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Levelling Up: China's race to an autonomous future

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KPMG China Future 50 Ranking Series

汽车科技
Autotech

Contents

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Executive Summary

Norbert Meyring
Automotive Sector Head
KPMG China

Autonomous driving will transform China's transportation landscape

China's autonomous driving (AD) industry has grown rapidly over the last ten years as the country aims to become a global leader in the most advanced segments of automotive technology. As a result, the major gaps – investment, technology, and talent – are narrowing between China and other nations developing autonomous driving vehicles and supporting technologies. As the world's largest auto market since 2009 delivering half of world's electric vehicles, Chinese autonomous driving technology and companies are globally competitive.

Autonomous driving is considered the crown jewel of automotive intelligence, an intricate melding of artificial intelligence, user-centric design, and sophisticated manufacturing. Full autonomous driving will transform the automobile from a purely mechanical product to what is frequently referred to in China as the 'mobile third space'. This ongoing transformation is already changing the value chain of the automotive industry and will create a broadened transportation ecosystem. Once realised, true autonomous driving will transform our concepts of mobility, logistics, and other areas of our personal and professional lives.

Significant challenges remain on the road to autonomous driving. Despite the great potential of autonomous driving in ensuring road safety and traffic efficiency, we are several steps away from the ultimate goal of fully autonomous vehicles. The challenges are diverse: technological barriers on perception technologies and governing algorithms, a regulatory environment which is slow to change and based on a pre-defined set of rules and technologies, and the high cost of manufacturing and operating autonomous vehicles and components. As a result of these challenges, market participants are pursuing different approaches to the development and commercialisation of autonomous driving technologies.

Some firms – including many car makers - are adopting an incremental approach, first embracing low- to mid-level autonomous driving and driver assistant systems (L1 to L3) for eventual application in the mass market. Deploying driver support technologies on a large scale allows automakers to collect data and upgrade their own research and development capabilities before upskilling to higher level autonomous driving. Some firms – including many technology companies - are jumping directly to higher level autonomous driving (L4 or higher), taking a more disruptive approach. These technology companies may partner with car companies or ride-hailing platforms to test sophisticated components or software without developing their own vehicles.

There is no consensus on a 'correct' model of AD development – whether ambitiously disruptive or conservatively incremental. After a late and tumultuous start in China, AD technology companies are setting more rational development targets and timelines. Beginning in 2014 and peaking in 2017, the number and value of investments into China's automotive sector soared. Companies, even those outside of the automotive industry, set goals to develop and commercialise autonomous-capable vehicles within several years, less than half the time of development of a conventional mass market vehicle. Many of these companies subsequently failed, with the products they "developed" existing in concept only. Now, as a second phase of investment flows in, investors have been more rigorous in their due diligence while AD companies have been more pragmatic. This second phase of development focuses on making cars smarter, testing fleets of autonomous driving vehicles on open roads, and solving real-world problems with clear commercial objectives. Most autonomous driving scenarios are at an early stage of commercialisation and unprofitable current scales. However, all scenarios including Robotaxis are steadily moving from the test track to the open roads.

One thing is clear – China remains committed to the development of autonomous driving and policies will demonstrate this support. With the current stage of technological development, record levels of funding, and a strong talent pipeline, a majority of executives polled in the KPMG 2021 Global Automotive Executive Survey (GAES)[1] believe that fully autonomous vehicles will be operating on roads in China by 2030.

In this report, we summarise the status quo of China's autonomous driving market and explore AD scenarios including Robotaxis and Autonomous line haul trucking. Integrated throughout are observations from a wide range of industry experts and senior automotive industry executives.

1. *KPMG International, Global Automotive Executive Survey 2021, November 2021*

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KPMG China's Leading Autotech 50 Fifth edition - Innovators in Autonomous Driving

Companies are arranged in alphabetical order based on their Chinese pinyin names

China's Leading Autotech Innovators

Benewake
Neusoft Reach
FABU
Freetech
Hesai Technology
HYPERVIEW
WHST
RoboSense
WeRide
Pony.ai
CIDI
ZVISION
Inceptio Technology
MINIEYE
DeepRoute.ai
UISEE
Plus
Waytous
Zongmu Tech

China's Emerging Autotech Innovators

Chuhang Technology
HAOMO.AI
G-PAL
LiangDao Intelligence
MaxSense
MOTOVIS
QCraft
SENIOR.AUTO
TAGE Idriver
UDI
Metoak
MAXIEYE
iMotion Automotive
Trunktech

Attention: The featured company profiles of these start-up are based on information submitted by the Autotech candidates and on interviews conducted by KPMG with their senior executives. This list is neither a complete market screening nor an exhaustive listing of companies in the automotive market. The authors of the China Leading Autotech 50 aim to enhance the attention given to technological innovation in China's automotive sector and to promote industry communication. This publication is not an evaluation of the compliance or creditworthiness of these companies nor an endorsement of the company or their business model. The contents should not be construed as providing investment advice.

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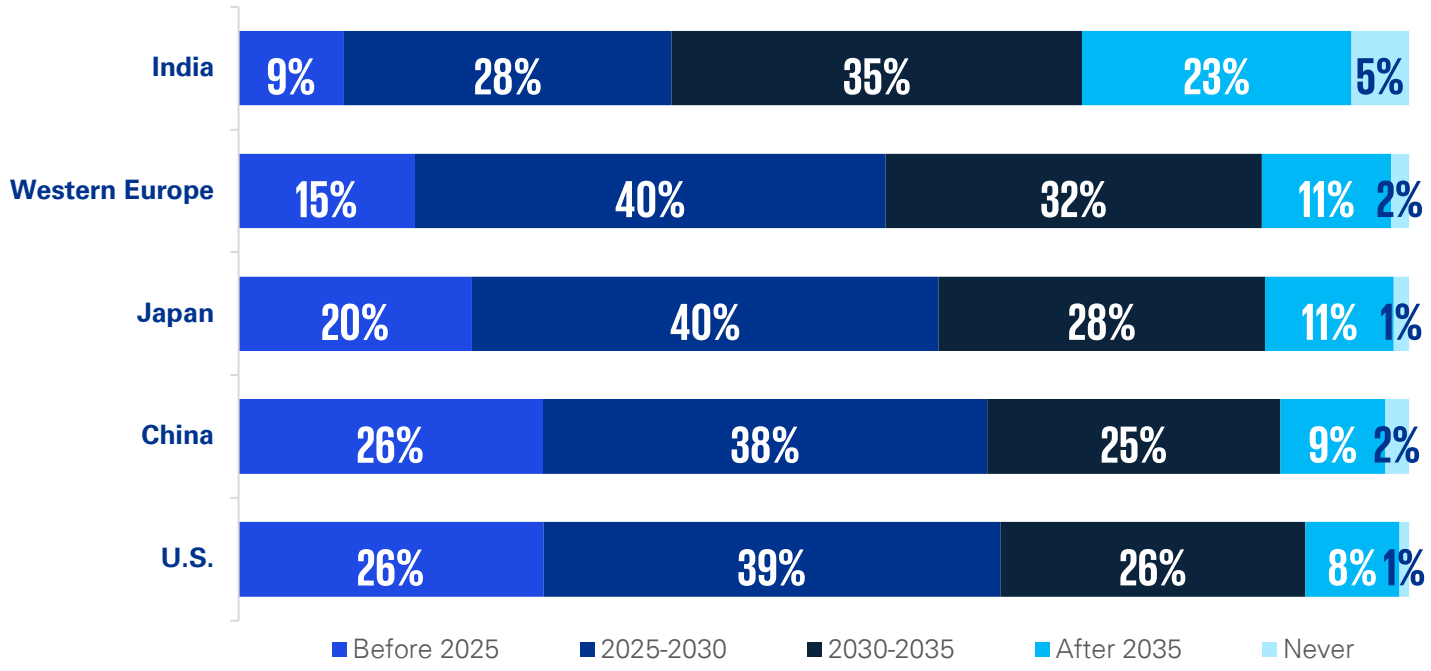
Pathways to Autonomous Driving

Autonomous driving mass commercialisation is expected to be realised by 2030 in major cities of China

The industry is likely to see mass application of autonomous driving around 2030 in major cities in China, according to KPMG research. Autonomous vehicles are likely to enter the market in the coming decade in the form of ride-hailing or delivery vehicles. Based on GAES[2] research, 64 percent of executives believes that autonomous driving shared vehicles and shipment service vehicles will be commercialised by 2030 in China's main cities.

In terms of government-established targets, mass adoption of autonomous driving vehicles is expected be realised in select cities in China by 2030 and in most regions by 2035. China Industry Innovation Alliance for the Intelligent and Connected Vehicles (CAICV) published China Intelligent Connected Vehicle Technology Roadmap 2.0 (Technology Roadmap 2.0) in 2020 to provide market guidance. According to the report, sales of vehicles with partial autonomous driving and conditional autonomous driving will exceed 50 percent of total vehicle sales by 2025. Moreover, the equipped rate of Cellular Vehicle-to-Everything (C-V2X) in new vehicles will be 50%. High-level autonomous driving will be commercialised firstly in specific scenarios and limited areas and will be continuously expanded in years ahead. By 2035, the country plans to have popularised all types of high-level autonomous driving vehicles in most regions across the country.

Figure 3.1 – When do you believe autonomous ride hailing and / or delivery will be commercially available within major cities in the following markets?



Source: GAES 2021, KPMG International

2. KPMG International, Global Automotive Executive Survey 2021, November 2021

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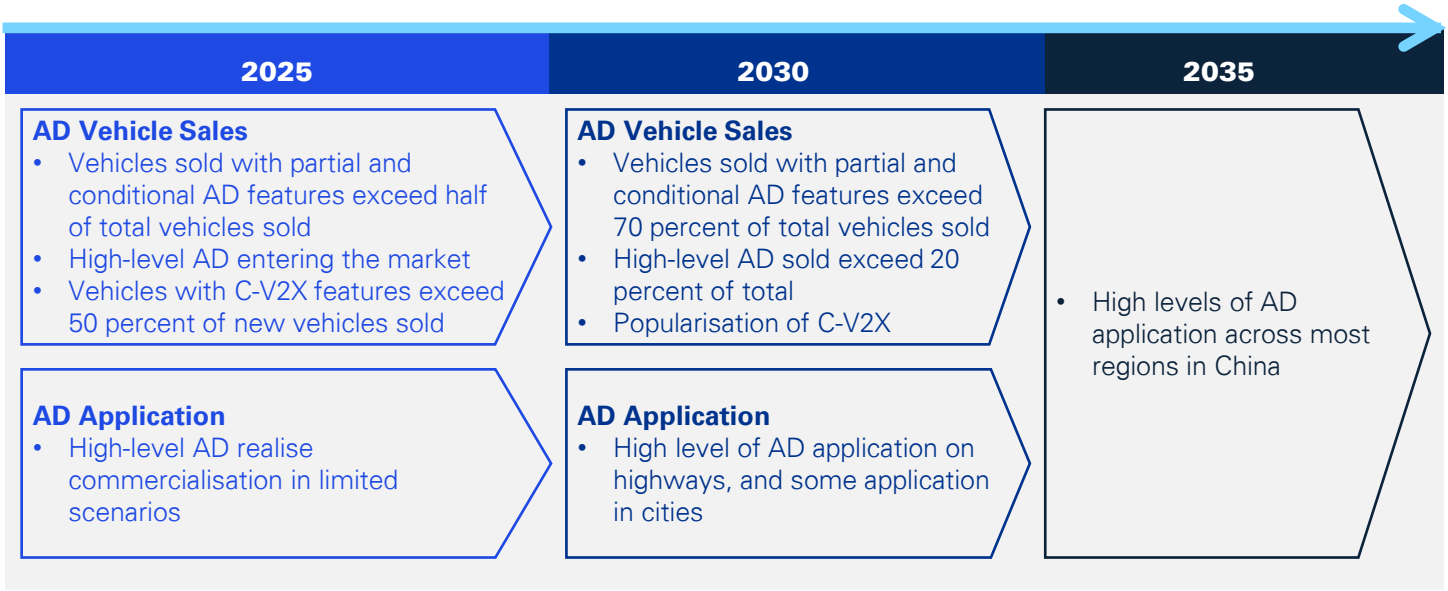
Figure 3.2 – Goals for China's intelligent and connected vehicle development



Source: CAICV[3]

> With the development of China's new infrastructure in the transportation sector, the development of V2X will be accelerated. This will encourage the achievement of full autonomous driving and improve driving safety."
>
> **- Wei Ma**
> *Co-founder and General Manager*
> *CIDI*

Commercialisation of autonomous driving in China still faces numerous challenges

Ideally, autonomous driving transformation would mean a complete and instantaneous replacement of human drivers by autonomous vehicles. In reality there will be a challenging transitional period characterised by evolving regulations, technology, customer acceptance, and cost.

Standards and regulations urgently need to be strengthened. Internationally, policy and standards continue to be promulgated, including: the Automated Vehicles 3.0[4] in the United States, the Connected Automated Driving Roadmap[5] in Europe, and the Guideline regarding Safety Technology for Automated Vehicles[6] in Japan.

China has been slower in publishing autonomous driving regulations and legal frameworks. The governing laws, collectively the Law of the People's Republic of China on Road Traffic Safety, regulate vehicles and their human drivers. As a result, autonomous vehicles can only conduct test drives on legal "test roads", which limit developers understanding of real-world driving conditions. More significantly, understanding liability and responsibility under autonomous driving scenarios remains unclear when

3. *CAICV, China Intelligent Connected Vehicle Technology Roadmap 2.0 published in Beijing, November 2020*
4. *U.S. Department of Transportation, Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0), October 2018*
5. *ERTRAC, Connected Automated Driving Roadmap, March 2019*
6. *MLIT Japan, Guideline regarding Safety Technology for Automated Vehicles in Japan, September 2018*

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> Car makers in China continue to invest in their digital capabilities. In some cases, separate divisions or brands are being established to allow for more autonomy in advanced product development."
>
> **- Luther Kang**
> *Partner*
> *Deal Strategy & M&A, KPMG China*

accidents happen. Moreover, highway law and insurance law currently do not include provisions for autonomous driving.

In terms of technology, there is an urgent need for breakthroughs. The technology of intelligent connected vehicles is developing rapidly. L1 and L2 autonomous driving are being deployed on an increasingly large scale. In some specific scenarios, autonomous driving systems have already reached a high level of sophistication. Domestic companies have made considerable progress on system integration into vehicles, but key technologies, such as sensors and governing algorithms, need to be improved.

The acceptance of intelligent connected vehicles by society is still evolving, in part due to price concerns. According to previous GAES surveys[7], early customer acceptance of autonomous driving functionality is higher in China than in most other countries. However, many of these technologies are relatively expensive compared to other premium features, causing vehicles to be unaffordable for many customers. As a result, the pace of growth in the autonomous driving industry has been slowed.

Autonomous driving systems rely on mobile data networks, smart roads and cloud computing, building on existing trends of infrastructure upgrading. China's digital infrastructure is already highly sophisticated, and China is now entering a phase of developing smart traffic infrastructure. These systems require a significant investment in both capital and deployment time. Moreover, commercialisation for sustainable operation and upgrading of this infrastructure will also be a challenge for future consideration.

Vehicle types and scenarios are the main factors influencing the commercialisation speed of autonomous driving. Different types of vehicles have different commercialisation. Full autonomous ride hailing services are at the high end of the complexity spectrum. They require high levels of security, well-defined policies, and heavy cross sector investment. On the lower end of complexity, cargo-carrying vehicles in closed operating environments are easier to commercialise since safety requirements are not as complex and regulations already exist or are more readily revised.

> The future transportation mode in China will aim to improve the efficiency of the whole transportation system, not just focus on personal travel."
>
> **- James Yu**
> Co-founder and CEO, QCraft

7. *KPMG International, Global Automotive Executive Survey 2020, June 2020*

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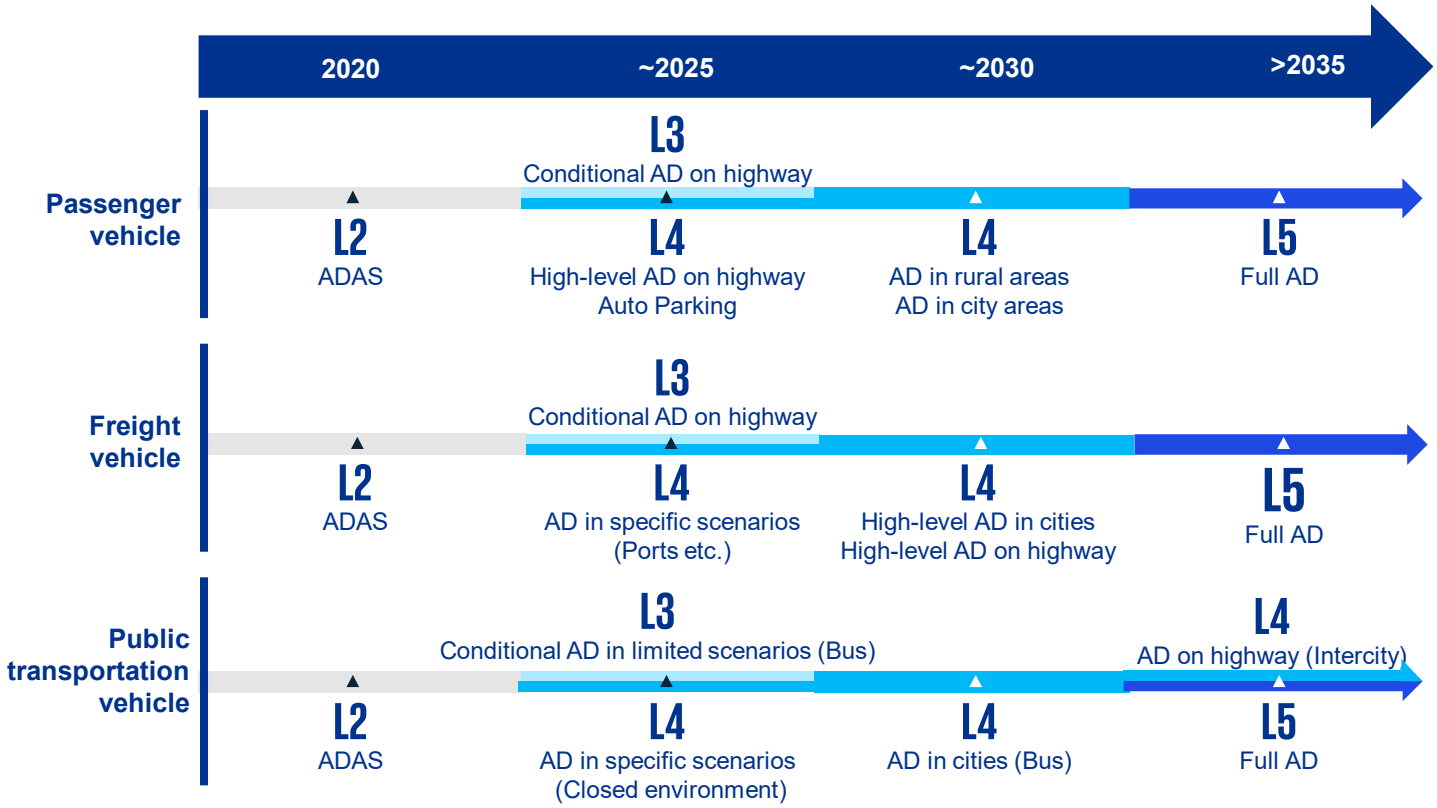
Figure 3.3 - Diverging development path



Source: CAICV[8] , KPMG analysis

Cooperation between multiple parties has already formed in the industrial chain of autonomous driving

Traditionally, there has been an iterative development cycle, led by the OEMs, which dictates the paced evolution of vehicle technology. Early developments of autonomous driving technology, including most ADAS solutions, have followed this incremental approach. Primary considerations are market competition, cost, safety, vehicle portfolio and potential sales impact. Some OEMs use turnkey solutions provided by suppliers: radar, chassis, cameras, computing units, and the software to integrate them. However, the latest generation of pure New Energy Vehicle (NEV) auto makers are taking a more aggressive stance on autonomous driving development. They tend to develop their own autonomous driving systems, push innovation into their supply base, and avoid obsolescence through frequent over-the-air (OTA) updates. This has disrupted the established relationships between major players in the industry, and has attracted new interest from cross-sector players, particularly technology companies.

> “As the significance of vehicle software increases, the interest in developing advanced automotive software increases to match. We see more and more start-ups and tech company crossovers developing software in response to growing demand and to match China’s unique software environment.”
>
> **- Thomas Bailey**
> *Associate Director,*
> *Automotive Sector Executive*
> *KPMG China*

8. *CAICV, China Intelligent Connected Vehicle Technology Roadmap 2.0 published in Beijing, November 2020*

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The competitive landscape of the automotive industry is transforming. Cooperation is becoming common practice in across all areas of the automotive ecosystem, and is accelerating the popularisation of AD. We believe that OEMs, tech firms and suppliers will prioritise establishing new partnerships to accelerate AD development. The benefits are many: decreased development costs, shortened technology innovation cycles, increased competitiveness, and increased influence in defining autonomous driving system standards, etc., and all support further alliances between technology companies, OEMs, suppliers, and start-ups. The result: tech firms have entered the autonomous driving supply chain and secured positions as tier 0.5 suppliers with advantages in hardware chips, software and algorithms.

Figure 3.4 – The industrial chain of autonomous driving

Table is for illustrative purposes only. Companies are arranged in alphabetical order based on their English names.

Source: Oriental Securities, KPMG analysis

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The acceleration of Level 2+ & Level 3 ADAS mass adoption

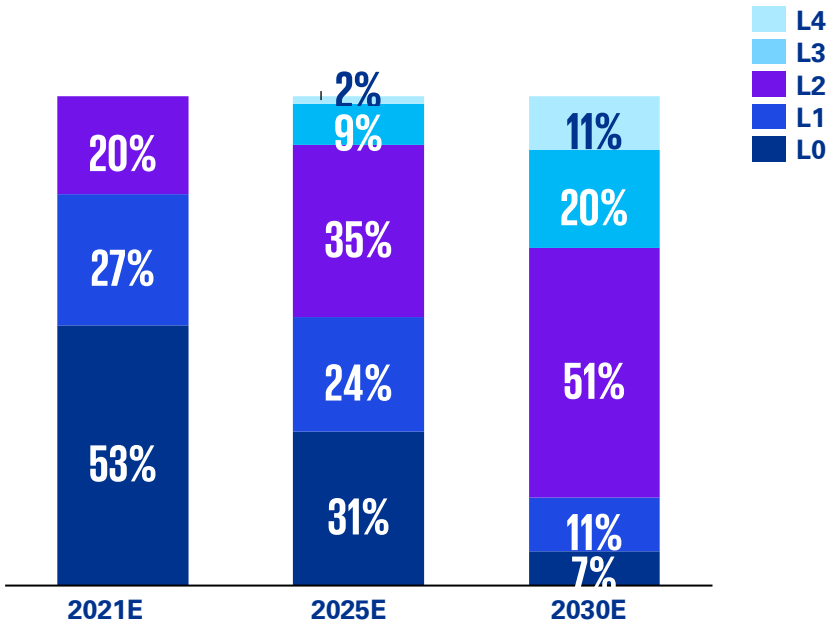
Market dynamics of ADAS development

The penetration rate of ADAS systems have increased rapidly, and still have a lot of growth potential in the future. China is currently in the stage of advancing from assisted driving (L1) to semi-autonomous driving (L2+), which will firstly let ADAS to be popularised as a transitional product. At present, L2 advanced assisted driving technology is maturing, and the penetration rate is gradually increasing. The Technology Roadmap 2.0 has clearly stated that by 2025, the sales of L2-L3 intelligent connected vehicles will account for more than 50% of the total car sales in that year, and by 2030, this proportion will exceed 70%. KPMG estimates that the 2025 target laid out in the Roadmap is achievable, and that penetration of L2 and above be approximately 50%.

Autonomous driving technology is rapidly developing to L3, and it is expected that 2022 will be the start of mass production of L3 vehicles. NEVs are encompassing more technology value-added features meeting requirements of target customers. Moreover, with numerous new vehicles with autonomous driving systems being released, the penetration rate of L3 is expected to continuously increase. In addition, the development of NEV companies and increasing customer acceptance are contributing to the rising penetration rate of L3.

> We are at the cusp of much higher rates of adoption of mid-level autonomous driving in China. Vehicles with L2 or L3 capabilities are becoming more widespread and more affordable."
>
> **- Andrew Ji**
> *Partner*
> *Head of Advisory – Automotive Sector*
> *KPMG China*

Figure 3.5 - L0-L4 penetration rate projection in new vehicles sales in China



Source: IHS Markit

Most ADAS features are expected to become more popular. The penetration rate of almost all ADAS features are expected to increase in the next few years[9], especially Multi-View Camera Systems, Autonomous Emergency Braking and Adaptive Cruise Control - three features that will be used heavily in future autonomous driving systems. As such, the penetration rate of Cruise Control will decrease as this feature will be replaced by Adaptive Cruise Control.

9. Soochow securities, Software Defined Vehicles, ADAS is Developing Acceleratingly, May 2020

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Figure 3.6 - ADAS features penetration rate forecast

Features	2020	2022E	2025E
Multi-View Camera System	28.8%	40.8%	51.8%
Adaptive Driving Beam	25.8%	35.8%	47.8%
Lane Departure Warning	30.7%	40.7%	49.7%
Lane Changing Assist	25.2%	31.2%	36.2%
Traffic Sign Recognition	11.0%	21.0%	32.0%
Rear Cross Traffic Alert	16.6%	26.6%	37.6%
Cruise Control	40.5%	25.0%	5.0%
Lane Keeping Assist	23.3%	33.3%	48.3%
Autonomous Emergency Braking	41.7%	53.7%	69.7%
Adaptive Cruise Control	27.0%	43.0%	69.0%

Source: Autohome, Soochow Securities

ADAS technology is an important stepping stone for the popularisation and commercialisation of AD

Before 2019, vehicle with L2 ADAS systems only appeared in vehicle with a price range above RMB 350 thousand. However, since 2020, L2 ADAS systems started to be installed in middle end vehicle, and even in low end vehicle with a price range between RMB 100 to 150 thousand. ADAS, as the first step towards autonomous driving, will be the gateway technology that must educate and build trust with drivers, passengers, and regulators. Customers will only accept autonomous driving in the future if ADAS can firstly be proven safe and convenient. For OEMs to reach a broad market, they must adopt intelligent technologies to attract consumers in the midrange and lower-end vehicle markets to prepare users for higher levels of autonomous driving.

Factors driving the accelerated adoption of Level 2+ ADAS

- Policy regulation of Level 3 ADAS use case to be launched in 2023

  Since 2017, the Ministry of Transportation published several policies for commercial use vehicles to improve safety and reduce accidents. Some ADAS features like Lane Departure Warning, Autonomous Emergency Braking, and Forward Collision Warning have become standard features equipped in commercial use vehicles. ADAS features have also become an important element in passenger vehicles. In the latest China-New Car Assessment Program (C-NCAP)[10], several features like Autonomous Emergency Braking, Lane Keeping Assist, Blind Spot Detection etc. have become elements in the assessment of new cars. These advanced features comprise 80% of the active safety system score, which now contributes 25% of total C-NCAP safety score. Previously, the active safety system score only contributed 15% of the total safety score, highlighting the growing importance of ADAS in vehicle safety.

10. *China Automotive Technology and Research Center Co., Ltd, C-NCAP Management Regulation, 2021*

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In March 2021, the Ministry of Public Security of China sought public advice for revisions to road-traffic safety laws[11], which clarified the requirements for autonomous driving vehicle road tests and how to determine fault when accidents occur due to traffic violations. This is the first time that such regulations have been published at the national level, and it can be expected that these will help to address gaps in current regulations related to the autonomous driving industry. Building on these regulations, we expect more comprehensive regulations to be published in 2023.

Undoubtedly, safety-related technologies, safety standards and new car assessments will continue to be developed and be globally aligned. Looking at overseas markets, the new car assessment programmes in Europe and US evaluate more ADAS features that increase the safety of new vehicles. As a result, ADAS features are developing from optional to standard features. 20 automobile manufacturers in the US will consider Autonomous Emergency Braking as a standard feature by September 1, 2022[12].

- Level 2+ ADAS technology maturing and cost decreasing for wide-scale applicability

  The cost of ADAS hardware has decreased in recent years as the technology matures. For example, the price of lidar was an early obstacle to its use. The equipment was traditionally used in industrial manufacturing, where unit cost was less of a factor. However, solid state lidar has replaced traditional lidar scanners, significantly reducing the cost. Moreover, as autonomous driving systems will continue to be popularised in the future, demand for lidar will increase and manufacturing processes will benefit from economies of scale, provided the technology remains competitive. With new emerging high potential lidar technologies like OPA and Flash lidar, we expect lidar to remain technologically and economically competitive. Domestic and global lidar companies have already announced significant cost reductions over the past several years.

  There are two main types of perception systems for autonomous driving – a) cameras with millimetre wave radar, and b) lidar with the support of camera and radars. Both approaches are already used in mass production. Most automotive manufacturers are using the second approach to realise ADAS features, as they consider the accuracy to be the paramount concern. Since algorithms cannot fully offset the low quality of collected data from standard sensors, lidar has an irreplaceable advantage in advance autonomous driving system. Moreover, as lidar technology is maturing, not only has its cost decreased but it can also deliver better performance from smaller-size sensors. Therefore, it is expected that lidar integration will be the future trend for ADAS systems.

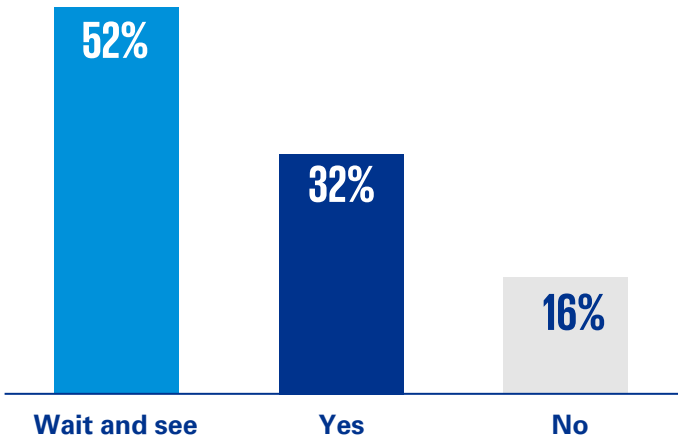
- High proportion of clients are willing to pay for ADAS

  Rising customer willingness to pay for autonomous driving features is one of the key drivers of autonomous driving development. A customer survey conducted by Yiche Research in late 2021[13] reflects this trend:

  - Nearly one-third of customers are willing to pay a premium for autonomous driving related features
  - More than 50% of customers are waiting to see how autonomous driving technology develops, indicating their likelihood to become future customers if the technology becomes mature and safer.

> "In 2022, LiDAR will enter the stage of large-scale mass production together with the commercialization of L3 level ADAS systems. The scale will expand rapidly in the next five years."
>
> **- Yifan Li**
>
> *Co-funder and CEO, Hesai Technology*

Figure 3.7 – Customer willingness to pay for vehicles with AD features



Source: Yiche Research

11. The Ministry of Public Security, China Solicits Public Opinion on Revised Road-traffic Safety Law, March 2021

12. U.S. Department of Transportation, NHTSA-IIHS Announcement on AEB, December 2017

13. Yiche Research, Customer Survey on Autonomous Driving, October 2021

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- Tech companies are cooperating with OEMs to accelerate series production of autonomous driving private vehicles

  Since the commercialisation of fully autonomous driving vehicles is still in testing stage and won't be realised in the short-term, technology companies realise the necessity of cooperation with successful OEMs to develop L2+ and L3 vehicles in series production:

  - Through the development of ADAS solutions for OEMs, technology companies can generate ADAS solution revenue to sustain their operations and fuel R&D into areas like chip development, where existing processing speeds are able to manage L4 autonomous driving
  - Data collected from sold ADAS vehicles will also help technology companies to improve their L4 algorithms

  Therefore, with cooperation between technology companies and OEMs ADAS adoption in vehicles is likely to be accelerated as OEMs continue to offer more available ADAS features.

> "The combination of multiple types of sensors is a trend. Apart from the lowering cost, the mass production of domestic millimeter wave radar will provide better data support for companies in the value chain."
>
> **- Yongyan Chu**
> *CEO, Chuhang Technology*

Figure 3.8 – Cooperation examples between technology companies and OEMs

Year	Announcement
2021	Joint-venture between Momenta and BYD to co-develop advance autonomous driving technology
2021	Strategic alliance between GAC Group, WeRide and Ruqi Mobility to develop Robotaxis
2021	Strategic alliance between Baidu and Great Wall to produce Auto Valet Parking vehicles

Source: Press releases from company websites accessed April 2022, KPMG analysis

- Traditional OEMs & New forces actively promoting L2+ ADAS vehicles

  Among OEMs, new players have adopted more aggressive autonomous driving adoption plans as compared to traditional OEMs. This has accelerated the AD development plans of both traditional international and domestic OEMs.

  New players, like Tesla, NIO, XPeng, etc., are aiming to establish a reputation as market leaders in the market for AD technology. Traditional Chinese OEMs are responding by adopting a "self-developed software + embedded hardware" strategy. Equipping vehicles with cameras, millimeter wave radar, ultrasonic radar, and even laser radar before delivery can improve autonomous driving capability through subsequent OTA updates.

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New ADAS monetisation models emerging with significant potential

OEMs have also found new potential revenue streams through new monetisation models of autonomous driving services. They have started to charge customers either a one-time payment, or on a recurring basis.

Figure 3.9 - Paid services for ADAS have become a new growth point for OEM revenue

Company	Model	Solution	One-time payment	Subscription	Price[1] of the vehicle with AD	AD as a % of total price
XPeng[2]	P5 550P	X Pilot 3.5	25,000 RMB, if paid before delivery, 45,000 RMB thereafter	/	231,500 RMB	10.80%
	P5 460E+	X Pilot 3.0	20,000 RMB, if paid before delivery, 36,000 RMB thereafter	12,000 RMB/year, free after 3 years	209,240 RMB	9.56%
NIO	ET7	NAD	/	680 RMB/month	448,000 RMB	/
	EC6	NIO Pilot	Full package 39,000 RMB	/	407,000 RMB	9.58%
Li Auto	One	AD	/	/	349,800 RMB	/[5]
Tesla	Model 3	FSD	64,000 RMB	199 USD/month[3 4]	354,988 RMB	18.03%

1: Total price is calculated excludes NEV subsidies, as of April 2022, 2: XPeng: Total price calculated assuming AD features payment before delivery, 3: Not available in China as of April 2022, 4: New customer 199USD/m, old customer 99USD/m, 5: Include in total price, AD price not available

Source: Official websites, KPMG analysis

One-time payment or subscription models are most popular choices across regions in China. However, as the market develops from ADAS to fully autonomous driving, OEMs & mobility providers are likely to experiment other monetisation models (e.g. pay by mile or by trip, etc.) that will eventually disrupt the traditional automotive value pool.

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Deep-dive on two key scenarios – Robotaxi & Autonomous line haul trucking

Of all the scenarios, these two are estimated to have the largest market size in the future and attract the most public attention.

Figure 3.10 – Autonomous driving core niche scenarios

Scenario	Description	Vehicle type	Technology
Robotaxi	Complex environment, borderless environment with high speed variance	Passenger vehicles	**L4** AD in rural areas AD in city areas AD in highway
Autonomous line haul trucking	Well-defined environment along major trucking routes with steady, high speed	Heavy duty trucks	**L4** High-level AD in cities High-level AD in highway
Port vehicles	Closed environment with low speed and well-defined interactions	Container transporter	**L4** AD in limited scenarios
Mining vehicles	Closed environment with low speed and well-defined interactions	Dump trucks	**L4** AD in limited scenarios
Last-mile delivery	Relatively closed environment with low speed	Unmanned delivery vehicles	**L4** AD in limited scenarios

Source: KPMG analysis

> We are yet to enter the latter half of the autonomous driving race. Instead, we are at the end of the beginning, as we move from AD pilots into mass commercialisation."
>
> **- Gansha Wu**
>
> *Co-founder and Chairman CEO, UISEE*

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Robotaxi to realise mass commercialisation near 2030

- As the capstone of autonomous driving, Robotaxis are the most promising autonomous driving scenario

  As Robotaxi technologies mature, so will the market. By the end of 2020, there were 365 million users of ride-hailing services, occupying 36.9 percent of total internet users[14]. According to IHS Markit projections, China's driverless Robotaxi market is expected to reach RMB 1.3 trillion by 2030[15]. This will be a new market and a major disruption as taxis and ride sharing vehicles can be replaced by Robotaxis. Moreover, we expect that Robotaxis will cannibalize some of the private vehicle market, particularly in urban centres.

- Robotaxi gained significant improvement in recent years but are still restricted

  Robotaxis have gained improvement in recent years. Beijing announced opening the country's first commercial autonomous driving pilot on November 25, 2021[16]. This marked the first time a mega city in China gave the green light to commercial Robotaxi test. Baidu, Pony.ai, and others have conducted test runs in some major cities like Beijing and Shanghai. Further, some areas of Beijing Yizhuang are allowing customers to order and pay for Robotaxis by mobile phone app. Most Robotaxi services are only available only between specific locations. In the fourth quarter of 2021, 213,000 passengers[17] took Baidu's Apollo Go, nearly doubling from the previous quarter.

  There are still some bottlenecks that are currently unavoidable. Technology companies currently own the most sophisticated autonomous driving systems, but security drivers are still needed if the system cannot effectively respond to an unexpected situation. This is expected to change in the short term in some pilot cases. Moreover, the areas that currently allow Robotaxi testing are much less complex than normal urban roads. Therefore, technology companies have slower accumulation of representative data to improve their algorithms for normal urban roads, making it harder for them to develop L4 systems. Equally, the lack of data and lack of sufficient testing on urban streets makes new regulation that would permit Robotaxis to drive on normal streets more difficult to implement.

- As policies and technologies continue improve, the long-term outlook for Robotaxis is bright

  Technology is also improving to improve decision-making in autonomous driving vehicles. Intelligent vehicles depend on chips with high computing power. ADAS sensor technologies are maturing, including more advanced chips that can process huge amounts of data to make appropriate decisions while operating. Some leading companies provide full-stack solutions including chips, algorithms and sensors. In addition, software like high-precision maps have also seen significant improvement in the last several years. By 2021, 28 Chinese enterprises have the qualifications required for high-precision mapping. Further, 5G infrastructure can give vehicles a higher network speed enabling them to transmit data almost instantaneously.

  Currently, the Chinese government is attaching importance to the V2X approach toward autonomous driving nationwide. In the innovative development strategy for smart vehicles issued by 11 Chinese ministries[18] goals about smart transport systems, coverage of wireless communication networks for vehicles such as LTE-V2X, 5G-V2X have been set.

> The purpose of Robotaxi commercial pilots is not only to show cars without real drivers, but to provide high-quality mobility service with AD and strengthen customers' confidence with on-road trials. Safer-than-human driving is the minimum threshold for society to accept autonomous driving. This is a standard the industry needs to achieve together. The basis of mass application and commercialisation of AD is strong technical capability"
>
> **- James Peng**
> *Co-founder and CEO, Pony.ai*

14. China Internet Network Information Center, The 47th China Statistical Report on Internet Development, February 2021
15. IHS Markit, Prospect of China's Autonomous Driving and Future Mobility Service Market, 2021
16. Beijing Daily, Announcement for Autonomous Driving Commercial Pilot in Beijing, November 2021
17. China Daily, Baidu to Launch Self-driving Taxi Service in Zhejiang, March 2022
18. National Development and Reform Commission, The Innovative Development Strategy for Smart Vehicles, 2020

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- Tech firms are currently the main driving force in the Robotaxi field

Cooperation between tech firms, ride-hailing firms and car companies has become common practice in the Robotaxi industry. Autonomous driving companies need auto firms' manufacturing experience and ride-hailing platforms to gather massive data for autonomous driving algorithm development. Meanwhile, automakers need better autonomous driving algorithms to upgrade mass-production vehicles and only a few are investing in their own Robotaxi services. In addition, third parties providing ride-hailing services are also preparing for the Robotaxi market, but they still need time to improve their technology and manufacturing capabilities to be ready for the future market.

Tech firms are currently the main driving force in the Robotaxi field. Tech firms are often light-asset, with business models focused on quick adoption of new technology trends. OEMs are engaging in the Robotaxi business mainly through cooperation with autonomous driving firms. For example, the ride-hailing platform SAIC Mobility partnered with Momenta to launch the SAIC Mobility Robotaxi[19] .

There are more than 10 players in China developing Robotaxis, including technology companies, tech start-ups, OEMs and ride-hailing companies. The current major measures of an enterprise's Robotaxi capability are the scale of their fleet, their operating area and their number of users. In terms of the fleet size and deployment progress, Baidu has taken the lead in this market with far more tested mileage and the largest fleet size. Early successes are dependent on receiving a license, so companies are working very closely with authorities throughout their development cycle.

- Robotaxi is operating at high speed and the commercialisation in open environments expected by 2030

The next step for Robotaxi? More testing. Before April 2022, Robotaxis could only drive at limited speeds and still need a safety driver to be present. However, as Baidu and Pony.ai obtained the first batch of permits for driverless Robotaxis in China[20], Robotaxi testing has advanced to a new stage. The next step will be to develop L4 autonomous driving which will allow Robotaxis to drive at higher speed in more complex environments. Achieving this not only requires supportive policies and advanced technology, but also sufficient testing to collect sufficient data used to improve algorithms and ensure the systems are safe for use on public streets. Therefore, the next step for technology companies to improve systems is extensive test driving.

> "With the high adoption rates of ride-hailing in China, the interest in developing Robotaxis by the ride-hailing operators is very high. They already have a very large user base, large fleets for testing, and are data-driven companies at their core."
>
> **- Zhe Tong**
> *Associate Director, Automotive Business Development*
> *KPMG China*

19. *SAIC Mobility, SAIC Mobility Robotaxi Land in Suzhou, December 2021*
20. *CGTN, Baidu, Pony AI granted China's first driverless Robotaxi permits in Beijing, April 2022*

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Autonomous line haul trucking estimated to realise mass commercialisation by 2030

- A big and promising market

  According to China's National Bureau of Statistics, there were 8.4 million of heavy-duty trucks in China by the end of 2020[21], all of which have the potential to be replaced by autonomous driving heavy-duty trucks in the future. KPMG estimates that the average labour cost per truck (typically requiring two drivers) is nearly RMB 300,000 per year. China's Ministry of Transport also stated that as of 2020, there were over 17 million truck drivers across the country. In KPMG's view, this represents great potential in labour cost savings if autonomous trucks can be applied to the market. In addition, intelligent driving systems can also maximise fuel efficiency of vehicles, providing additional savings to businesses.

> "Successful AD companies in logistics must continue to invest in vehicle-grade, mass production oriented full-stack development. This will create value for logistics users with excellent products and will promote the scaling up of the autonomous driving freight network."
>
> **- Julian Ma**
> *Founder and CEO, Inceptio Technology*

- Autonomous line haul trucking enters the road test stage

  Autonomous line haul trucking has taken the first step towards commercialisation. Technology companies like Inceptio Technology and Plus have already begun to scale production of L3 autonomous driving trucks and are carrying out commercial shipping operations. Compared to other applications such as mining and ports, L4 autonomous driving for line haul trucks requires more sensing and computing capability. However, as highways are a relatively stable environment with fewer traffic dynamics, steady speeds and fewer adjustments per kilometre than city driving, technology companies are making headway with L4 road testing. In December 2021, Inceptio Technology completed 24 kilometres of L4 testing in a closed highway[22], a sign that the industry is entering the development stage for L4 autonomous driving trucks.

  It is expected that initial tests for L4 autonomous line haul trucking will be completed before the end of 2023, allowing operational testing to begin in 2024. Mass commercialisation will be achieved between 2026 and 2030.

  Regulations are currently favourable for autonomous driving trucks. Recent regulations in China now require trucks to equip autonomous driving related features to improve safety and lower the risk of accidents. It is expected that the government will demand a higher level of autonomous driving in trucks going forward, to further promote highway safety.

- Driven by technology companies, business models include light, heavy and hybrid asset models

  Autonomous line haul trucking providers can utilise various business models with light or heavy asset requirements. Companies that use the light asset business model provide autonomous driving software to OEMs, who produce and sell the autonomous driving trucks. Others retrofit existing trucks or co-develop products with manufacturers. In the heavy asset model, technology companies sell or lease trucks directly to customers. In the hybrid model, technology companies primarily follow the light asset model, but also sell or lease trucks to customers.

21. *China's National Bureau of Statistics, Statistics for Heavy-duty Trucks, 2020*
22. *Inceptio Technology, Inceptio Technology Completed L4 Testing, 2022 March*

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Other niche AD scenarios

Ports – technical sufficiency for mass application expected before 2025

In 2020-2021, the first step of commercialisation in port autonomous driving has been realised and potential business models have become clear. Ports have been considered a classic application scenario for autonomous driving vehicles due to the closed environment, highly structured interactions between humans and vehicles, and low speeds. In this scenario, autonomous driving vehicles can help improve efficiency, reduce disruption, increase human safety, and address labour shortages.

Technologies company are leading development efforts in the port scenario. The typical usage scenario is for existing vehicles or vehicle designs to be retrofitted by a technology company and sold to the port authority or one of the service companies operating in the port. Technology companies sell the trucks outfitted with autonomous driving systems and operate the truck fleet for ports. Main players include companies specifically focused on port vehicles; as well as which focus on multiple different AD applications and offer autonomous driving system truck systems for ports. There are also OEMs that develop their own autonomous driving systems.

The port scenario is expected to realise mass application before 2025. Port autonomous driving is expected to achieve explosive growth in the next two years. As the market matures, it is expected that market competition will be fiercer, causing market share and capital to be increasingly concentrated on leading companies.

> With strong plan and control capabilities, driverless trucks can operate stably under various port conditions such multivehicle intersections while still dispatching containers safely and efficiently."
>
> **- Bei He**
> *CEO, SENIOR.AUTO*

> At present, some mining zones not only achieve autonomous round the clock operations under extreme weather and complex road conditions, but also do so under multiple scenarios without safety supervisors."
>
> **- Long Chen**
> *Co-founder and CEO, Waytous*

Mining – currently in operational testing and expected to realise mass commercialisation by 2025

There are already several mines in China using autonomous driving vehicles. For example, Waytous, a retrofitter and operator of autonomous mining vehicles, has operated in over 30[23] autonomous driving programs. AD used in mines has the potential to decrease the likelihood of accidents, both saving human lives and reducing operating costs. To support the industry, the government has published several policies in favour of the development of mining AD applications. Further the government has established a target to transform all mining operations to intelligent mines by 2035[24].

Technology companies are driving the development autonomous driving in the mining sector. There are similarities between the mining and the port scenarios, including the business model. There are currently two business models applied to the autonomous mining scenario: one is where technology companies produce vehicles for the mining companies fleets. Another involves light assets only; technology companies provide the technology to OEMs and help OEMs modify the vehicles and provide maintenance — this is the main model of the market at present.

With mines already deploying AD vehicles in their operations, the next step for the mining scenario is to commercialise it on a large scale. Major players in the market are expected to achieve large-scale operations and commercialization within the next two years. At the same time, based on the versatility of truck autonomous driving technology, players in other scenarios have gradually begun to deploy the technology to mining scenarios to gain a foothold in this growing sector.

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23. Waytous Official WeChat account, 14th April 2022

24. China's National Development and Reform Commission, Guideline for Intelligent mining, February 2020

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Last mile delivery – many operational pilots, expected commercialise by 2025

Numerous companies like JD.com, Cainiao, Meituan are testing AD delivery vehicles in closed environments on small scales. However, vehicle unit costs remain high and operating scenarios are limited, making large scale commercialisation difficult to achieve at present. Despite this, with billions of packages delivered in China annually, AD delivery has the potential to significantly decrease delivery costs for retailers and logistics companies.

The delivery scenario features three main business models. The first one is to operate with light assets, providing only autonomous driving systems to delivery companies. The second one is the heavy asset model, where technology companies produce and sell delivery vehicles to customers. Some companies operate with as hardware platform providers only, keeping costs low and generating profit event at low volumes. In the third model, logistics companies develop complete solutions and vehicles to address their own needs. All models are being pursued in China.

While the technical problems involved in AD delivery are less complex, cost and service quality will be primary factors affecting adoption, as this scenario involves interaction directly with the general population. In the future, AD systems for delivery vehicles need to reduce costs, increase efficiency, and emphasize human-centric design to be commercially viable. Additionally, the human impact of mass commercialization would be significant, as the delivery sector employs millions of people in China.

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Ecosystem factors

– policy, standardisation, investment, and risk

China currently provides a favourable environment for the development and commercialisation of autonomous driving technology, with supportive policies that facilitate access to capital. This said, the overall segment faces many challenges along the way and may suffer setbacks similar to the development of electric vehicles in China at the end of the previous decade.

Central government and provincial policies to support autonomous driving innovation

As a key development direction for the automobile industry, autonomous driving has garnered attention from the Chinese government dating back to 2015, when the State Council released Made in China 2025[25] which is a guideline and outlined plan for the development and application of autonomous vehicles in the next 10 years.

China's 14th Five-Year Plan[26] for 2035, the country's highest-level initiatives for social and economic development published in 2021, set targets for autonomous driving and intelligent mobility.

In 2020, The State Council issued the New Energy Vehicle Industrial Development Plan (2021-2035)[27], which clearly proposed the goal of "developing highly autonomous vehicles to achieve commercial application in limited areas and specific scenarios by 2025, and to achieve large-scale application by 2035." In 2021, the Ministry of Industry and Information Technology (MIIT) and other ministries issued the Good Practice for the Administration of Road Tests and Demonstrative Application of Intelligent and Connected Vehicles[28] to establish requirements and further regulate autonomous driving testing. These documents laid the groundwork for the development of smart connected vehicles and supporting infrastructure.

China also attaches great importance to "new infrastructure" which supports autonomous driving. Information infrastructure such as 5G, artificial intelligence, cloud computing, data centres, as well as intelligent transportation infrastructure are the core supporting technologies to help achieve systems through perception, behaviour prediction and planning to achieve full autonomous driving.

> "This was the first time the country's Five-Year Plan mentioned autonomous driving, and this inclusion enshrined the importance of the AD industry. Funding, tax breaks, government contracts from state owned enterprises, and subsidies follow the Plan."
>
> **- Norbert Meyring**
> *Partner, Head of Automotive Sector*
> *KPMG China*

25. The State Council, PRC, Notice of the State Council on Promulgating "Made in China 2025" Plan, May 2015
26. The National People's Congress of the People's Republic of China, Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and Long-Range Objectives for 2035, March 2021
27. General Office of the State Council, PRC, Notice of the General Office of the State Council on Promulgation of the Development Plan for New Energy Automobile Industry (2021 - 2035), October 2020
28. Ministry of Industry and Information Technology, The Ministry of Public Security, Ministry of Transport, Notice on Promulgation of the Good Practice for the Administration of Road Tests and Demonstrative Application of Intelligent and Connected Vehicles (for Trial Implementation), July 2021

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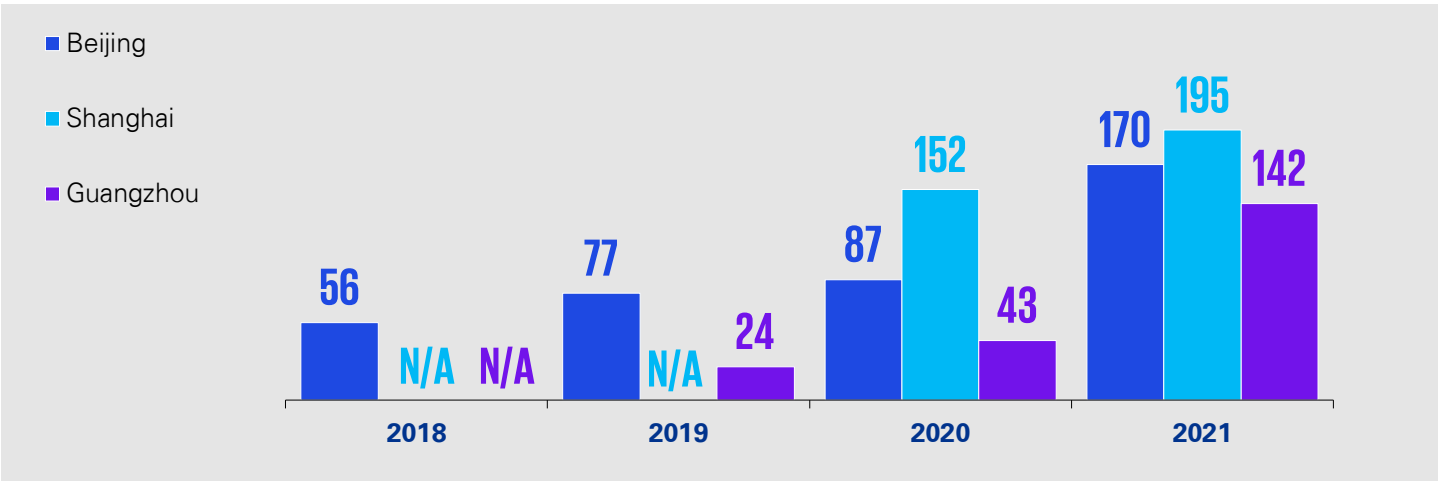
Figure 4.1 – Financial indicators on AD supporting technologies

Supporting technology	Investment or Market Size	Growth
5G	0.9 to 1.5 trillion yuan of investment between 2021 and 2025	-
Artificial intelligence	77.7 billion yuan of private investment between 2013-2021	CAGR approx. 43%
Cloud infrastructure services	455 billion yuan market size by 2025	2021 to 2025 CAGR 25%
Data centres	231 billion yuan market size by 2025	2020-2025 CAGR 19.2%

Sources: China Academy of Information and Communications Technology, Stanford 2022 AI Index Report, Canalys Research on Cloud Spend 2021, Shibuya Data Count Data Centre Market, KPMG analysis.

Several provinces have also introduced policies on autonomous driving. These policies prioritise autonomous vehicle development. By 2020, there were six province-level and 27 city-level autonomous driving test policies issued[29]. In 2021, Shaanxi, Gansu, Liaoning and other provinces began to emphasise autonomous vehicle technology research and development while Jilin, Shanghai, Fujian and other provinces prioritized the commercial application of autonomous vehicles. Zhejiang, Guangdong, and Shanxi also began constructing test zones for autonomous vehicles. As a result, more intelligent vehicles embedded with new autonomous features have been permitted to conduct road testing.

Figure 4.2 – Cumulative number AD vehicle testing licenses issued in select cities



Source: KPMG analysis of municipal government data

29. Baidu Map, 2020 China Urban Transportation Report, 2021

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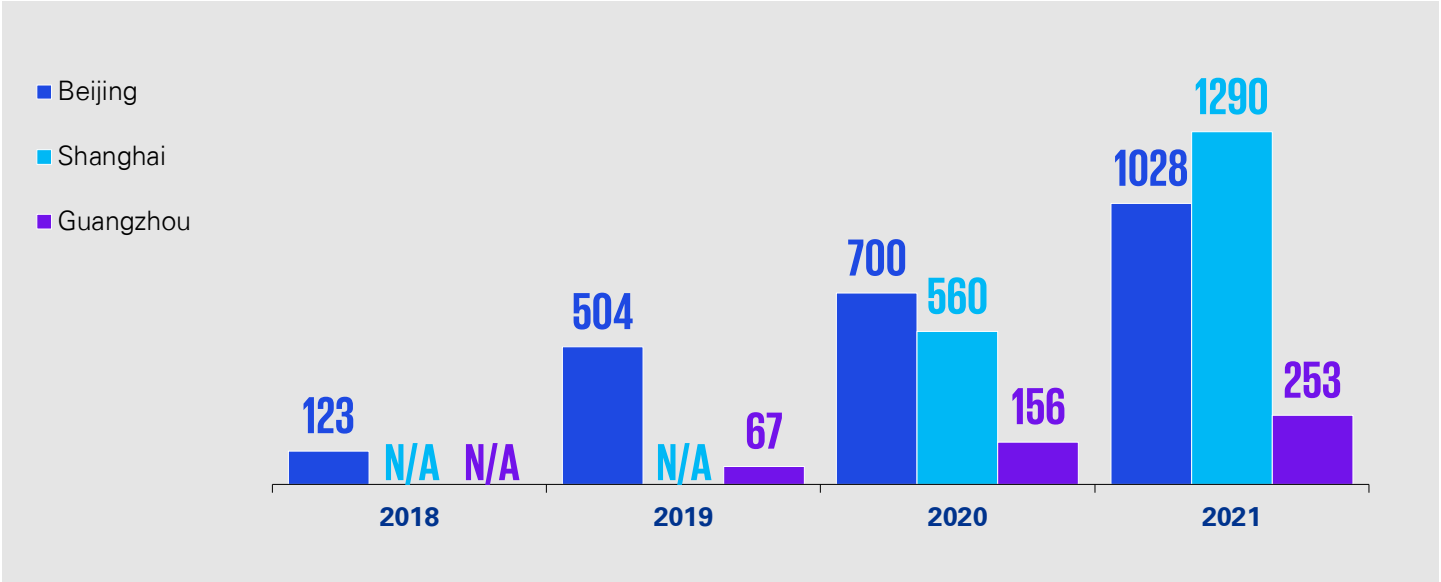
Support for vehicle testing has improved as well. Multi-modal test roads are popping up in China's first-tier cities, especially in Beijing and Shanghai, and were constructed to enhance data collection and improve testing rigor.

Figure 4.3 – Cumulative length (km) of AD test roads opened in select cities



Note: there was no official disclosure for Shanghai in 2018 or 2019, or Guangzhou in 2018
Source: KPMG analysis of municipal government data

Policies and regulations for autonomous driving are quickening their pace to catch up with technological development. There is a strong public-private interplay between regulators, technology companies, and car to continue developing standards.

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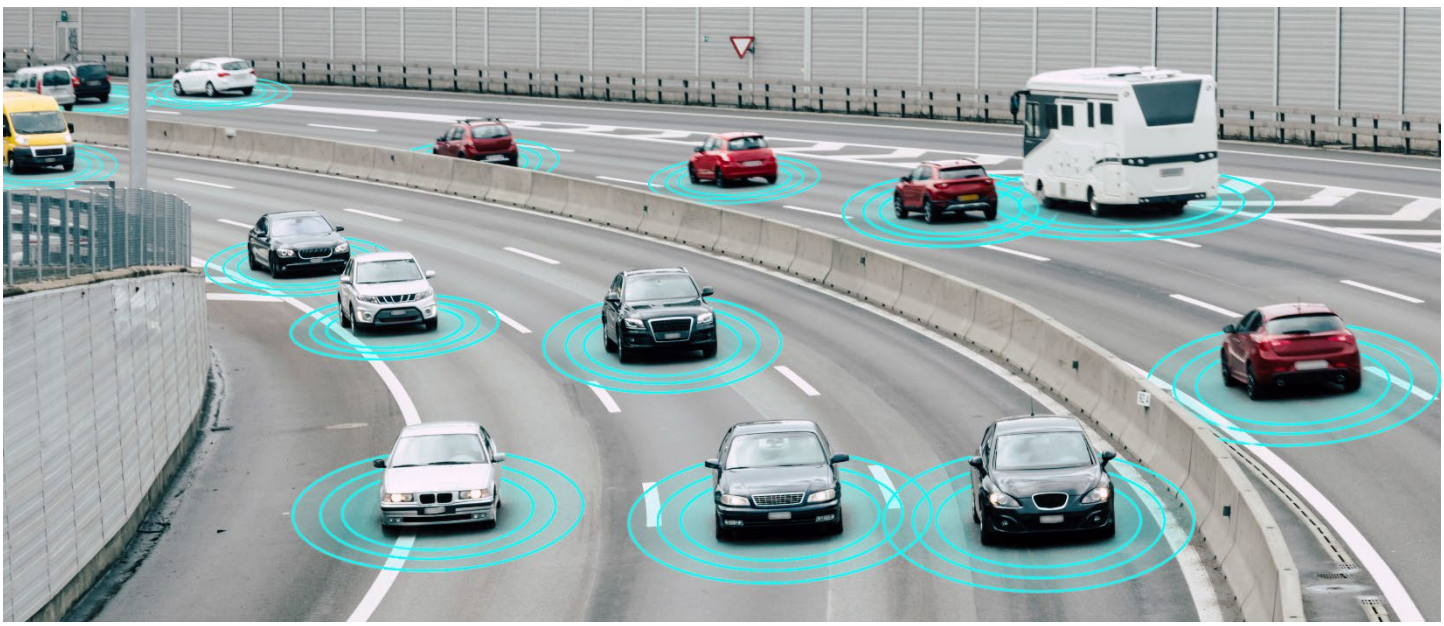
Increased global alignment and standardisation

China has aligned national AD standards closely with global standards in most areas of autonomous driving. China's Taxonomy of Driving Automation for Vehicles[30] published on 19th August 2021 and implemented on 1st March 2022 is generally aligned with the Society of Automotive Engineers' (SAE) 5 Levels of Driving Automation. Shared standards between China's national taxonomy and SAE J3016 enhances the universality of Chinese standards so automakers with operations worldwide can more easily standardise vehicle hardware and software, taking into account China's unique characteristics. As a result, there are few significant differences between the Chinese and SAE standards.

There is a close tie between industry and policy makers on the development of autonomous driving standards. Initiated by China Ministry of Industry and Information Technology (MIIT) and the Standardization Administration of China (SAC) the National Technical Committee of Auto Standardization (NTCAS) was established in 1988 by major players in the automotive industry including domestic and international car makers, technology companies and research institutes. Subcommittee 34 is responsible for Intelligent Connected Vehicles (ICV) which includes coverage of ADAS and autonomous driving.

The formulation of standards and the work of these associations is vital for promoting autonomous driving research and applications. For the government, it will help regulate an emerging industry, promote the development of intelligent connected vehicles, and provide the foundation for subsequent policies and regulations related to autonomous driving. For the industry, clear taxonomy orients research and development with clear directions and stabilises the market environment.



30. *China's Standardisation Administration, Taxonomy of Driving Automation for Vehicles, August 2021*

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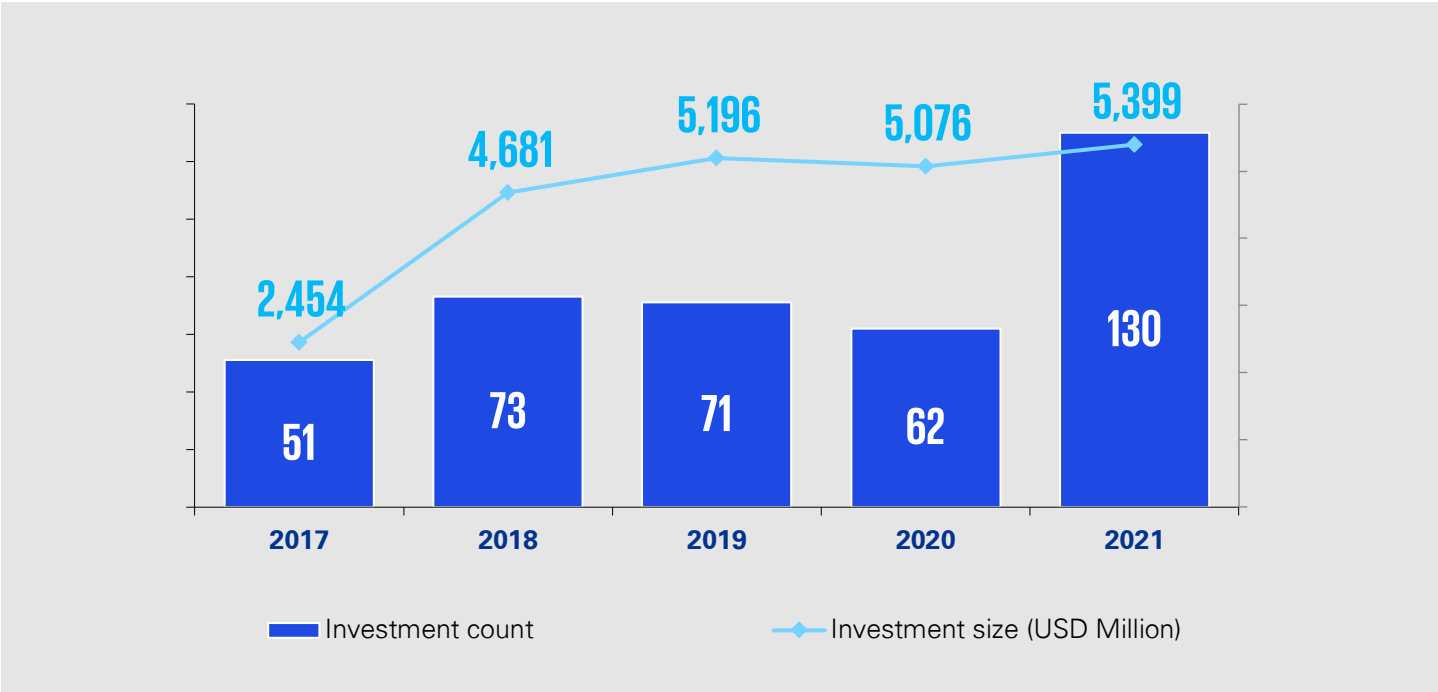
Investment in Chinese autonomous driving firms

Investment in China's autonomous driving soared to record highs in 2021.The total investment amount in the autonomous driving industry reached $5.4 billion USD, albeit spread over a larger number of transactions (see Figure 4.4). While transaction volume in the US and China have been similar between 2017 and 2020, total deal value in the US is significantly higher with each passing year, driven by large investments into Cruise, Argo, and Rivian. China will need to accelerate investment in order to bridge the capabilities gap.

Figure 4.4 – China – Venture capital investment into the AD industry over time



Source: Preqin, KPMG analysis

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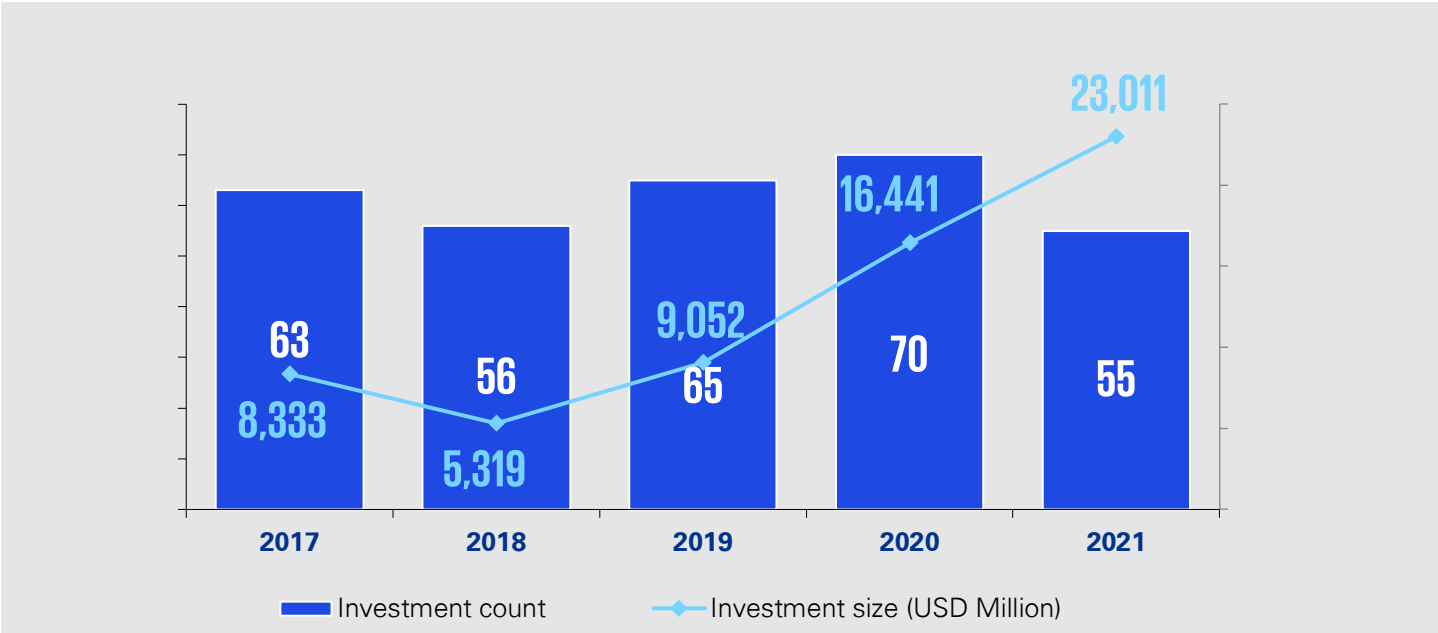
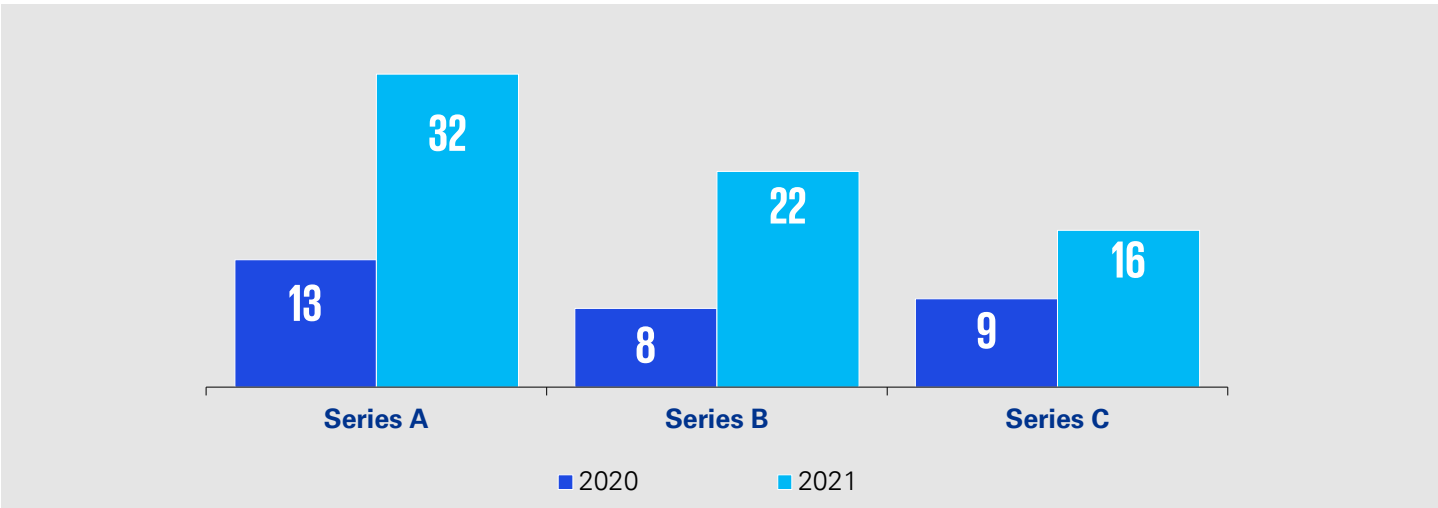
Figure 4.5 – USA - Venture capital investment into the AD industry over time



Source: Preqin, KPMG analysis. Note that US investment data includes investments totaling $10.5b USD in Rivian, a manufacturer of electric vehicles with some autonomous driving capability. During the period, there were 248 investments in China without a specified deal value and 69 investments in US without a specified deal value which were included in the investment count.

The number of A and B series investment rounds related to AD increased significantly in 2021. Both traditional auto companies and Internet giants are actively deploying AD businesses, and investments in newer partnerships continues to grow.

Figure 4.6 – China - Venture capital investment into the AD industry by round



Source: Preqin, KPMG analysis

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In some cases, competitors are investing into the same companies, suggesting that capital is more readily available than investment targets. For example, following investments from General Motors in September 2021, autonomous driving solution provider Momenta secured a USD $500 million investment in series C+ funding from Shanghai Automotive (SAIC) and Toyota, bringing its total series C financing to over $1 billion[31]. Such a large amount created a sensation in 2021.

"We continue to see high levels of M&A activity and interest in China from domestic and multinational investors. While deal volume may be deflated in the short term due to the ongoing global chip shortage, we expect volume in 2023 to accelerate."

- William Zhang
Partner
Head of Tax – Automotive Sector
KPMG China

As well as enjoying growing levels of capital, autonomous driving companies benefit from an increasingly diverse background of investors. Investment institutes, traditional automobile manufacturers and tech giants all dove wallets-first into autonomous driving field, bringing their global connectivity, manufacturing might, or software savvy. According to KPMG analysis[32], there are 83 public investments initiated by three China's leading carmakers, 30 of these investments focused on autonomous driving systems, chips, connectivity, V2X and new EV brands, which indicates the strategy of traditional OEMs to enter participate by partnership in the autonomous driving ecosystem.

"The founders of AD companies are ambitious, and many seek to scale quickly. They know they will need to raise capital and their global profile to attract talent and be competitive. The IPO prospects for automotive technology companies in China are very strong."

- Oliver Xu
Partner
Head of Audit – Automotive Sector
KPMG China

31. *Momenta, Momenta completed over $1 billion in round C financing, December 2011*
32. *KPMG analysis based on Tianyancha data, accessed March 2022*

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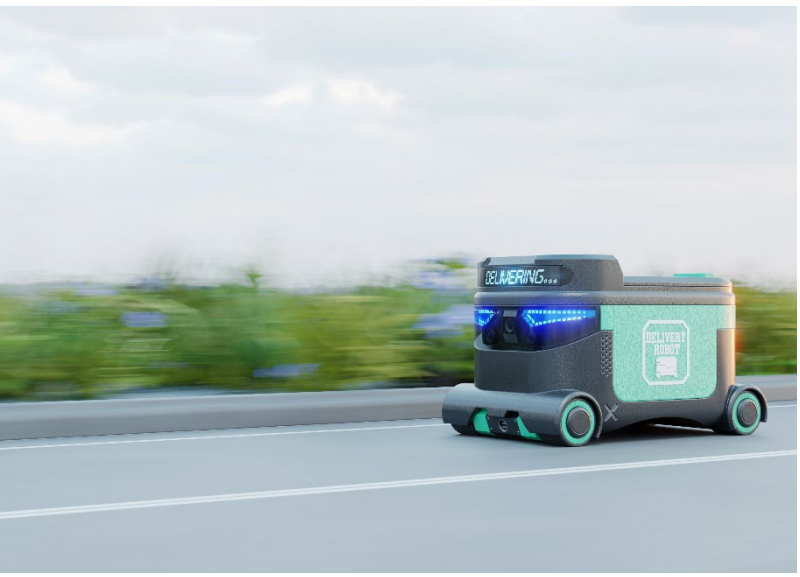
Risks

Globalised technology risk

For decades, drivers have benefited from the automotive sector's global supply chain. Costs have been reduced, new technologies have been introduced, and vehicle availability has increased. However, when a crisis occurs in the form of a natural disaster, a human conflict, or another black swan event, the automotive industry is likely to be impacted. This has been made apparent by the global chip shortage. The chip shortage, along with other disruptions, have led to a manufacturing shortfall of approximately 12 million vehicles since the beginning of 2021[33].

As vehicles become more complex and require more sophisticated components, auto makers will face supply and development challenges. As companies and nations are reassessing their reliance on an international chip supply, so too will companies consider how and where they place their investments for autonomous driving research and development as well as component manufacturing.

Currently, many companies have already set electrification as the key priority for the next decade. Our prediction is that vehicle electrification will stimulate overall digitalisation, resulting in the further acceleration of AD development.



User trust

When asked about their views on different types of autonomous vehicles, consumer acceptance of autonomous driving stood at 50% in China, compared to 36% in the United States[34]. Much of this optimism comes from the wider acceptance of ADAS features in existing passenger vehicle models. The acceptance drops to 9% however for Robotaxis[35], demonstrating the gap between current acceptance of autonomous driving as a feature rather than a complete mode of transportation.

New vehicle brands are catering to younger customers not by engine specifications but by intelligent and smooth integration into their lifestyles. This caters to a desire to simplify and automate, a trait often associated with technology companies. More collaboration is needed among companies in autonomous driving technology and services to ensure that trust remains high, as individual incidents of technology failure can result in major setbacks. Several failures of autonomous driving features in 2021 made national news and placed companies in the spotlight and resulted in investigations by the authorities. These failures or overstatements of capabilities of their passenger vehicles have led several companies to rename, redescribe, or remove mentions of their autonomous driving features. Over time, both failures and underperformance can erode reputation and brand.

User trust of Robotaxis will remain an obstacle in the midterm until technology advances. Early pilot studies show that user trust increases after experiencing a Robotaxi first-hand. With an increasing number of pilot services, and the first round of approved paid Robotaxi services hitting the streets of Shanghai, Beijing and Shenzhen, Chinese citizens will be able to witness first-hand how the technologies and policies have coalesced. These commercial pilots will be heavily scrutinized from every angle domestically and globally.

There are many other risks on the road to the millions or billions of kilometres of testing required to bring autonomous driving to maturity. The risks mentioned above do not include the specific technical challenges, the commercial uncertainty, or the societal shift required to fully commercialise autonomous driving. Despite the risks, China is seeing the rubber hit the road on its autonomous driving ambitions.

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33. LMC Global Light Vehicle Production Disruption Tracker, Q1 2021 to Q1 2022

34. J.D. Power , Survey on Chinese consumer confidence index of autonomous driving, May 2021

35. J.D. Power, Survey on Chinese consumer confidence index of autonomous driving, May 2021

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Conclusion

The automotive sector is facing disruptions on multiple fronts. As we highlighted in our 2021 Autotech special report on electric vehicles in China, *Sinocharged*[36], the tipping point for vehicle electrification has already been reached and battery electric vehicles are destined to become the major mode of transportation in developed countries over the next several decades.

There are many parallels between autonomous driving and electric vehicles. Just as vehicles will never be one hundred percent electric[37], neither will Robotaxis become the sole means of passenger transportation. In the same way that commercial vehicle powertrains will likely remain a mosaic, so too will the applications of autonomous driving in the trucking industry.

There are still many small steps to be taken before autonomous driving becomes a mass-market product outside of certain zones or scenarios. Technologies need to advance. Business models need to be tested, modified, and tested again. Cross-sector and global collaboration need to continue. Most significantly, there will need to be a societal shift in the way we perceive the function of mobility, vehicle ownership, and the role of artificial intelligence in our lives.

One thing remains clear. While there may be setbacks, such as the global chip shortage and the supply chain crisis, the development ecosystem of autonomous driving in China remains strong. The country's strong alignment between top-level government policy, large car maker and suppliers, and start-ups is creating an unstoppable momentum towards an autonomous future in China.

36. *Sinocharged: The bright future of China's electric vehicle market*
37. *KPMG International, Place Your Billion-dollar Bets Wisely, 2021*

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Appendix

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Autotech

KPMG Automotive Insights

Data security regulatory requirements of the internet of vehicles 2022

22nd Annual Global Automotive Executive Survey 2021

China's Leading Autotech50 4th Edition

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