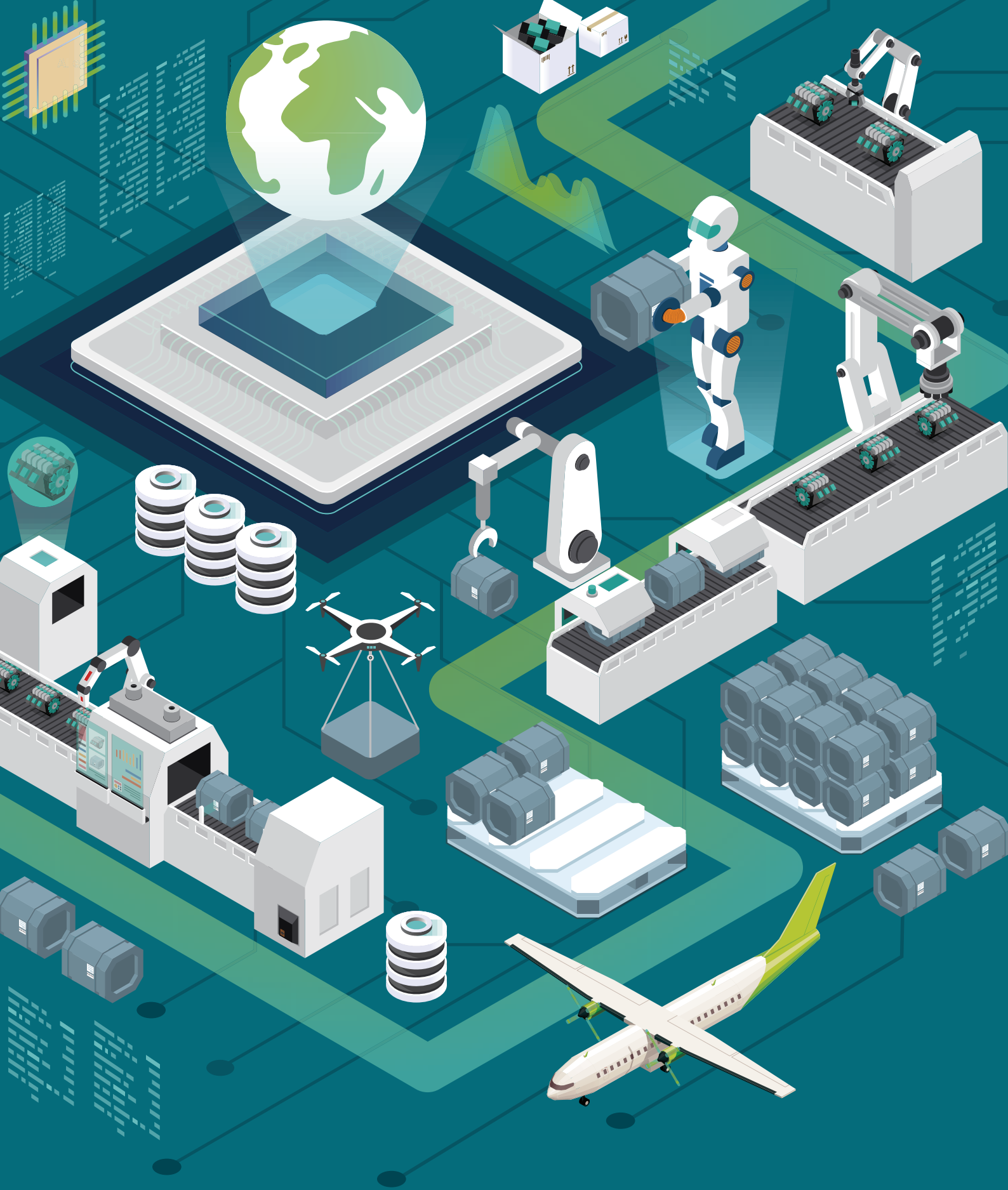
Artificial intelligence (AI) has been expanding applications from consumers to businesses, boosting productivity for stronger development. With massive accumulation of data, manufacturing has become a blue ocean market for AI adoption. In 2019, AI met the Industrial Internet of Things and the use of artificial intelligence in the Industrial Industry began. Now a global transformation is underway to empower manufacturing with AI. As a world manufacturing hub, Asia has great potential for industrial application of artificial intelligence. Among other countries, China, Japan, and South Korea who are more competitive with regard to policies, research and development (R&D) capabilities, data, and talent are viewed as leading the way on AI development in Asia. So far, most of the discussion around the use of AI in industries focuses on technology providers, with only a few on industry users. This report is intended to dive into the status quo and scenarios of AI adoption among manufacturers to provide insights into the gap between the actual and ideal effects of AI projects and identify industry trends.

AI can locate and solve pain points in manufacturing and will have perceivable impacts on the entire industry over the next two to five years. According to Deloitte's survey, the most critical pain points in production and operation facing manufacturing companies include rising costs, inflexible design of production lines, as well as unstable quality and yield of products. AI can help businesses elevate process automation, formulate forecasts of market trends, schedule production, and improve the efficiency of inspections. According to the survey, 93% of the companies surveyed believe that AI will be a pivotal technology to drive growth and innovation in the manufacturing sector; 87% have adopted AI or planned to do so within two years; and 83% hold that AI will make tangible impact on manufacturing and management in two to five years to come.

There is a large number of possible AI use cases around all manufacturing processes which can be roughly divided into smart production, products and services, business operations and management, supply chain, and business model decision-making. According to our survey, smart production is the first choice for AI adoption by most manufacturing companies (51%), followed by products and services (25%). However, the priorities of businesses will change significantly over the next two years, with more application scenarios in segments such as products/services and business management. Creation of new growth areas will have an increased focus on AI applications to enhance marketing efficiency, logistics services, asset and equipment management, insights to customer demand, as well as energy management.

Although the adoption of AI at scale in industries is worth looking forward to, the implementation results often turn out to be different than expected. Our survey shows that only 9% of the respondents say AI projects meet expectations, either from the perspective of benefits brought to the company or the budget and time invested. Which means, 91% of businesses consider their AI projects not satisfactory.

While AI booms in popularity, uninformed investment needs to be avoided. Prior to massive implementation, businesses should have clear strategies, target scenarios, profound data foundation, professional teams and partnerships, as well as proof and tests to unleash the potential of AI for true value creation.



1. Technology trends

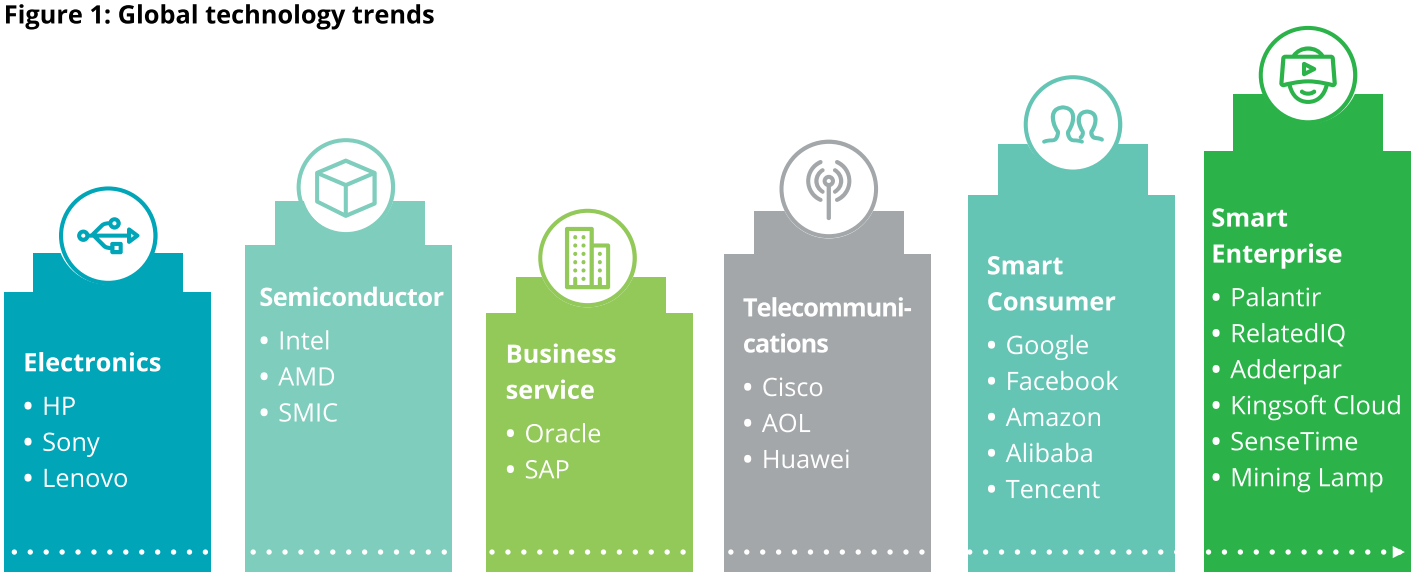
1,812 PB

US$ 2 billion

93%

During the past century, global technology development was mainly shaped by five prominent trends: “electronics", "semiconductors", "business services", "telecommunications", and "smart consumer". As the value brought by "Internet plus consumer" reached its peak and now a plateau, the sixth trend—"smart enterprise"—has become visible. The smart transformation where companies direct their own solutions with digital technology is considered the tech trend of the future, which will be a key contributor for value creation in the next stage (see figure 1).

Figure 1: Global technology trends



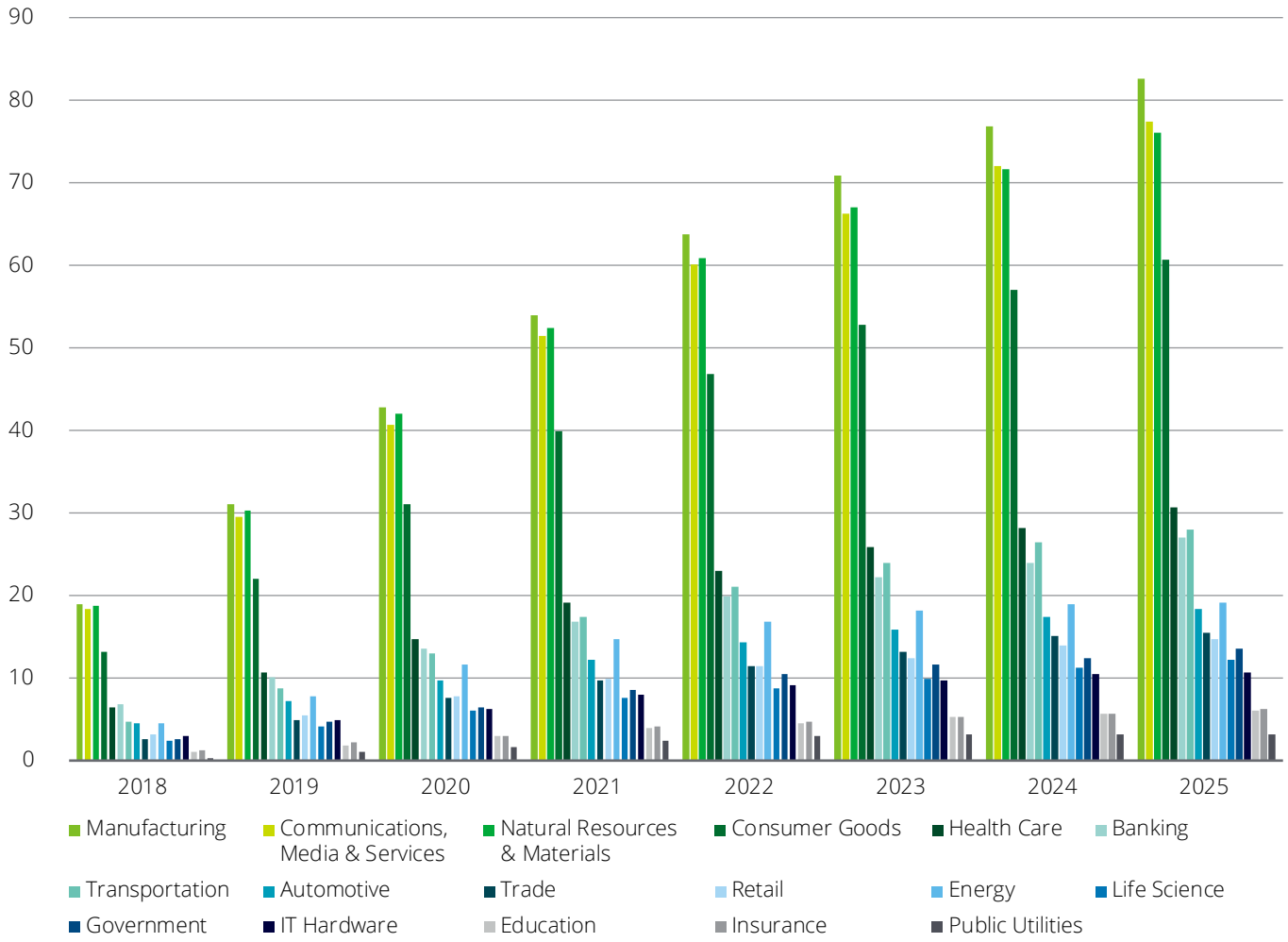
Source: Formation 8, Deloitte Research

The core of the smart enterprise trend is to guide businesses through manufacturing and management with data analysis and insights. The new technology trend will have impact on a wide variety of industries and largely increase the productivity of major sectors.

Conventional industries with larger market will remain the market leaders. By 2030, the top three sectors will be manufacturing (16%), communications, media and services (16%), as well as natural resources and materials (14%). The vast manufacturing industry, among others, will be the fastest-growing sector with accelerating digital transformation to promote well-rounded smart solutions to management, factory, and logistics.

Figure 2: Global artificial intelligence market size (by industry)

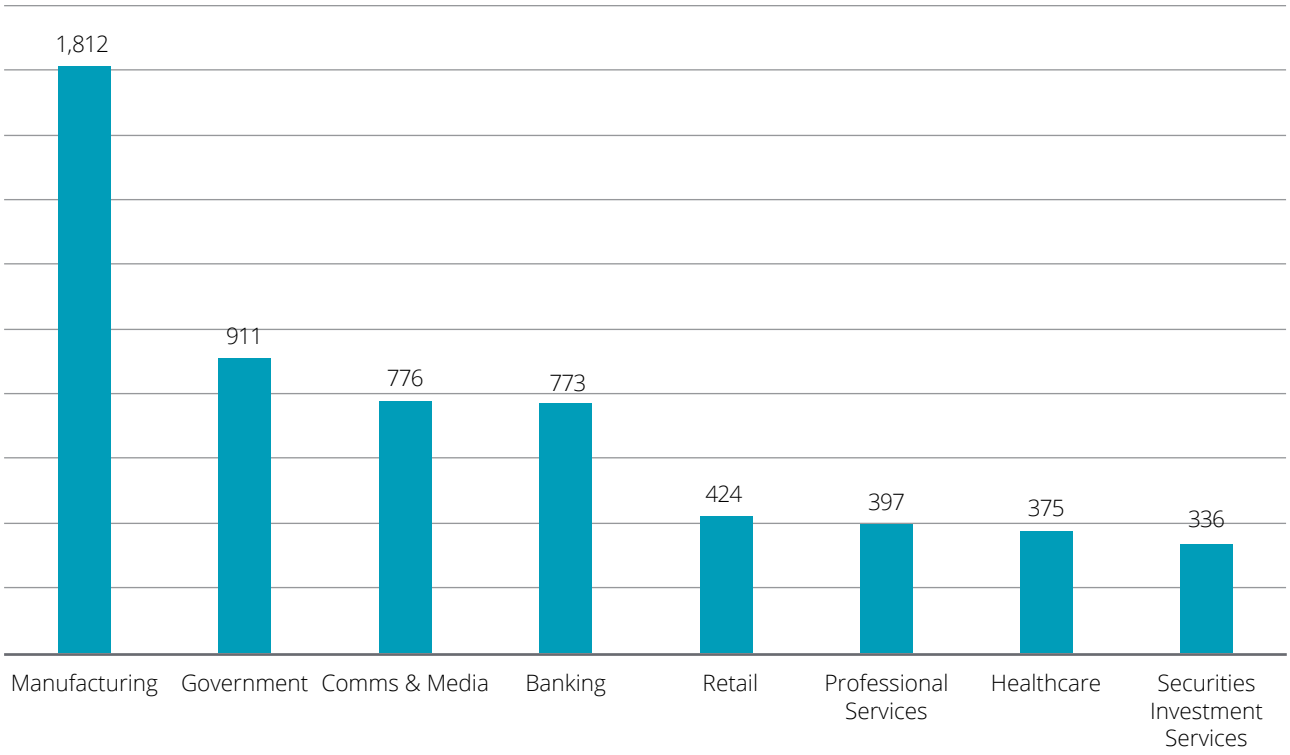
In 10 billion US dollars



Source: Gartner

An enormous amount of data has been created rapidly and sustainably during the process of manufacturing, such as production, quality control, and management. For a factory with 1,000 sensors which send signals every 10 seconds, there can be an inflow of 360,000 entries per hour, which means over one million entries per day. Manufacturing is estimated to produce a volume of about 1,812 petabytes (PB) of data every year, which is more than communications, finance, retail and more industries (see figure 3). As the process of decision-making became increasingly complex due to the spike in digital information over the past two decades, manufacturers have been trying to process and utilize that information more efficiently, using smart technology to discover data patterns and address the problems which were previously unable to be anticipated. Machine Learning (ML), for instance, is helping manufacturing companies increase the precision of preventative maintenance for each machine in the workshop to identify the approach to augmenting production/capacity of each equipment/workflow for optimized systems and the entire supply chain.

Figure 3: Manufacturing tops in volume of data created
Annual data creation by industry (petabytes)



Source: GP Bullhound, Deloitte Research

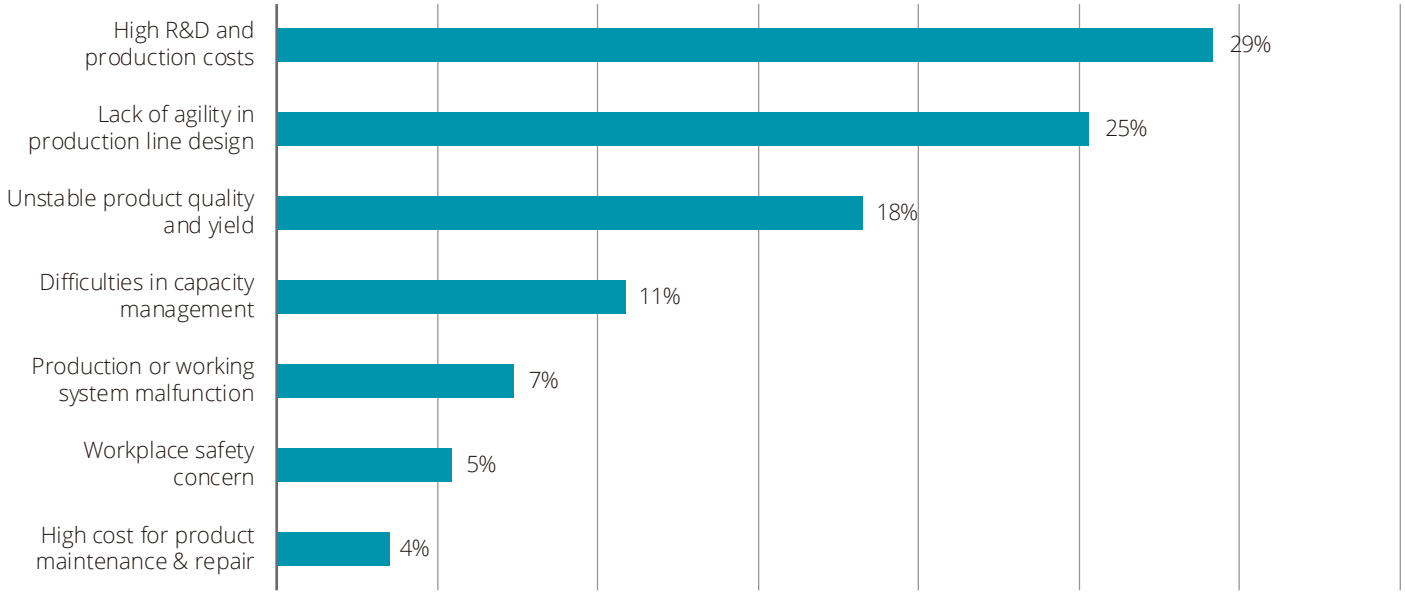
1.1 Manufacturing industry has high hopes for AI

Manufacturers are generally faced with challenges in production and operations, among which the biggest ones include rising costs, a lack of agility in the design of production lines, and unstable quality and yield (see figure 4). As the manufacturing sector carries out smart transformation to address such challenges, artificial intelligence is one of the key technologies to resort to. Over the past decade, plenty of algorithms have been developed and numerous tools created for pragmatic applications. The extensive adoption of AI in the arena of finance and the internet has demonstrated a great success. Industry experts generally believe that 2019 witnessed the rapid development of AI in industrial manufacturing as well as the implementation of other various technologies.

AI can mainly address three types of manufacturing problems: 1) help businesses elevate process automation, enhance smart operation, and cut operational costs, 2) predict market trends and schedule production to enable on-demand manufacturing with the lowest inventory possible while meeting the needs of each process, and 3) increase the level of quality inspection and product yield. That's why manufacturing has high hopes for AI—to tackle those pain points for the industry (see figure 4). According to Deloitte's survey on AI adoption in manufacturing, **93% of the companies surveyed believe that AI will be a pivotal technology to drive growth and innovation in manufacturing** 39% strongly believe and 54% generally believe (see figure 5).

Figure 4: Biggest challenges in the production system for the companies surveyed

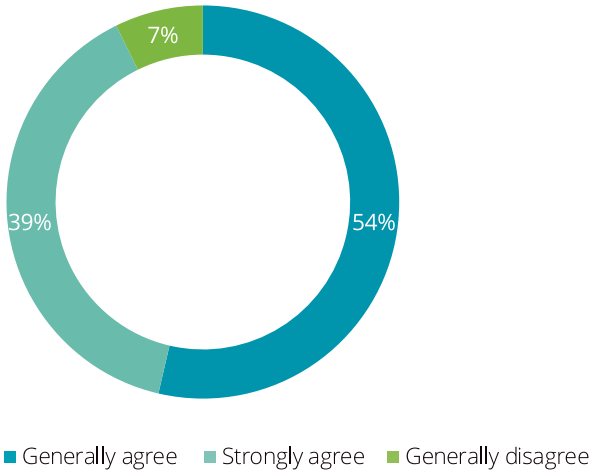
Biggest challenges in the production system



Source: 2019 Deloitte survey on AI adoption in manufacturing

Figure 5: Businesses holds high expectations for AI

Do you agree that AI will be the key to the growth and innovation in global manufacturing?



Source: 2019 Deloitte survey on AI adoption in manufacturing

1.2 AI development in Asia Pacific

The industrial revolution empowered by artificial intelligence has begun across the globe. Many countries in Asia, a global manufacturing base, has made AI development a national strategy, hoping to upgrade the manufacturing sector and create value dividend in real economy (see Table 1). China is the major driver of AI development in Asia Pacific who has particular strengths in policy support and data accessibility. Japan, South Korea, India, and Singapore are all pioneers who announced national AI strategies, making Asia Pacific a global front-runner in artificial intelligence. China, Japan, and South Korea who are more competitive with regard to policy, R&D capabilities, data, and talent are considered by the companies surveyed as the regional leaders of AI development among major Asian countries (see figure 6).

Table 1: AI strategy of major countries in Asia Pacific

	Strategy	Highlight
China	Next Generation AI Development Plan	Successively introduced the development goals by 2030, the Three-Year Action Plan for Bolstering the Development of the Next-Generation Artificial Intelligence Industry (2018-2020), and the White Paper on Artificial Intelligence Standardization, with stipulated quantitative objectives and standards
Japan	AI Technology Strategy	Established a phased development plan for artificial intelligence to: 1) develop and apply data-powered AI in various fields, 2) utilize AI and data among the public, and 3) connect different fields to build an AI ecosystem
South Korea	Five-year AI Plan	Investment KRW2.2 trillion to strengthen AI research and development for: 1) establishment six AI postgraduate schools to train 5,000 AI experts (1,400 researchers and 3,600 data management experts), 2) government funds to support large defense, medical, and public security AI projects and initiate R&D challenges, and 3) government investment in infrastructure to support AI start-ups and SMEs.
India	National Strategy for Artificial Intelligence[1]	Focus on R&D with the core concept of AIforALL. The new AI research institute, COREs, will focus on basic research and be a technology provider for the International Conference on Tools with Artificial Intelligence (ICTAI) to promote AI adoption in key arenas globally.
Singapore	AI Singapore[2]	The AI Singapore strategy was released in 2017, aiming to invest SGD150 million in AI during 2018-2022. Currently it focuses on the R&D and application of AI in the health, city solution, and financial services.
Australia	A four-year AI investment plan[3]	The Australian government's 2018-19 budget earmarks USD29.9 million over four years to strengthen Australia's capability in AI-focused development. The government will formulate "technology roadmap" and "standards framework" for AI. Measures to be funded include additional funding for the Cooperative Research Centers Program to back AI projects, funding PhD scholarships, and school-related learning to address AI and ML skill gaps.

Source: Deloitte Research

Figure 6: AI resource evaluation on major countries in Asia Pacific

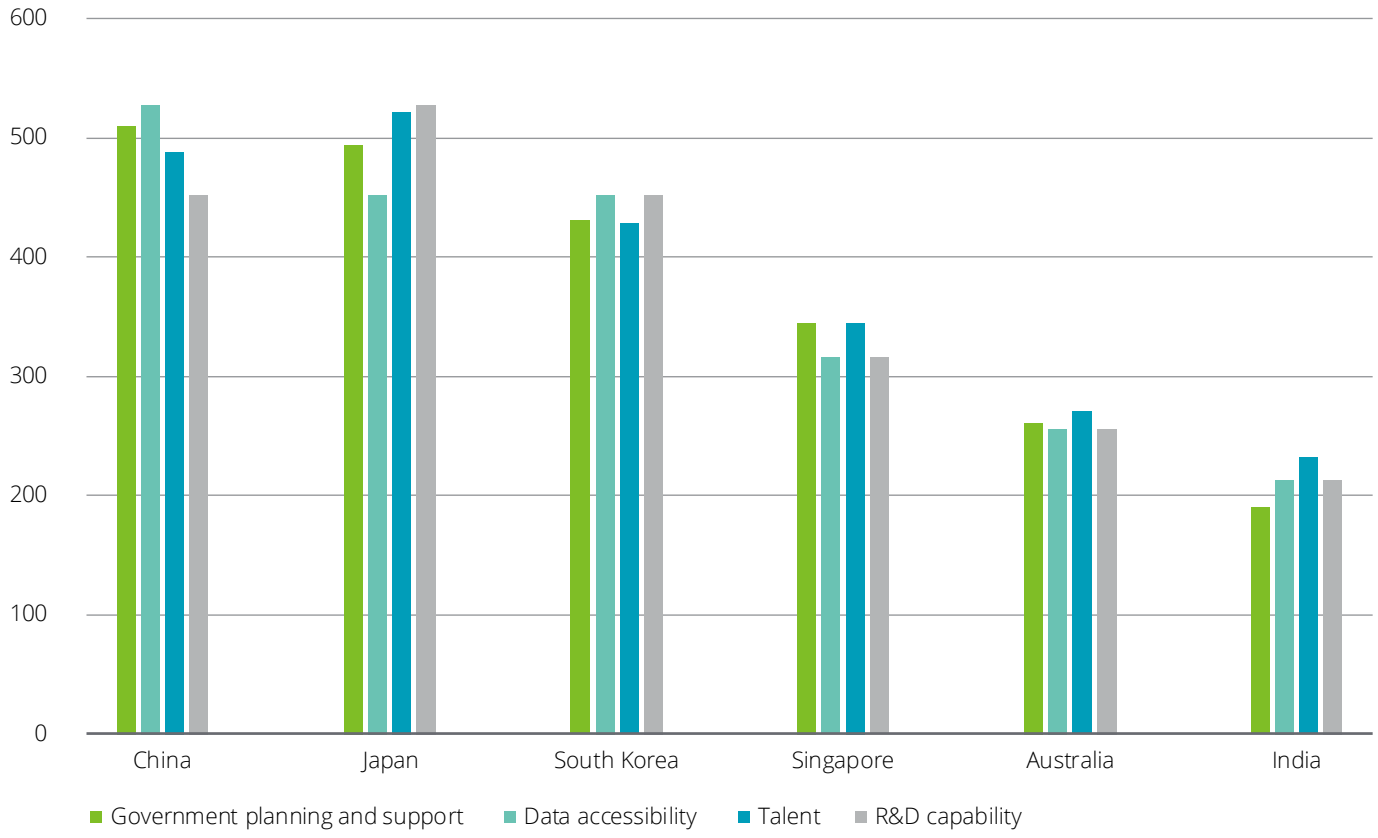
Government planning and support
National strategy, industry strategy, subsidies, government guide funds, etc.

Data accessibility
Amount of data, equipment connection, data sharing, sensitivity to data security, etc.

Talent
Quantity and quality of professional talent, number of leaders, talent pool, etc.

R&D capability
State and corporate AI R&D investment, R&D publications, ecosystem-based cooperation, etc.

AI resource evaluation on major countries in Asia Pacific



Note: The vertical axis represents the score of the country. Higher score means more resources. The result is a weighted score based on the evaluation of the companies surveyed on the quality of the country's resources.

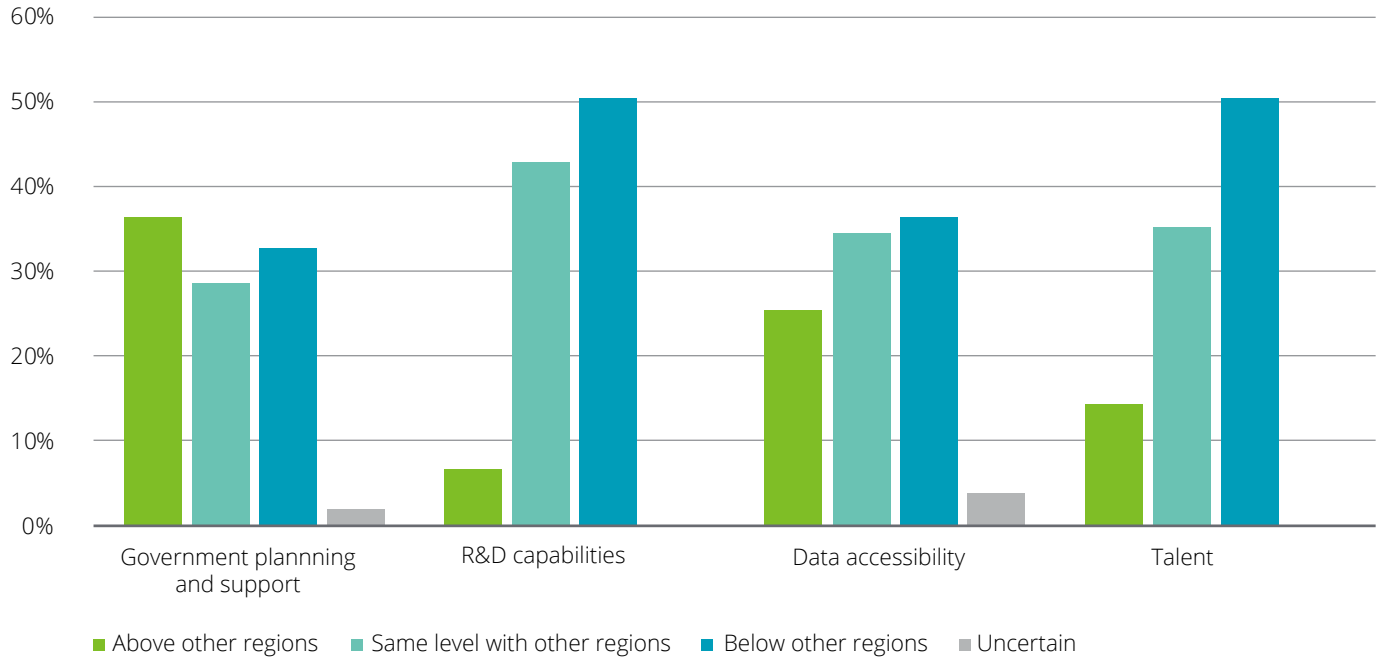
Source: 2019 Deloitte survey on AI adoption in manufacturing

Despite the strong policy support and other advantages in AI development, Asia Pacific is also confronted with challenges. According to Deloitte's questionnaire results, talent, and R&D capabilities are the weaknesses of Asia Pacific as compared with North America and Europe. Approximately 40% (the highest proportion) of the companies surveyed believe that Asia Pacific holds better AI resources than North America and Europe do. In talent and R&D capabilities, however, 50% of the respondents believe that other regions have higher quality of resources than Asia Pacific does (see figure 7).

The shortage of AI talent is the biggest challenge facing Asia Pacific and the major reason that it lags behind North America and Europe in R&D capabilities. The Center of Data Innovation recently published a report which analyzed the talent, research, development, application, data, and hardware in China, the United States (US), and European Union (EU). According to the report, China preforms strongly in application and data, the US leads in talent, research, development, and hardware, and the EU ranked second in talent, research, development, and application. In contrast, China falls short to the US and EU regarding the number of professionals and top-notch talent (see Table 2). It is estimated that North America has three times as many AI experts as China, India, Japan, and South Korea have in total. [4] Although Asia Pacific continues to grow rapidly in AI papers and patents, it lacks leading creative talent who can create new algorithms instead of perfecting current ones. Therefore, the priorities for AI adoption in Asia Pacific should be to enhance teaching capabilities in AI related disciplines, encourage more focus on the quality than quantity of scientific research, cultivate a more dynamic culture of open data, as well as provide a more appealing work and life environment to attract and retain AI talent.

Figure 7: Respondents' evaluation on the quality of AI resources in Asia Pacific

What is your opinion on the AI resources in Asia Pacific compared with North America and Europe?



Source: 2019 Deloitte survey on AI adoption in manufacturing

Table 2: China falls short to the US and EU in high quality AI talent

Year	Indicator	Country/Region		
		China	**US**	**EU**
2017	Number of AI researchers[5]	18,232	28,536	43,064
2017	Number of top AI researchers by H-index[6])	977	5,185	5,787
2018	Number of top AI researchers by papers published in top academic conferences	2,525	10,295	4,840
2018	Top AI researchers by proportion of Ph.Ds[7]	11%	44%	21%

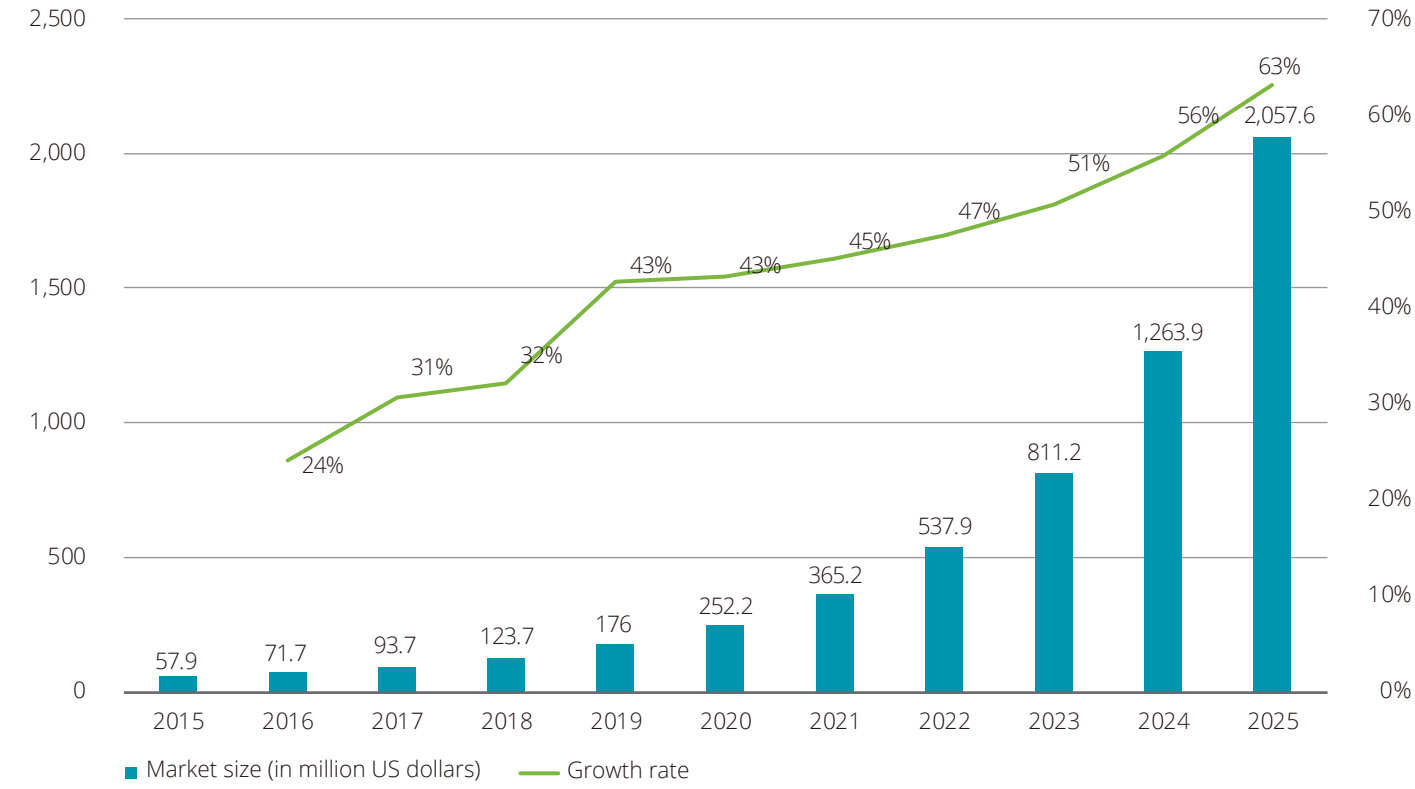
Source: Center for Data Innovation (US)

1.3 Market size for manufacturing AI

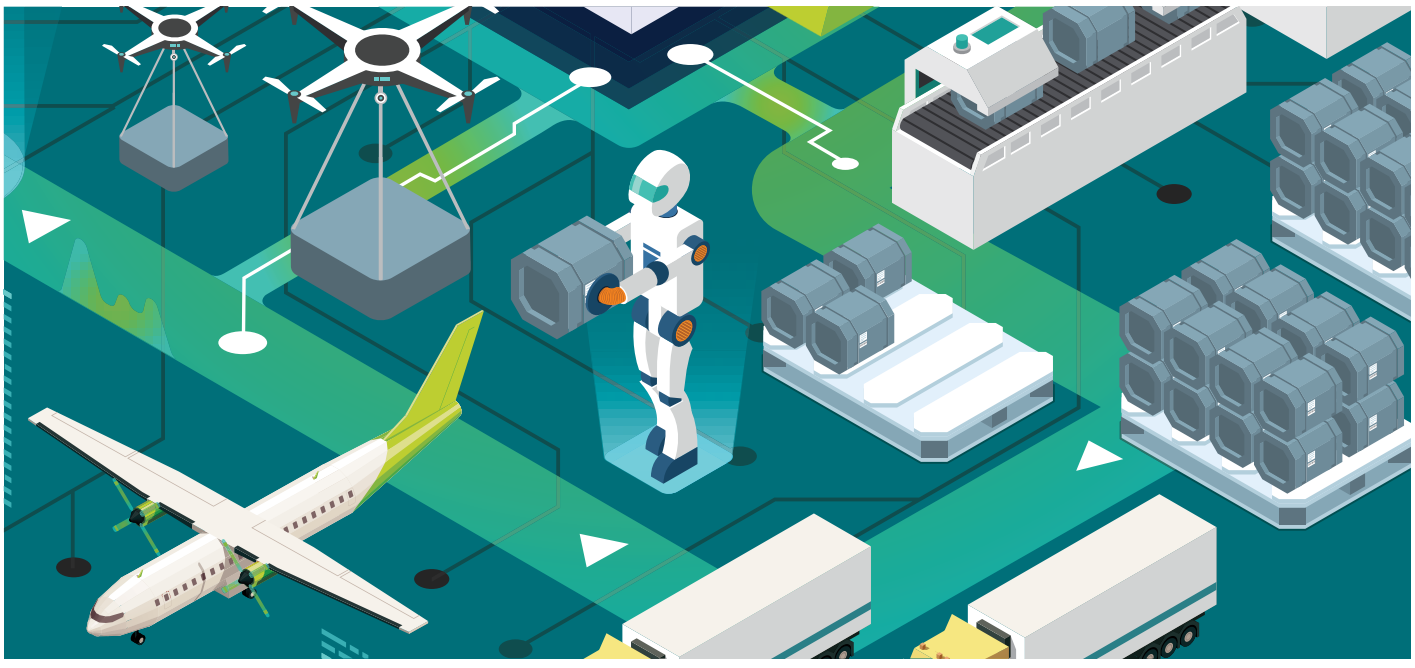
China's performance in AI adoption is outstanding. The market size of AI in the manufacturing sector is expected to exceed USD two billion by 2025, at an annual growth rate of over 40% from 2019 (see figure 8). The significant growth of AI adoption in China's manufacturing industry is contributed by favorable policies, ample funds, and the potentials for AI implementation:

- **Favorable government policies create an open environment for AI development.** In 2017, "artificial intelligence" was included in the government work report for the first time as a national policy to promote artificial intelligence. China supports and provides a relatively open platform for AI development, which will give AI entrepreneurs and professionals more space for growth. The Chinese government particularly encourages the development of AI in the manufacturing sector (e.g. providing policy support for smart robot and self-driving). Big data is more openly used in society and among manufacturing companies.
- **Being a main innovation field, AI development is well funded in China.** As artificial intelligence becomes a main field of technology innovation, high-tech and Internet giants have played a leading role in AI development. The capital market will not overlook this highly promising filed. In addition, there are many Chinese enterprises who have enormous data assets and funds. It is a huge opportunity for developing AI.
- **China's manufacturing provides a wide platform for the domestic development of AI.** In the manufacturing sector, workers with little specialized skills (who are responsible for routine/ predictable/programmable tasks in the secondary industry) will be the first to be replaced by robot. China's manufacturing is mainly driven by traditional industries and requires relatively less skills. Workers in this industry are highly replaceable by automated robot. In the future, those highly repetitive, rule-based, programmable processes will be completed by AI and smart industrial robots collaboratively. The data produced during the whole process of a production line such as operation, testing, transportation, and warehousing will in turn provide high volumes of relatively rule-based information for AI computing and ML to optimize algorithms and increase the accuracy of forecasts. Data collection is undoubtedly the basis for analysis, testing, and machine learning. Only when there is a sufficient data can ML make its maximum impact.

Figure 8: Market size of AI adoption in the manufacturing sector of China



Source: Bizwit, Deloitte Research



2. Artificial intelligence in use

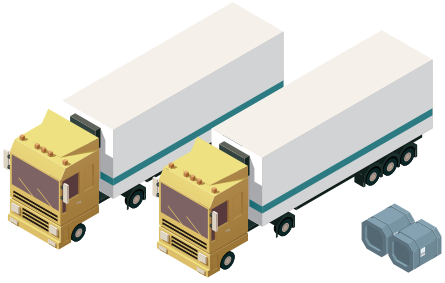
Artificial intelligence can have multiple applications in manufacturing which can be generally categorized into five fields: smart production, products and services, business operations and management, supply chain, and business model decision-making. Smart production takes a proportion of 51% to be the primary choice deployment among manufacturing companies, followed by products and services applications (25%). That situation, however, may change dramatically in the coming two years. The popular industrial AI applications will focus more on products/services and supply chain management than smart production. Popular applications of the future will include those enable shortening design cycle, marketing efficiency improvement, asset and equipment management, insights to customer needs, and energy management, just to name a few.

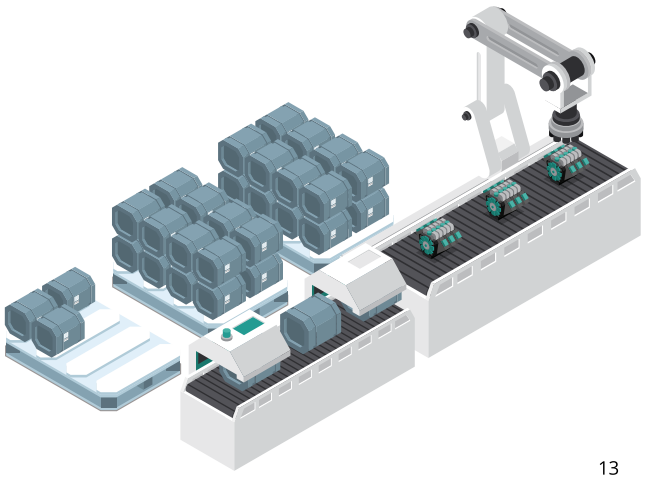
51%
used in smart production

87%
adopted or planned to adopt

21%
used in products and services

At the pragmatic stage, there is not a significant difference in algorithms. What tells one product apart from another are clearly defined application scenarios and engineering capabilities. This chapter will discuss the application scenarios and trends of artificial intelligence in manufacturing.





2.1 Adoption level and main scenarios

According to the 2019 Deloitte survey on AI adoption in manufacturing, 87% of the companies surveyed say they have adopted or planned to adopt artificial intelligence within two years. Based on the level of AI adoption, 18% of the businesses have achieved perceivable results, 34% are at stages of pilot project or trial implementation, 35% have planned to deploy, while 13% do not have plans to invest in artificial intelligence (see figure 9).

The result parallels in the way how a company promotes AI projects. Among the companies surveyed who have implemented AI projects or planned to do so in the future, 15% said they have AI projects with complete strategy and consistent plans, 28% are gathering proposals and building learning models for Proof of Concept (POC), and 57% of them have pilot projects, but most of which are inconsistent or fragmented (see figure 10).

Figure 9: AI adoption level and progress of the companies surveyed

AI adoption level and progress of the companies surveyed

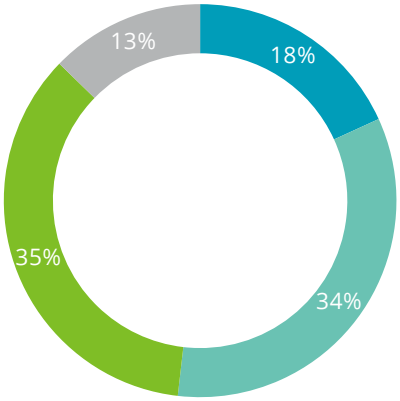
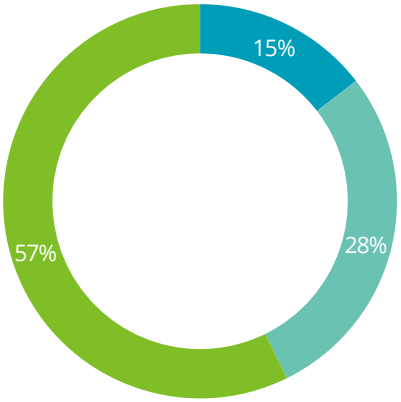


Figure 10: AI Adoption level of the companies surveyed who have deployed or planned to do so

AI Adoption level of the companies surveyed who have deployed or planned to do so

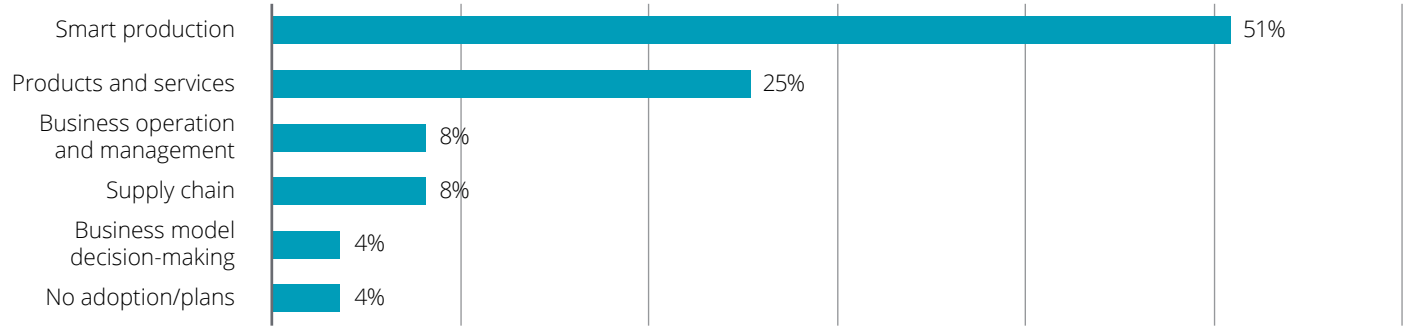


Source: 2019 Deloitte survey on AI adoption in manufacturing

Artificial intelligence can have multiple applications in manufacturing which can be generally categorized into five fields: smart production, products and services, business operations and management, supply chain, and business model decision-making.

Our survey finds that smart production is and will be the first choice deployment (51%) among manufacturing companies in the next two years, followed by products and services (25%). Respondents who choose supply chain and business operations and management account for 8% and 4% respectively. The rest 4% of the companies surveyed have not yet formed a plan about AI deployment (see figure 11).

Figure 11: Key fields for AI adoption among the companies surveyed
Key fields for AI adoption among the companies surveyed (now or within 2 years)

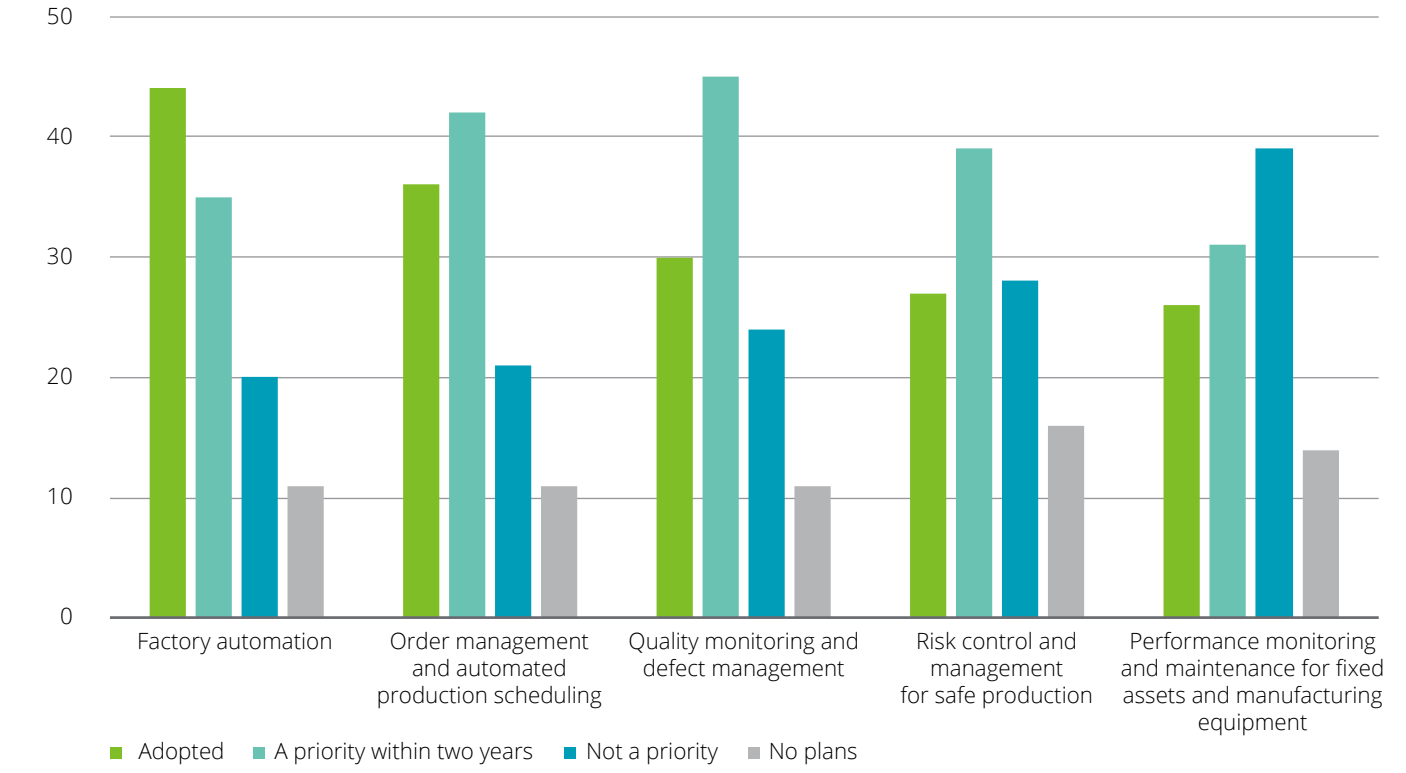


Source: 2019 Deloitte survey on AI adoption in manufacturing

2.2 Smart production

In the field of **smart production**, artificial intelligence is more utilized for factory automation, order management, and automated scheduling. Over the next two years, a growing number of AI technologies will be put into use in quality monitoring and defect management, which will be bolstered with the advances in computer vision technology (see figure 12).

Figure 12: AI adoption in smart production among the companies surveyed
Scenarios in smart production that the companies surveyed have adopted or planned to adopt AI



Note: The figures to the left refer to the number of companies.
Source: 2019 Deloitte survey on AI adoption in manufacturing

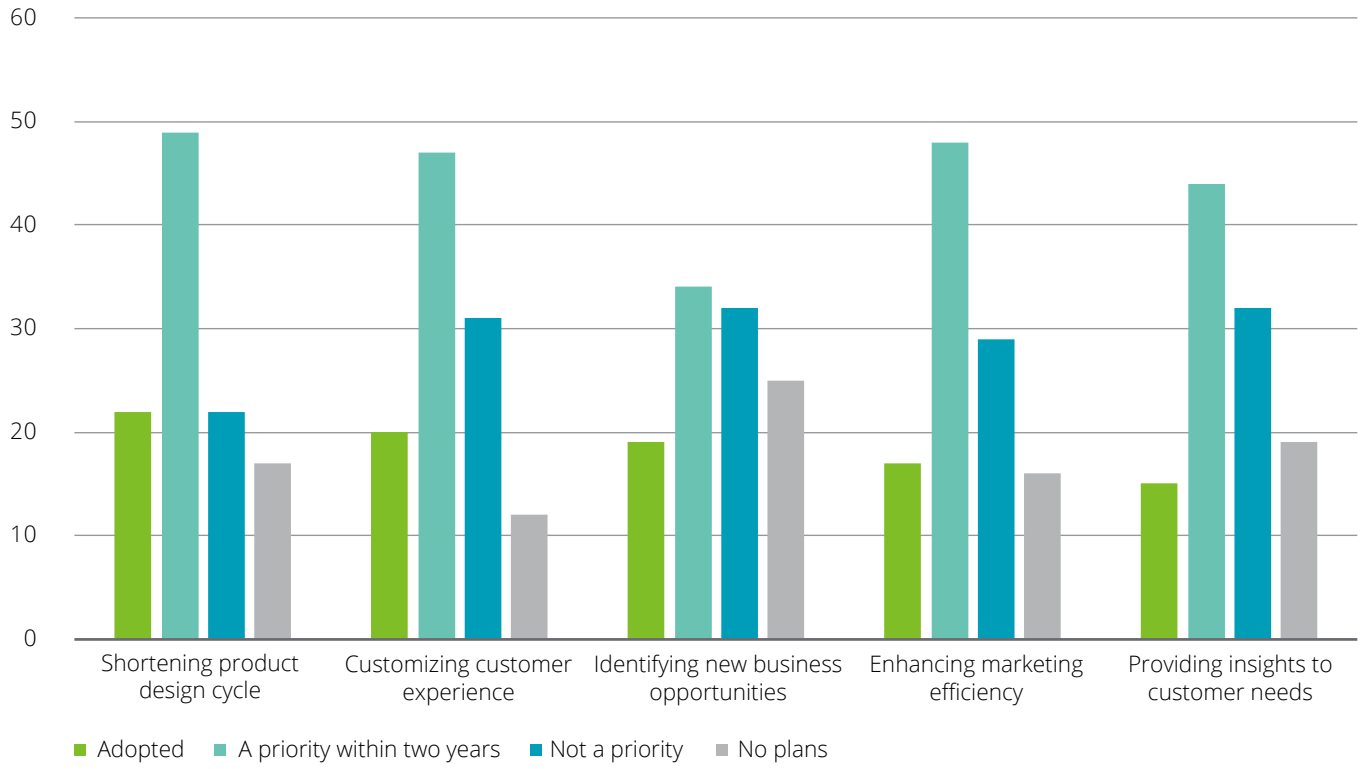
The extensive use of robots will likely enhance the adoption of AI applications though there is limited information on how many robots runs AI software. Artificial intelligence used in factory automation is largely related to the mass introduction of robots in the facilities. In China, industrial automation and skill shifts are accelerating. During the past three years, a number of industrial companies have automated 40% of their workforce. Since 2012, the amount of robots installed in China increased by 500% (while it was 112% in Europe). Though the majority of robots in the manufacturing plants are running by generic programming to carry out high accuracy and repetitive work. Adding AI applications, the robots will be able to sense the changes in environment, recognize different objects to take respective actions, and even make decisions on certain special occasions. In automated production scheduling, AI applications often focus on the optimization of delivery time, planning and manufacturing, processing sequence, and timely distribution of materials, particularly in discrete industries with multiple processes and resources in need of optimization. [8]

AI applications are expected to grow rapidly in quality monitoring and defect management, largely thanks to the advances in machine vision. Using a ML algorithm trained on remarkably small volumes of sample images, machine vision tools can pick out microscopic defects in precision products at resolutions well beyond the human eye. Another way to enhance product quality is to optimize techniques. AI can sense and analyze the data of key techniques and improve product yield. Those applications can create sizeable economic value for businesses manufacturing expensive product with high quality requirements.
Given the quality, diversity, amount, and collection method of data define how well machine learning can play its role, the use of AI in the field of smart production has certain requirements for the facilities of the company, such as having complete automation equipment and management system, and wide utilization of sensors.

2.3 Products and services

While only a limited number of companies have deployed artificial intelligence technology in the

Figure 13: AI adoption in products and services among the companies surveyed
Scenarios in products and services that the companies surveyed have adopted or planned to adopt AI



Note: The figures to the left refer to the number of companies.
Source: 2019 Deloitte survey on AI adoption in manufacturing

products and services field at this point, the businesses who plan to invest in AI as a priority in the coming two years are growing strikingly, with special focus on the applications in shortening design time, customizing customer experience, and marketing efficiency enhancement (see figure 13).

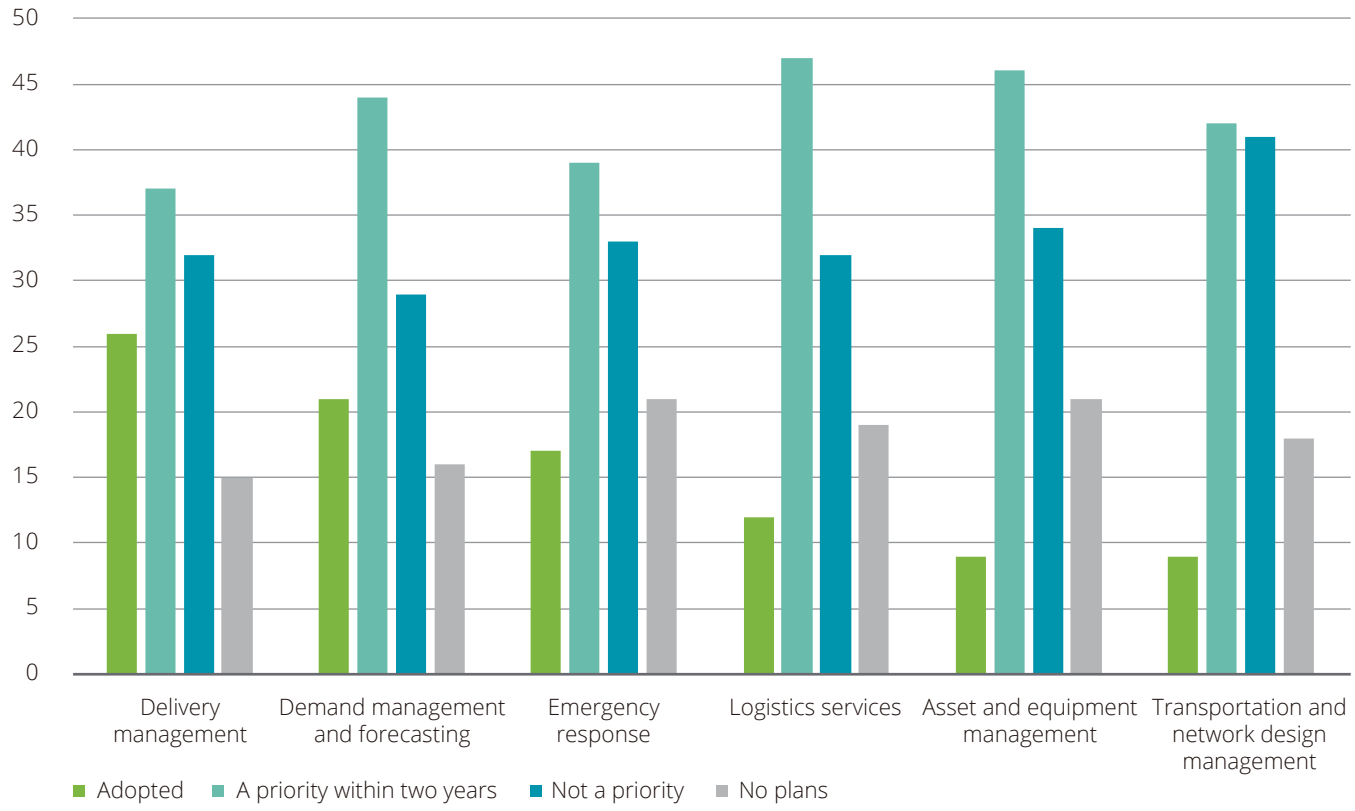
Manufacturing companies face challenges to enhance product performance, lower energy consumption, and shorten the cycle of design. A current popular application to reduce the time of design enabled by AI is generative design which utilizes algorithms to delve into all possible solutions based on preset goals and rules. Specifically, it includes three steps. First, the designer or engineer needs to input the objectives and parameters (i.e. materials, production methods, cost limitations, etc.) into a generative design software. Then, the software will explore all the possible combinations of solutions and promptly generate design alternatives. Finally, machine leaning will be used to test and learn from the results of each iteration.

A manufacturer needs to understand the product life journey after they leave the factory as it should manage what is going on in the facilities. In this regard, artificial intelligence is also highly promising in enhancing customer experience, providing insights to customer needs, and increasing marketing efficiency. Take user experience (security) as an example, iPhone X adopted Face ID that enables biometric authentication with facial recognition technology and is more secure. Apple claims the probability that a random person could unlock someone else's fingerprint using Touch ID is 1 in 50,000. In contrast, the chance to unlock someone else's face with Face ID is 1 in 1,000,000, which is 20 times more secure than Touch ID. [9]

2.4 Supply chain management

AI adoption in supply chain among manufacturing companies is mainly for delivery and demand management as well as forecasting. Over the next two years, logistics services, demand management, forecasting, as well as asset and equipment management will increasingly adopt AI (see figure 14).

Figure 14: AI adoption in supply chain among the companies surveyed
Scenarios in supply chain that the companies surveyed have adopted or planned to adopt AI



Note: The figures to the left refer to the number of companies.
Source: 2019 Deloitte survey on AI adoption in manufacturing

AI adoption in delivery management guarantees secure and precise delivery of goods, which accounts for the largest share of AI adoption in manufacturing supply chains. Coordinating storage shelves, goods, and robots based on artificial intelligence technology enables faster entry and exit of goods in the warehouse and efficient arrangement of stacking racks. In factory warehousing, automated assembly line and robots for distribution, storage and delivery have been put into use. AI can find the optimal route for each material to minimize the time for distribution.

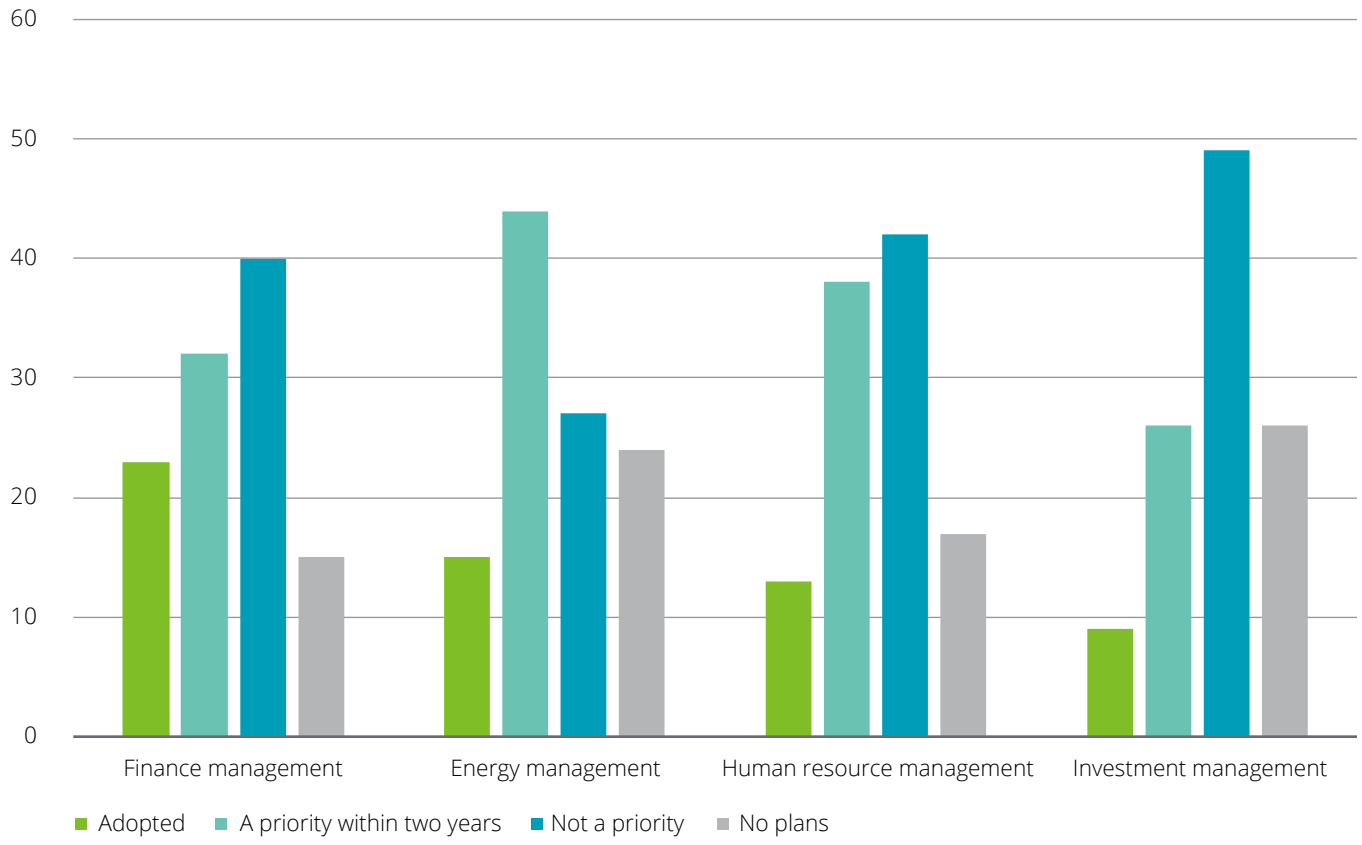
Another challenge of supply chain management is to estimate the most trending products for the next season. Supply chain executives need to make reasonable planning about the inventory, personnel, and logistics capacity, and transport the goods at the warehouse near the sales outlets in advance, where AI renders better, in-depth analysis and forecasts on consumption trends. By integrating internal sales data, consumers' product use records, track record of product lifecycle, competition intelligence, market trends, and social media data, artificial intelligence can profile consumers' demand preferences and purchasing behaviors. Based on that, designers can create hot-sale products for the next season and make more precise estimate of revenues.

2.5 Business operations and management

At the current stage, most AI adoption in business operations and management are in the arena of finance. Significant growth is expected in energy and human resource management (see figure 15).

For manufacturing companies, energy consumption accounts for a high proportion of production costs. The difference in equipment, techniques and processes, product mix, and energy management can have varied impact on energy consumption. The use of AI for efficacy diagnosis can help businesses make energy saving more efficient. There are companies who successfully adopted artificial intelligence for energy use analysis and optimization and realized factory-wide reduction of energy consumption. Steel manufacturers are also introducing AI learning and analytics applications for energy consumption control in the factory.

Figure 15: AI adoption in business operations and management among the companies surveyed
Scenarios in business operations and management that the companies surveyed have adopted or planned to adopt AI



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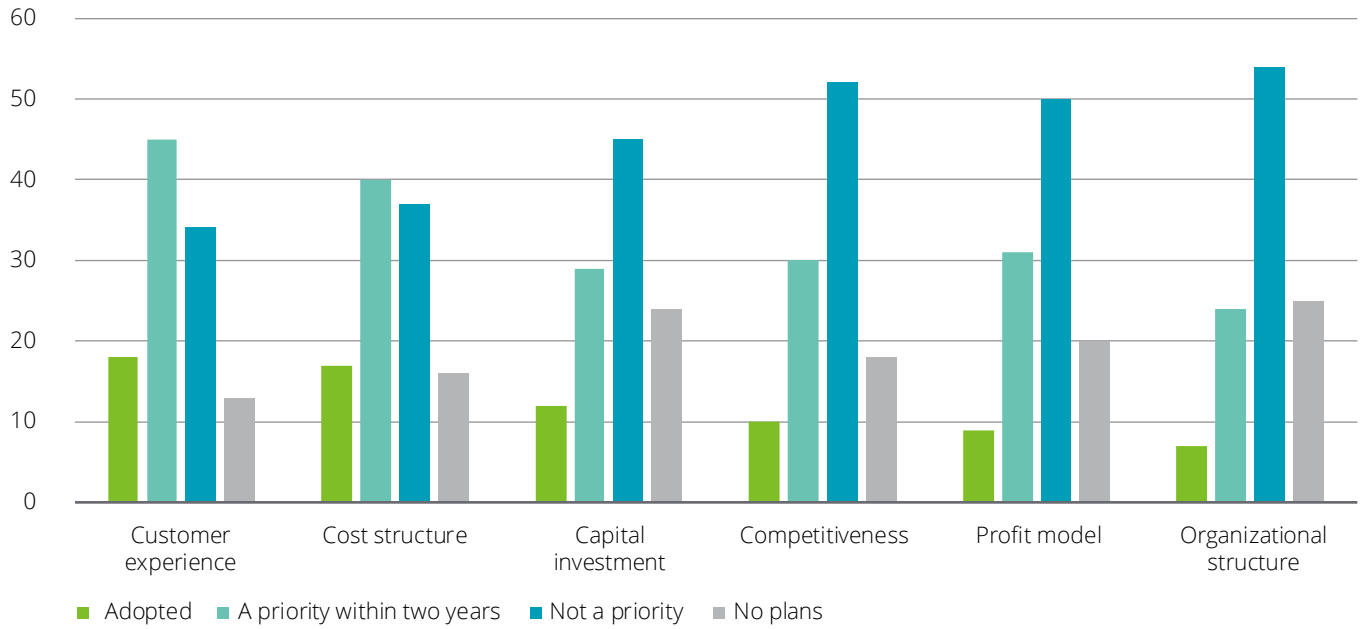
Source: 2019 Deloitte survey on AI adoption in manufacturing

2.6 Business model decision-making

For business model decision-making in the manufacturing sector, AI is mainly adopted in customer experience and cost structure scenarios. Customers are getting pickier, demanding customized products and services while expecting lowers prices. A considerable number of the surveyed companies plan to use AI to make precise forecasts of customer demand, develop smart products and services, or adopt flexible pricing and billing models, to provide integrated and interactive customer experience. As the costs of labor and resources in the manufacturing industry soar, cost structure has become another focal point of businesses. The potential of adopting AI in human labor substitution, inventory management, and maintenance of equipment stability can reduce the costs and expenses as well as optimize cost structure in business management (see figure 16).

Figure 16: AI adoption in business model decision-making among the companies surveyed
Scenarios in business model decision-making that the companies surveyed have adopted or planned to adopt AI



Note: The figures to the left refer to the number of companies.
Source: 2019 Deloitte survey on AI adoption in manufacturing

2.7 Popular applications for the next two years

In terms of specific use cases regardless of the fields, it shows that significant changes will take place in popular application scenarios over the next two years. The main changes include:

- Popular applications of AI in industries will shift from smart production to products/services and supply chain management;
- There will be new growth areas within two years, and businesses will have markedly increasing focus on AI applications in enhancing marketing efficiency, logistics, asset and equipment management, insights to customer demand, energy management, transportation and network management in supply chains.

Changes are inevitable as manufacturing transitions into Industry 4.0. The focus of the manufacturing sector is not only the process of production, but also the whole value chain. For instance, how to sense demand and make supply chain planning? How to achieve increased revenue from new and additional smart products and services? And how to establish customer relations with new approaches and integrate customer information? The capabilities of AI in processing mass data and decision-making can help realize the aforementioned steps and create value more efficiently.

Figure 17: Changes in popular AI applications in manufacturing (the figures to the right refer to the number of companies)

Smart production scenarios	Adopted	A priority within two years
Factory automation	44	35
Order management and automated manufacturing scheduling	36	42
Quality monitoring and defect management	30	45
Risk prevention and control for safe production	27	39
Performance monitoring and maintenance for fixed assets and manufacturing equipment	26	31

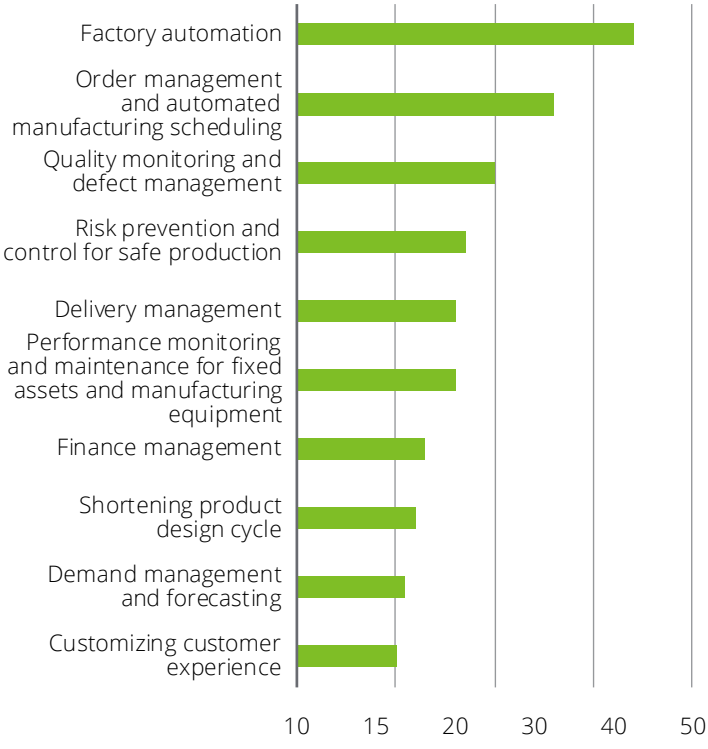
Business operations and management scenarios	Adopted	A priority within two years
Finance management	23	32
Energy management	15	44
Human resource management	13	38
Investment management	9	26

Products and services scenarios	Adopted	A priority within two years
Shortening product design cycle	22	49
Customizing customer experience	20	48
Identifying new business opportunities	19	34
Enhancing marketing efficiency	17	48
Providing insights to customer needs	15	44

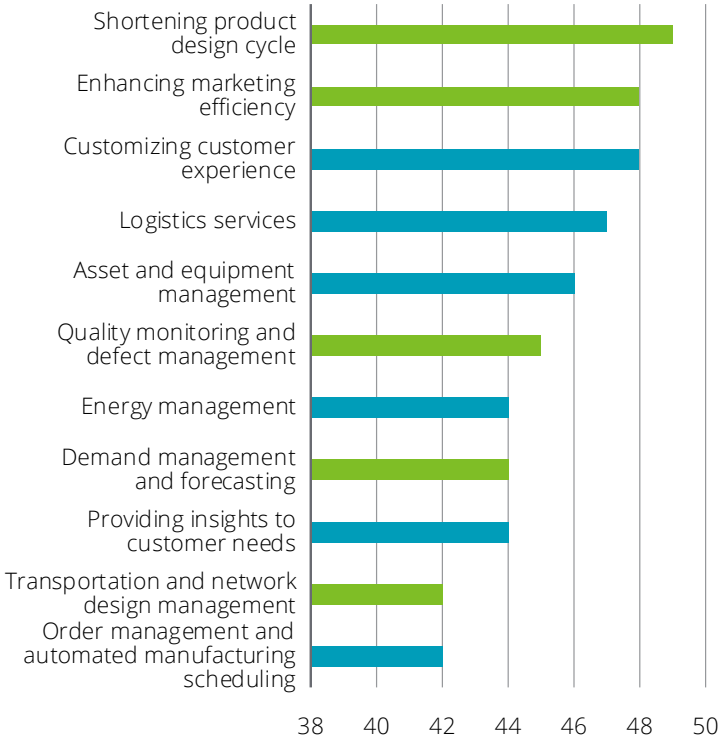
Supply chain management scenarios	Adopted	A priority within two years
Delivery management	26	37
Demand management and forecasting	21	44
Emergency response	17	39
Logistics services	12	47
Asset and equipment management	9	46
Transportation and network design management	9	42

Note: The marks in blue, green, and grey stand for businesses' high, medium, and low interest in the application scenario.

Current popular AI applications in manufacturing



New growth areas of AI in manufacturing within two years



Note: The figures to the right refer to the number of companies
Source: 2019 Deloitte survey on AI adoption in manufacturing


91%
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110
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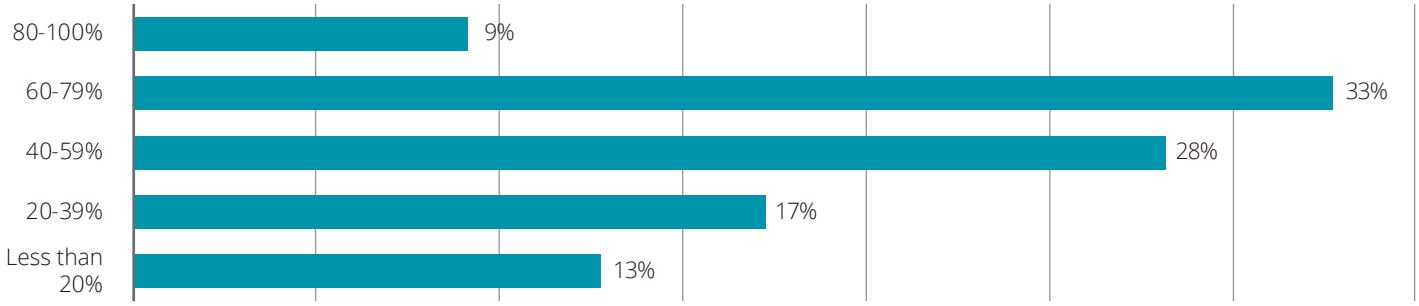
3. The difference between implementation and expectations

3.1 91% of AI projects failed to meet expectations

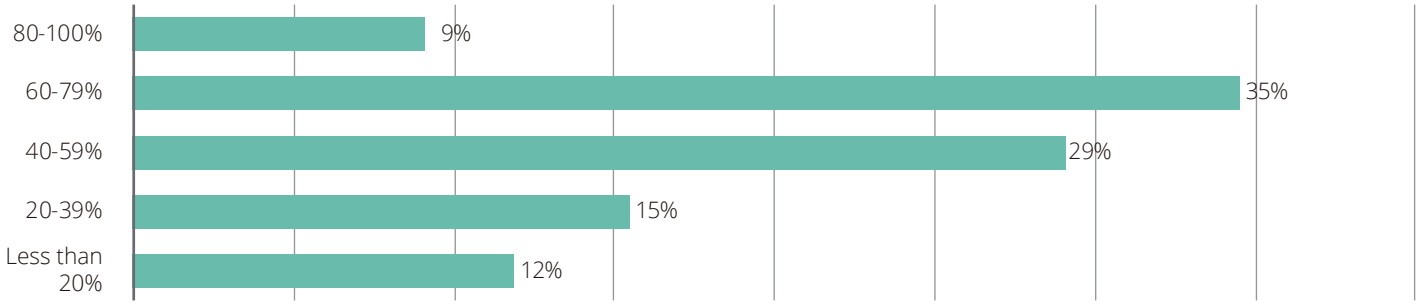
There are a considerable number of AI implementations among Chinese manufacturers, but what are the actual effects? Our survey found that only 9% of the surveyed companies thought their AI projects reached 80%-100% of expectations, either from the perspective of benefits or the budget and time invested, which means 91% of the AI projects failed to meet expectations (see figure 18).

Figure 18: The gap between AI implementation and expectations

From the perspective of benefits, to what extent do AI projects meet the company's expectations?



From the perspective of budget and time invested, to what extent do AI projects meet the company's expectations?



Source: 2019 Deloitte survey on AI adoption in manufacturing

It is quite common that gap exists between the effects and expectations in AI implementation due to the following:

- **Obstacles from existing experience and organizational structure:** When management reform or process optimization is required for the introduction of AI technology, it is rather difficult for employees to implement new process since they are confined to the existing patterns. Funds, training, and time are also huge risks for companies to bear. Additionally, the lack of expertise to make adjustments to organizational structure is also another great challenge for applying AI.

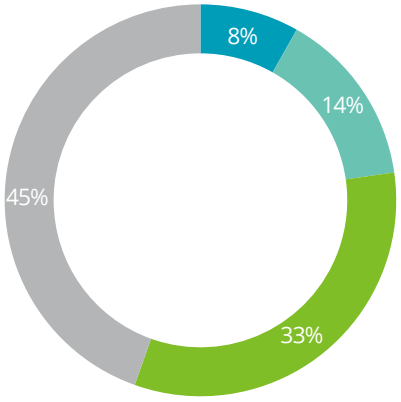
- **Infrastructure limitations:** AI implementation has certain basic requirements for infrastructure of a company. According to the Deloitte survey, 45% of the surveyed companies believe that the impact of infrastructure is so strong that they have to delay the original plans; while 14% think that the impact is too strong to finish certain transformation. For starters, companies should have sensors to collect key variables that are actual and effective, and only in this way can they decide which process to improve to enhance quality and efficiency (see figure 19).
- **Data collection and quality:** With qualified infrastructure, the collection methods, quality, and diversity of data are crucial to define ML capabilities. Large manufacturing companies in China at present have complete automation equipment and management systems, however the utilization of data generated doesn't match—the data collected using a large amount of resources are usually not key information.
- **Lack of engineering experience:** AI technology companies need to put hypothesis into practical scenarios. It not only depends on the technical capabilities of the project teams but also the ability of combining the craftsmanship with algorithm as well as utilizing software and hardware resources to create reliable products.
- **Excessively large scale and complexity:** AI is usually applied to deal with concrete problems. General large projects often involve multiple factors and decisions that are beyond the capabilities of AI at the current stage.

3.2 Over half of the surveyed companies find the gap unacceptable

Among the surveyed companies, 51% believe that the gap between expectation and implementation is unacceptable therefore they selected projects that were successfully implemented before. While 49% of the surveyed can accept the gap to a great extent because they think mistakes are inevitable (see figure 20). That says a lot about many failures and prices came with the innovative projects. Companies should learn to understand and control failures, and eventually use AI to gain long-term benefits, instead of letting setbacks stop them from fulfilling AI implementation.

Figure 19: Impact of a company's infrastructure on AI projects

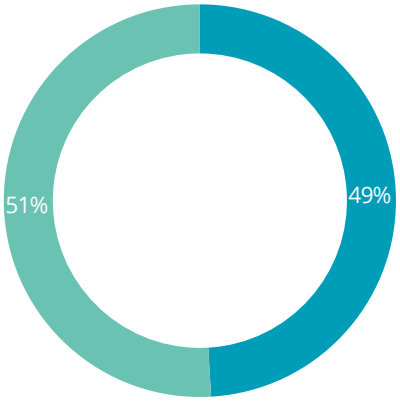
Impact of a company's infrastructure on AI projects



- None
- High impact - cannot proceed with certain transformation
- Low impact - can be resolved
- Medium impct - have to delay original plans

Figure 20: Companies' attitude towards AI project results

Companies' attitude towards AI project results



- Companies who believe mistakes are inevitable and can accept the difference between the effects and expectations to a great extent
- Companies who selected projects that were successfully implemented before and cannot accept the difference

Source: 2019 Deloitte survey on AI adoption in manufacturing


49%
51%
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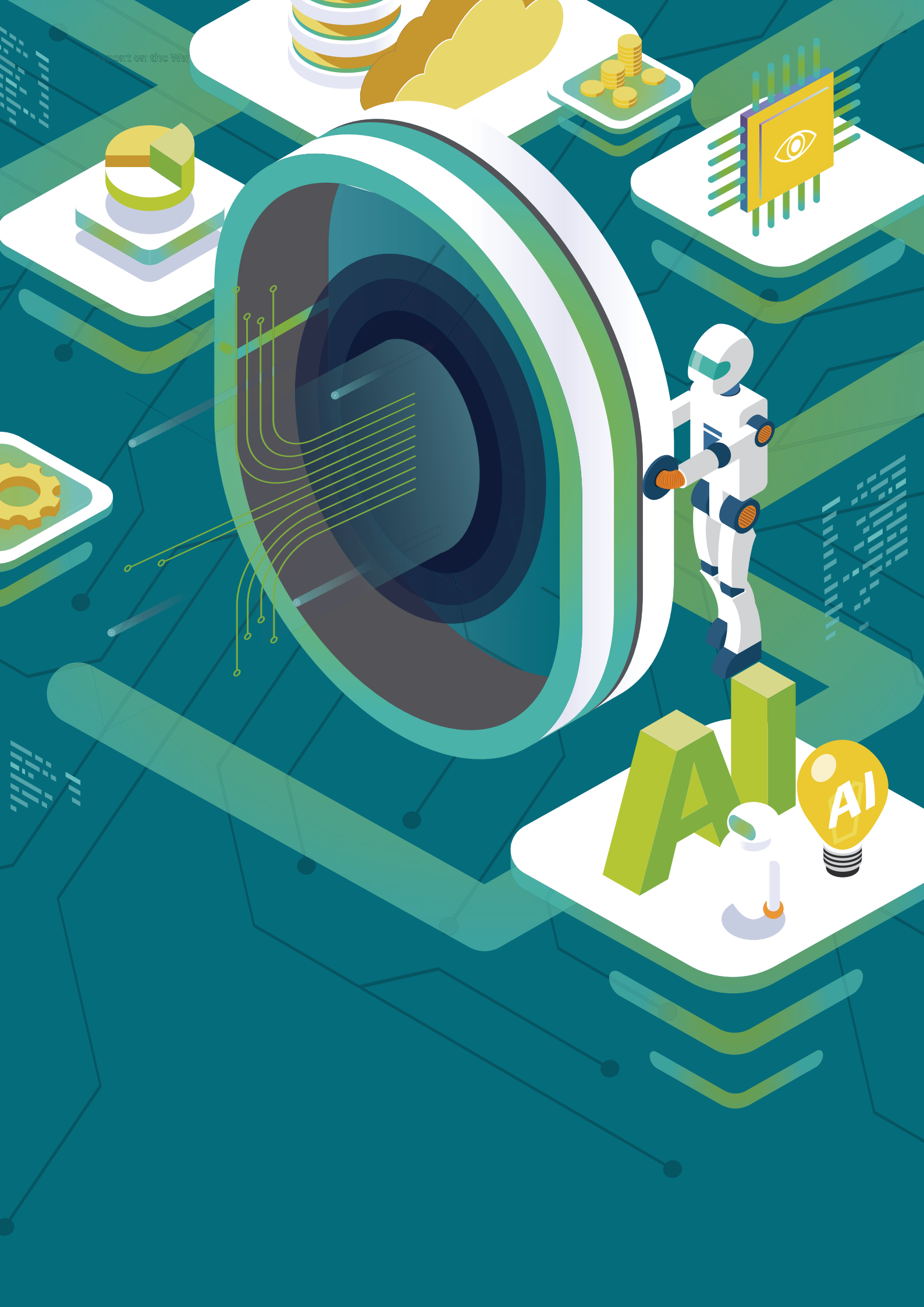

AI
AI

4. Future is now

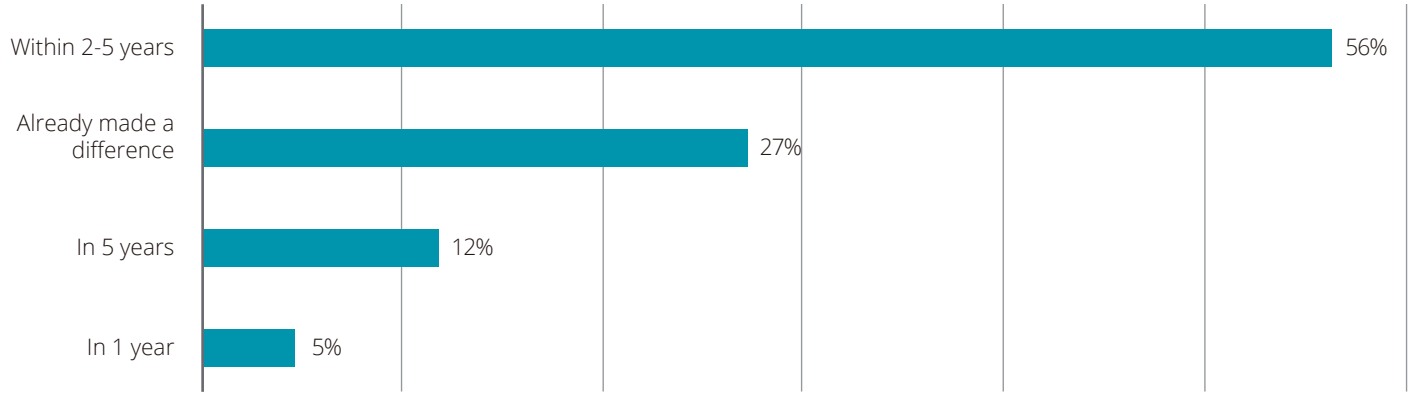
4.1 AI is expected to make a difference

The adoption of AI in the manufacturing industry has been put into practice to change the way of production and management of manufacturers. According to the Deloitte survey, 83% of the surveyed companies think that AI has made or will make impact that is practical and visible. Among them, 27% believe that AI projects have already brought value to the company and 56% think that will do in 2-5 years (see figure 21).

Apparently, the preparedness for AI adoption varies among different industries. With regard to assets, technology, standards and regulations, as well as the ecosystem, the industries such as electronics and communication equipment, household appliances, automobile manufactures, and electric power and electrical engineering are relatively better prepared for AI adoption (see figure 22).

Figure 21: The expected time when AI can make a difference

When will AI projects have actual, visible impact on companies?

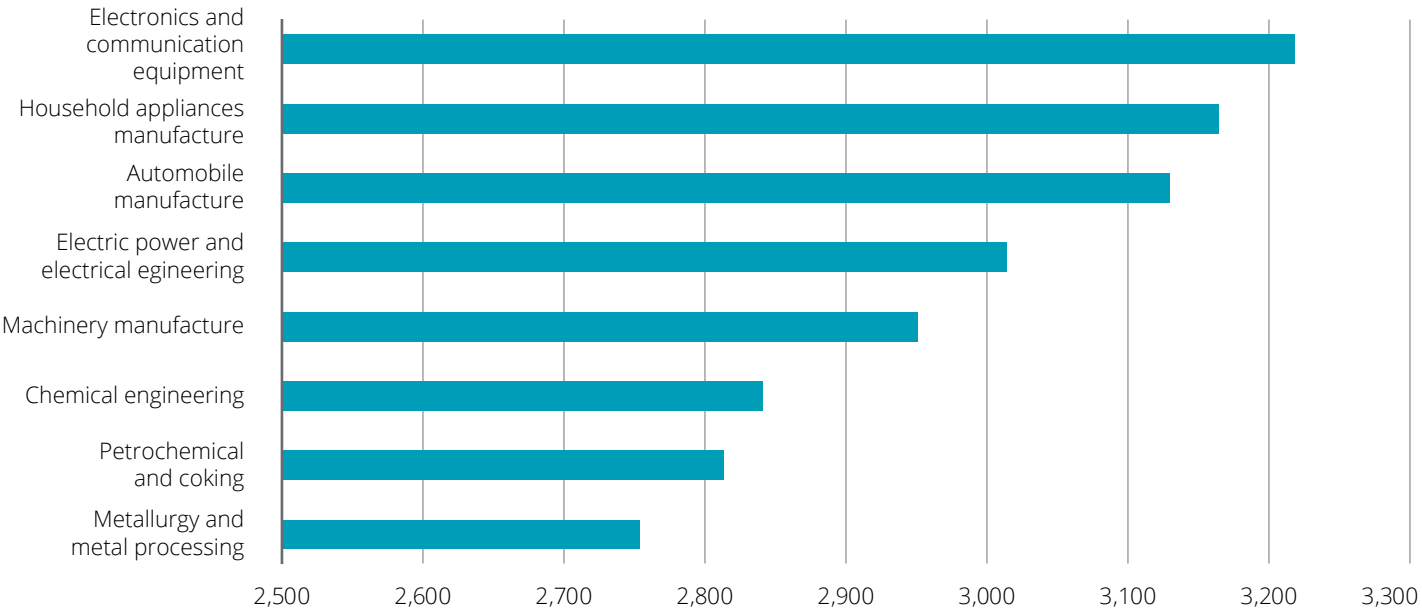


Source: 2019 Deloitte survey on AI adoption in manufacturing

Figure 22: Preparedness of major industries for AI adoption

	Assets	Technology	Standards and regulations	Ecosystem
Electronics and communication equipment	●	●	◕	●
Household appliances manufacture	◕	●	◕	◕
Automobile manufacture	●	●	◑	◑
Electric power and electrical engineering	◕	●	◑	◑
Machinery manufacture	◑	◕	◔	◔
Chemical engineering	◑	◑	◔	◔
Petrochemical and coking	◑	◔	○	○
Metallurgy and metal processing	◔	◑	○	○

Preparedness of industries for AI adoption (Higher score means being better prepared)



Source: 2019 Deloitte survey on AI adoption in manufacturing

4.2 Companies investment preference

Of all the companies surveyed, 32% are expected to make an investment of more than RMB20 million towards AI over the next two years, and another 32% estimate their investment to top RMB5 million, while others will stay between RMB5-20 million (see figure 23).

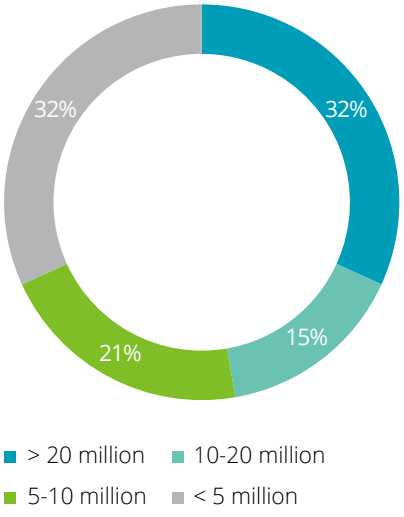
From the perspective of technology trends, growingly more companies will invest on hybrid technology systems to optimize production, costs, inventory, or quality control, to predict sales and price, or to perform predictive maintenance. As for technology targeting single aspects, such as visual surveillance, robot localization, expert system, companies are less enthusiastic to invest (see figure 24).

AI can optimize product configuration significantly, including which is relied upon by manufacturers to produce according to orders—the "configure, price, and quote (CPQ)" workflow. For example, the sales, designs, and installments of railway interlocking control systems of Siemens apply AI and ML, which is helpful to pick out the best out of 10^{90} possible configurations. ML is good at discovering the best configuration for what products are most likely to be produced to meet customers' demands. [10]

The prediction and decision support of AI are closely related to big data analysis. According to the survey, many companies are willing to apply AI for big data analysis to realize data visualization and precision management. Electric equipment manufacturers can use AI to process mass data remotely and be aware of problems ahead of time to provide better services to the smart power grid.

Figure 23: Companies' investment plans towards AI in the next two years

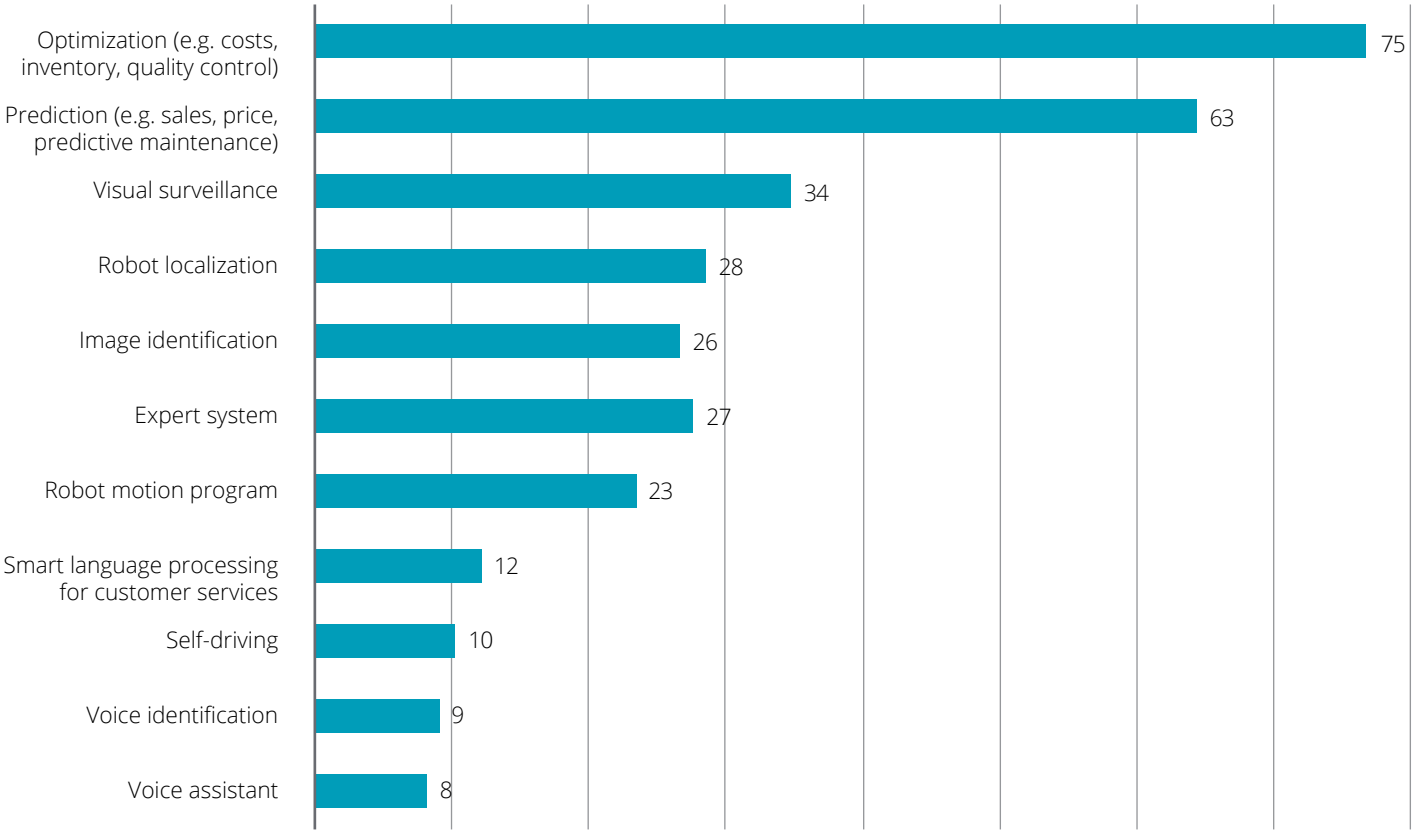
Estimated investment scale on AI within 2 years(RMB)



Source: 2019 Deloitte survey on AI adoption in manufacturing

Figure 24: The technology most popular with the surveyed companies

Priority AI technology the surveyed companies plan to invest within 2 years



Source: 2019 Deloitte survey on AI adoption in manufacturing

4.3 Layout the foundation for AI platforms

A concern raised about AI adoption in industries is extensibility. AI solutions are usually customized for specific applications and companies. It is commonly acknowledged in the industry that industrial AI platforms that allow for lower adoption costs for companies are necessary for AI implementation at scale in industries.

Many technology providers are establishing such platforms. Alibaba Cloud's ET Industrial Brain, for instance, is a development type industrial AI application platform. The platform is trying to lower the threshold for applying AI and arrange businesses in a configurable manner. The platform enables partners or end-users to build and customize their own industrial templates, to establish data models, and to create algorithm models. CraftWorks is a software company providing customized AI solutions for industrial customers. It is focusing on developing AI platform engines to let industrial customers build their own models instead of relying on specific AI solutions.

Meanwhile, industrial companies also show great interest in AI platforms as well as the technology domain. HARTING, a main provider of industrial cables, launched an IoT gateway named MICA that provides edge computing, connection, and ML reasoning. KonicaMinolta launched an AI platform for industrial automation, predictive maintenance, and quality control (image, sound, and data analysis).


AI

5. Deloitte recommendations

Large scale AI implementation in China's manufacturing industry is dawning, and leading companies have begun deployment to gain early mover advantage. Deloitte recommends AI adoption among companies with considerations of corporate strategy, scenarios, data foundation, teams, partnerships, Proof-of-Concept (POC), and implementation.

Figure 25: The key milestones in AI projects

Source: Deloitte China Smart Future Research Institute, Deloitte Research

5.1 Align with strategic objectives

Manufacturing companies need to ensure their AI deployment matches their strategy and business goals, be it bringing new revenue, reducing costs, or enhancing operation efficiency. The key is to choose an appropriate complexity to deliver business goals. AI applications also need to match the timeline set for business goals. The more advanced a technology is the longer time it needs to mature.

Businesses are advised to optimize relevant business processes and operation models and ensure the infrastructure is qualified to support the implementation prior to applying AI in any business scenarios. After all, industry 2.0 and 3.0 are inevitable for companies to achieve Industry 4.0.

5.2 Define user cases

Knowledge about where the technology can outperform humans is the proper strategy to find the right AI application scenarios. AI at present lacks the ability to solve common problems and apply universally. Thus, defining the areas within which AI can provide solutions as well as the edges to limit the demand for AI functions are necessary to implement the scenario and create business value. Solutions therefore can be reliable. For example, AI technology based on deep learning is better than humans when processing mass data, so it can substitute visual inspection, perform data audit, or decide the time for maintenance.

5.3 Build data foundation

AI based on deep learning still relies on big data. A company's data foundation determines whether its AI project will work. According to the self-diagnosis and self-assessment of data before AI implementation, the maturity of the data foundation can be briefly divided into the following levels:

L1: Lack of key business data
L2: Has complete basic data, but with internal data silos
L3: Has highly integrated data, but unable to support decision-making
L4: Support business data-driven decision-making, but unable to respond real time to business changes
L5: Support both data-driven business decision-making and real time response to business changes

When the data is at lower levels of maturity such as L1, the first step is not to implement AI but improve the data foundation through digitalization (or informatization). Internet and

financial services, among other industries, have the highest level of digitization to be the earliest adopters of AI given their day-to-day operations generate large quantities of data. However, for traditional industries with incomplete data foundations, enhancing their digitalization level through business process improvement is the precondition of applying AI.

5.4 Establish teams and partnerships

If a company wants to develop AI capabilities, it will need a professional team made up of the following types of talent:

- AI technology experts: scientists specializing in mathematics and statistics who are responsible for basic algorithm research; IT experts in conventional senses who are capable of using the latest AI algorithms to develop technology prototypes and make business products.
- Industry experts: experienced experts in different industries to be responsible for AI solutions to the specific sectors.
- AI adoption experts: qualified product managers with knowledge of the features of algorithms as well as the difficulties of the industry who can combine the expertise of AI technology and the industry for a better solution that fits.

Besides an internal team, businesses can also import AI expertise through partnerships to fill the capability gaps, especially in AI strategy, implementation process, technology practice, and project delivery. According to our survey, 96% of the companies surveyed choose to cooperate with external partners, mainly technology consultancies and AI companies.

Gartner divides AI technology providers into four types: leading cloud service providers (e.g. Amazon, Alibaba Cloud, Google), enterprise application suite vendors (e.g. business application procedures of ERP, SCM, HCM AND CRM), data science and ML platform vendors (a large amount of AI leading companies and startup companies), and system integrators (e.g. Deloitte and IBM). These providers have different strengths. Companies should choose the most suitable partners according to their business environment and objectives.

It should be noted that cross-border cooperation is a pivotal driver for science and technology development. Last year, the US has regarded AI as a sensitive technology that is of national security concerns. The uncertainties in China-US relations will have great impact on deep AI cooperation between the two countries despite a close cooperating relationship they've established.

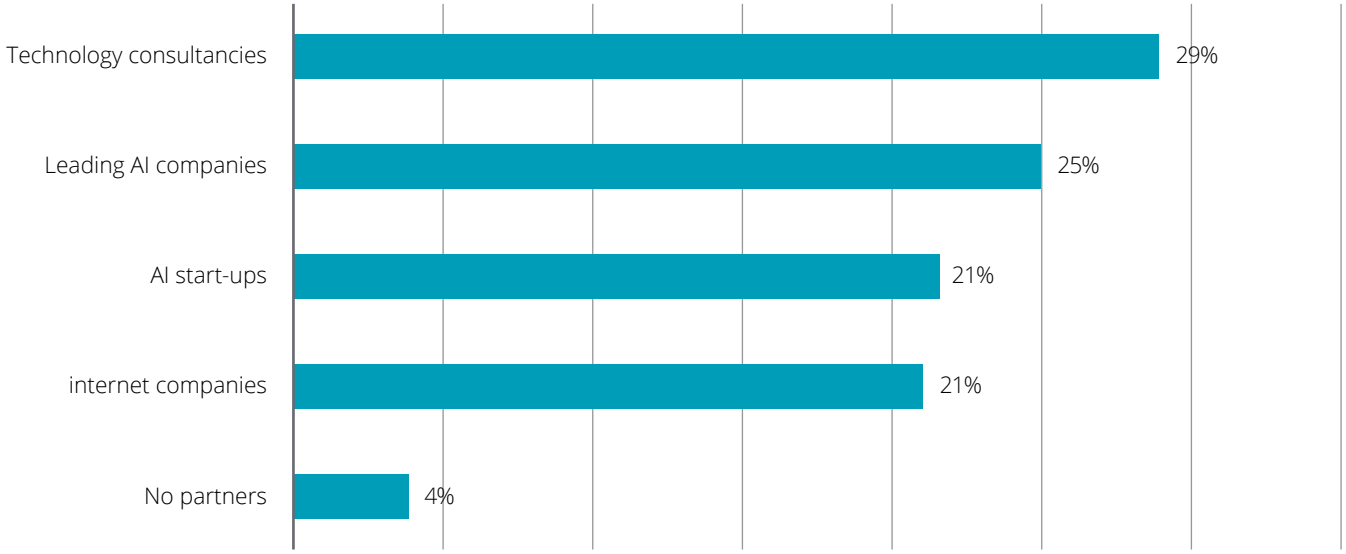
5.5 Run POC and implement at scale

With clearly-defined scenarios, a complete data foundation, and a professional team, the next step is to design a prototype and run a Proof of Concept (POC) based the process of AI. Iteration and large-scale implementation can be carried out if the prototype is proved to be feasible.

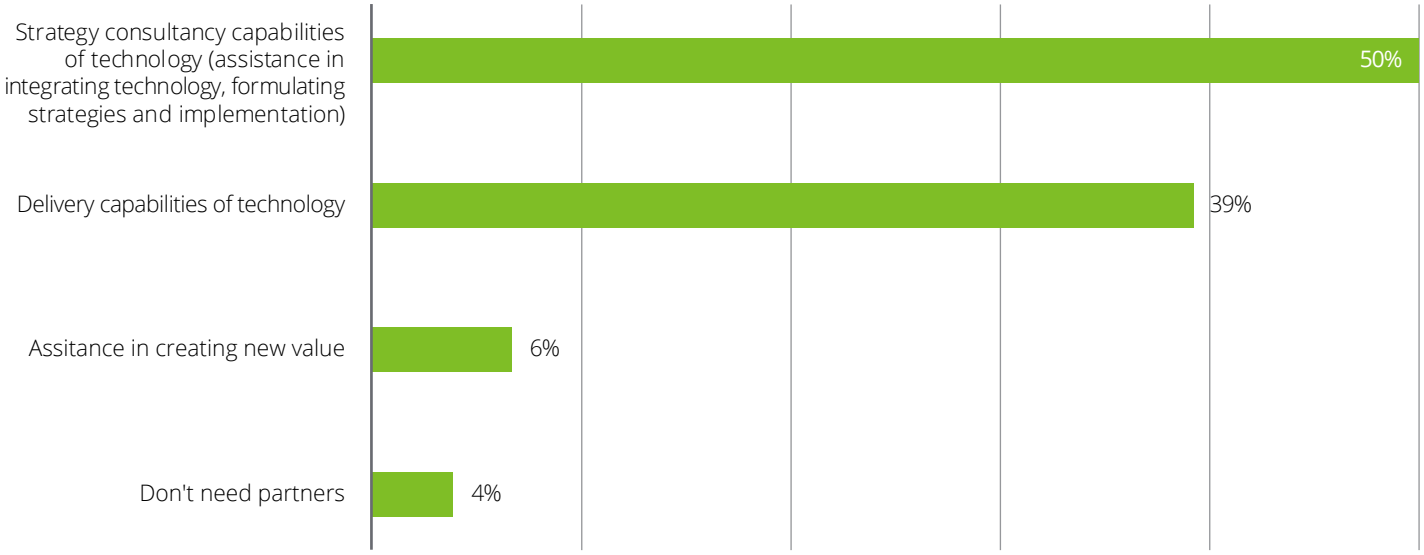
There are increasingly more factors motivating the incorporation of artificial intelligence into the global manufacturing industry. The high volumes of data accumulated by manufacturers, more mature AI technology, and stronger supporting project capabilities are all enablement for AI to fulfill its full potential.

Figure 26: Bridge the capability gaps with partnerships

Partners who are planning AI deployment and adoption



Partner capabilities that matter to the surveyed companies

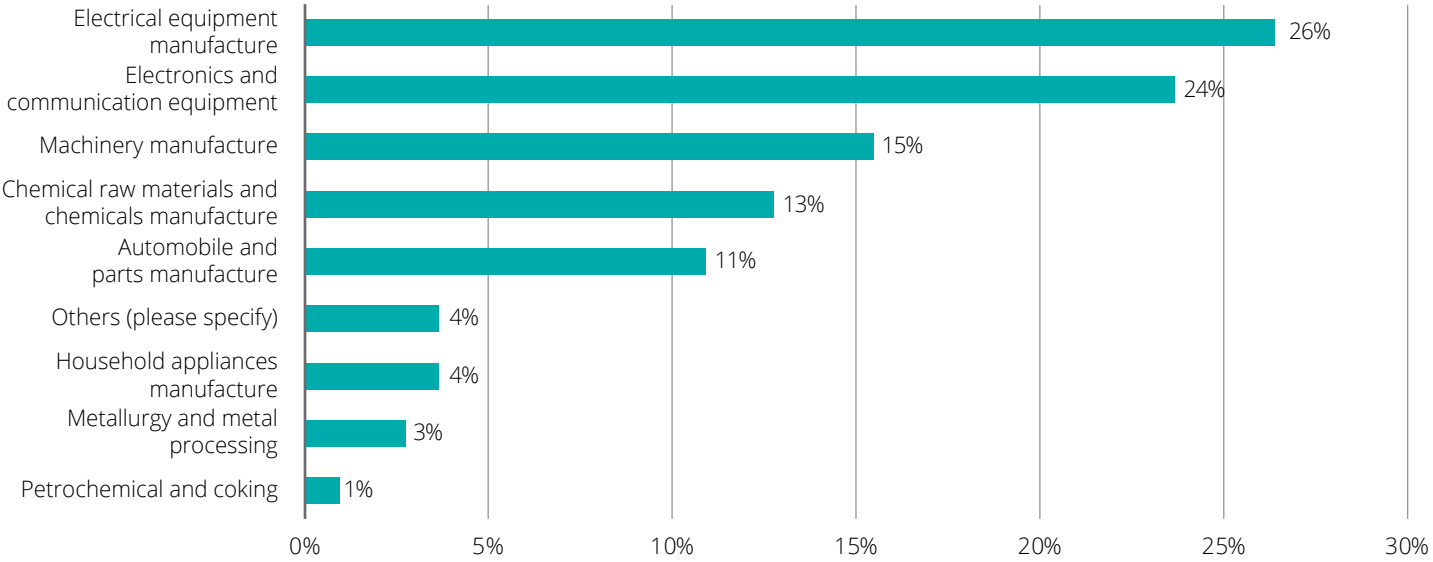


Source: 2019 Deloitte survey on AI adoption in manufacturing

About the report

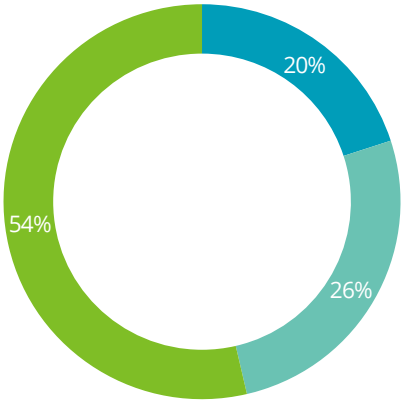
For a better understanding of the actual status and trends of AI adoption in manufacturing, Deloitte selected 110 large and medium-sized companies from the Top 500 Chinese Manufacturing Companies, and conducted a survey with the senior management and interviewed the representative companies.

Industries in which the surveyed companies operate



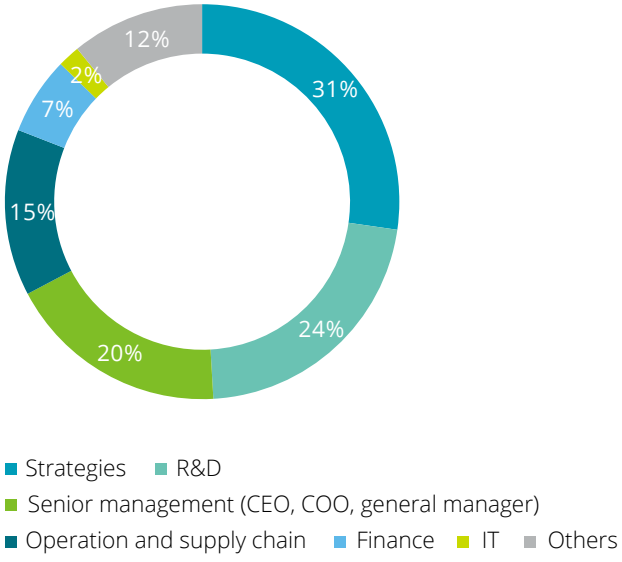
Source: 2019 Deloitte survey on AI adoption in manufacturing

The number of employees of the companies surveyed



Source: 2019 Deloitte survey on AI adoption in manufacturing

Functions of the employees surveyed



Source: 2019 Deloitte survey on AI adoption in manufacturing

End Note

[1] India's National Strategy for AI http://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-AI-Discussion-Paper.pdf

[2] AI Singapore, https://www.aisingapore.org/

[3] Budget 2018: Government seeks to boost Australian AI capabilities, May 8, 2018 https://www.computerworld.com.au/article/640926/budget-2018-government-seeks-boost-australian-ai-capabilities/

[4] "Global AI Talent Report 2019", jfgagne, https://jfgagne.ai/talent-2019/

[5] AI researchers refer to those who published papers on AI journals or obtained AI related patents during 2007-2017.

[6] H-Index is provided by Google Scholar and DBLP, refers to the number of papers whose citations are more than or equal to H, which is a metric to measure the productivity and research impact of a scientist.

[7] The proportion of Ph.Ds in AI researchers who published papers at 21 of the top academic conferences in the AI field.

[8] The right way to be introduced to the Internet of Industry (13)—scheduling optimization, industry intelligence officer, https://m.ydaobo.com/wenzhang/50355.html

[9] "The impact of AI on user experience", AI Reshapes Design, March 4, 2018, http://www.woshipm.com/ucd/970109.html

[10] "Next Level AI—Powered by Knowledge Graphs and Data Thinking" Siemens China Innovation Day, Michael May, May 15, 2019

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