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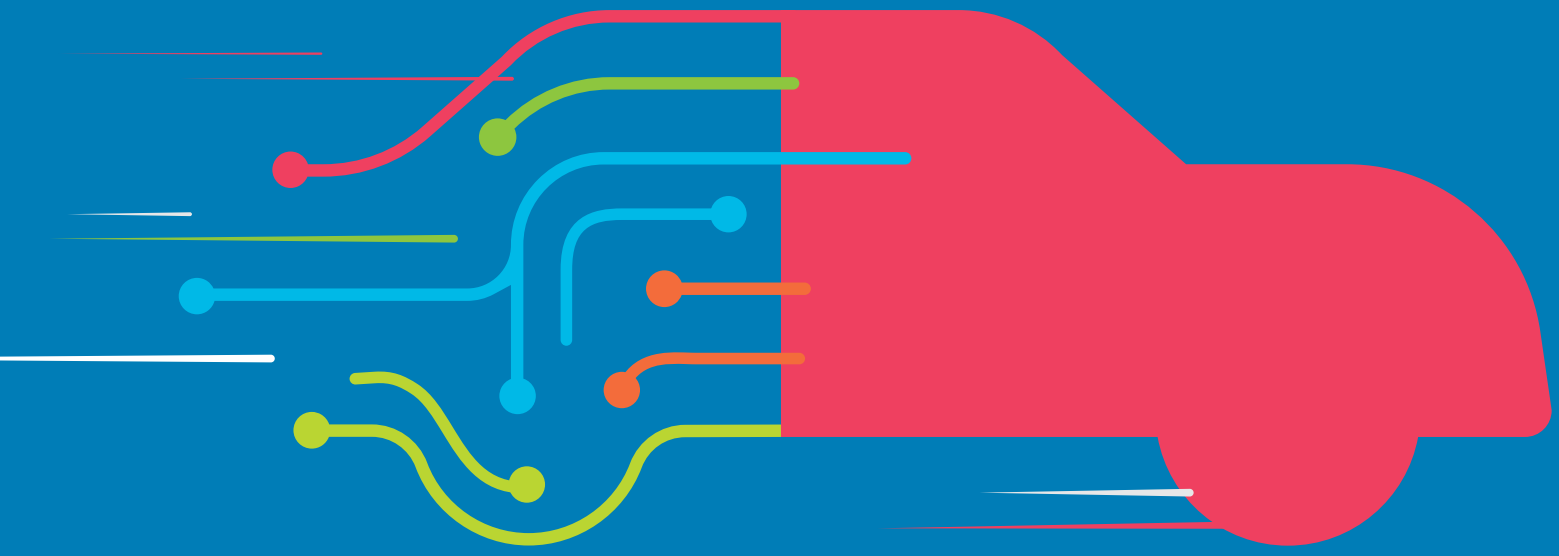


Accelerating automotive's **AI** transformation:

How driving AI enterprise-wide can turbo-charge organizational value

Introduction

Artificial intelligence (AI) holds the key to a new future of value for the automotive industry. While popular attention is focused on the use of AI in autonomous cars, the industry is also working on AI applications that extend far beyond – engineering, production, supply chain, customer experience, and mobility services among others.

"Not only are AI technologies critical for enabling our autonomous vehicles, but they are playing an increasing role in transforming our customer and employee experiences", says Jeff Lemmer, vice president and CIO, Ford Motor Company. *"Supply chain risk identification, and in-vehicle predictive maintenance, are just a few of the ways Ford is already applying AI to improve our customer and business operations."* Atif Rafiq, global chief information officer and chief digital officer, Volvo Car Group, echoes this sentiment, saying: *"Car companies are actively using AI in their autonomous driving efforts and this typically gets the most headlines. But every facet of this industry can benefit, including how cars are made and sold and to invent new customer experiences."* [1]

There are many examples of AI's reach into the industry:

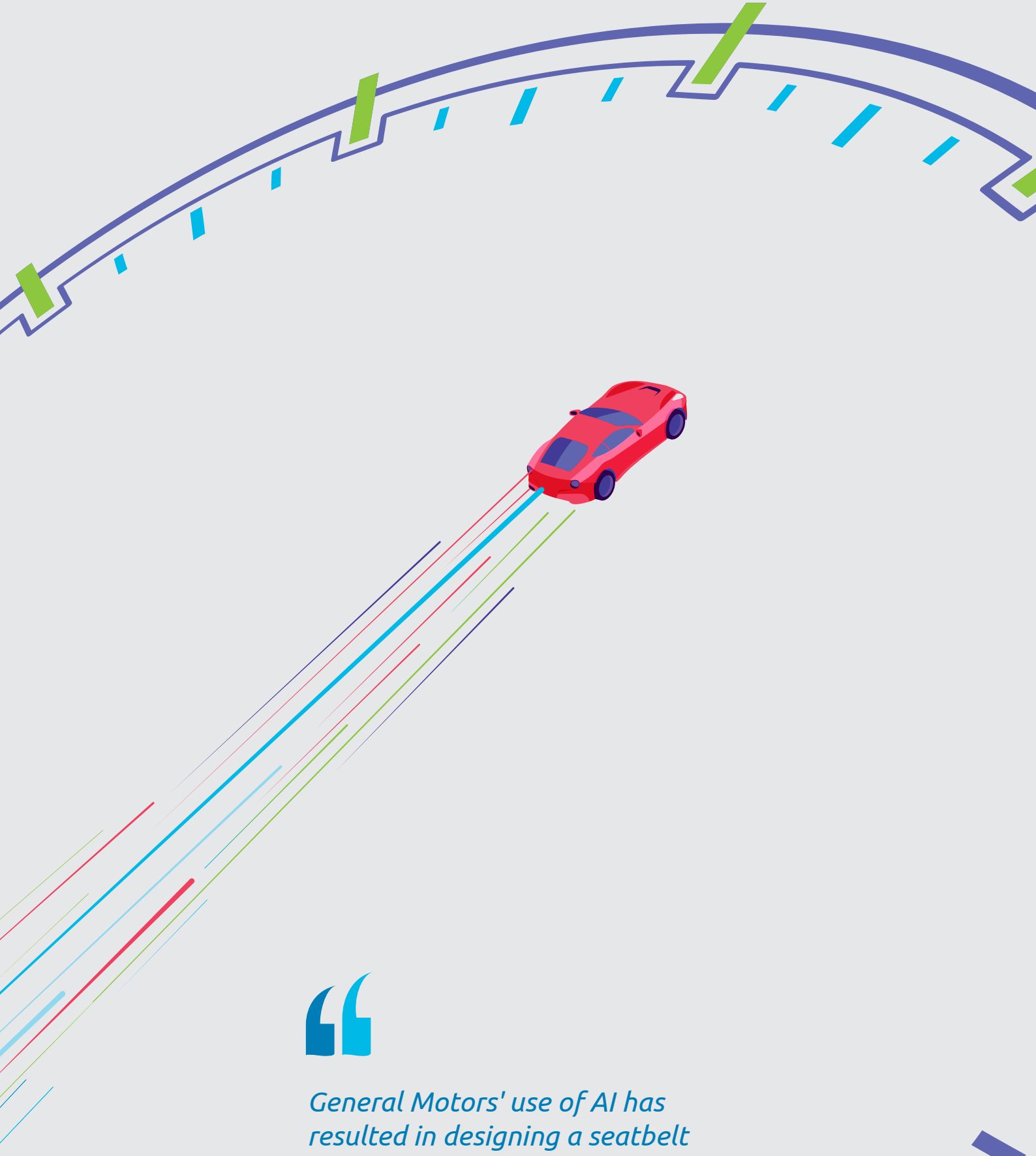
- General Motors' "Dreamcatcher" system uses machine learning to transform prototyping. The solution was recently tested with the prototyping of a seatbelt bracket part, which resulted in a single-piece design that is 40% lighter and 20% stronger than the original eight-component design.[2]
- Continental, one of the largest automotive parts suppliers, has developed an AI-based virtual simulation program. The program can generate 5,000 miles of vehicle test data per hour, when it currently takes over 20 days from physical efforts.[3]
- Volkswagen built its own speech technology team at its DATA:LAB in Munich in 2017 to take over standardized communication with suppliers. The goal of the project was to support procurement processes for commodities and merchandise under $10,000. [4]
- Škoda is testing the use of autonomous drones for stocktaking at its factory in Mladá Boleslav, Czechia. The technology detects, identifies and counts empty containers outside the factory from above, three times a day, and transmits the data it collects to Škoda's logistics department for processing.[5]

Given the impact that AI is having, we have undertaken significant research into AI in the automotive industry. Building on a cross-sector study we conducted in 2017, we have recently surveyed 500 automotive executives across eight countries as well as conducted in-depth interviews with industry experts and entrepreneurs (see research methodology at the end of this report). This report focuses on incumbent players in the automotive industry and not on the new entrants such as Google.

Our research finds that the industry has made modest progress in AI-driven transformation since 2017. Many organizations have yet to scale their AI applications beyond pilots and proofs-of-concept. Yet, there is a group of companies that are making significant progress in driving use cases at scale. Characteristics of this group of companies offer an insight into best practice in scaling AI.

In this report we explore:

- Where the industry stands in scaling its AI implementations
- What concrete benefits can result from scaled initiatives
- Where automotive manufacturers should focus their AI investments
- Success factors and recommendations for scaling AI.



General Motors' use of AI has resulted in designing a seatbelt part which is 40% lighter and 20% stronger than the original design.

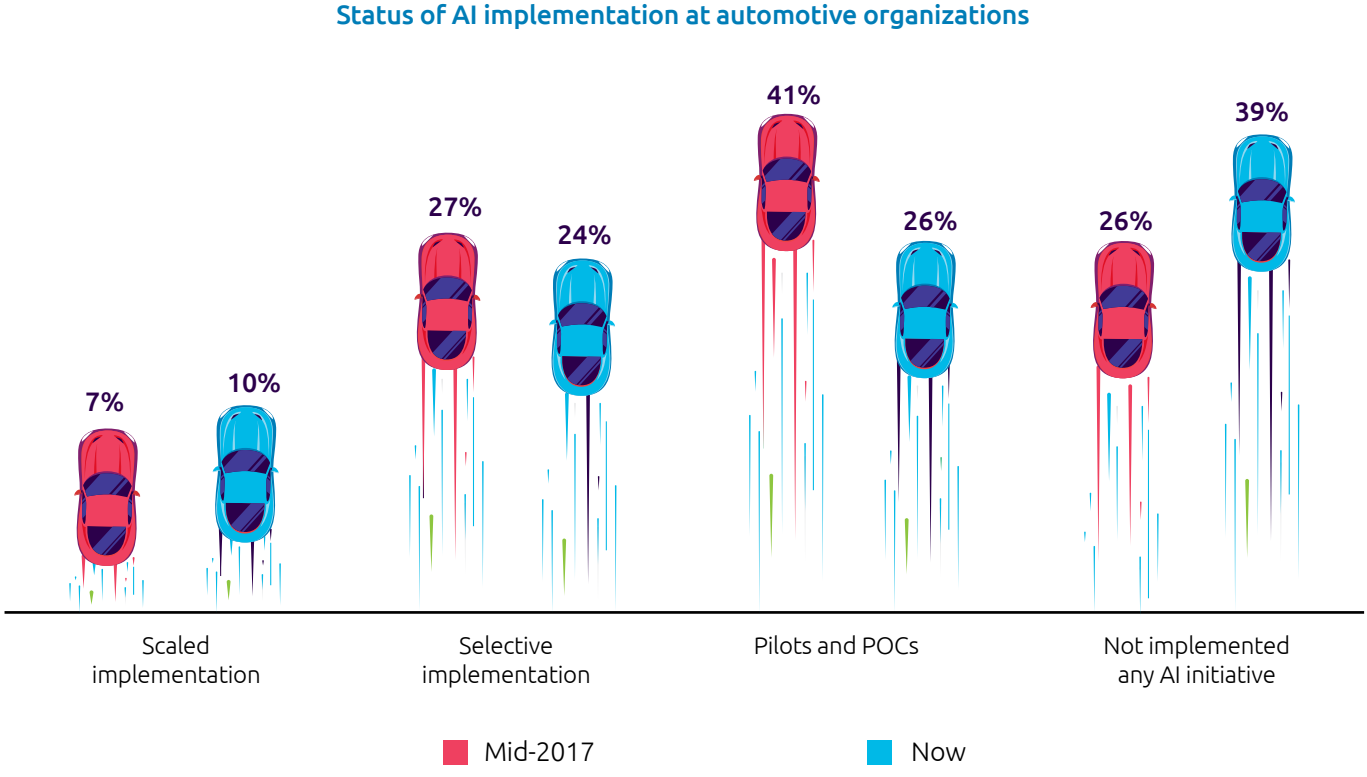
Modest progress in scaling AI

The number of automotive companies deploying AI at scale has increased only marginally

The industry is making slow progress in taking AI from experimentation to enterprise scale. As Figure 1 shows, our research found that:

- The share of automotive companies deploying AI at scale[6] has grown marginally to 10% compared to 7% in 2017.
- The number of selective AI implementations (at multiple sites in an organization, but not at enterprise scale) has not moved significantly, standing at 24% today (January 2019) versus 2017's 27%.

Figure 1: Number of automotive organizations implementing AI at scale has increased only marginally



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018-January 2019, N=500 automotive executives. Scaled implementation = ongoing implementation across all sites/enterprise wide with full scope and scale; Selective implementation = ongoing implementation at multiple sites in various parts of an organization, but not at an enterprise level; Pilots = initial roll out with limited scope at one site. "Now" refers to December 2018 – January 2019, the period during which the survey was conducted.

The share of automotive organizations deploying AI at scale has grown to 10% compared to 7% in 2017.

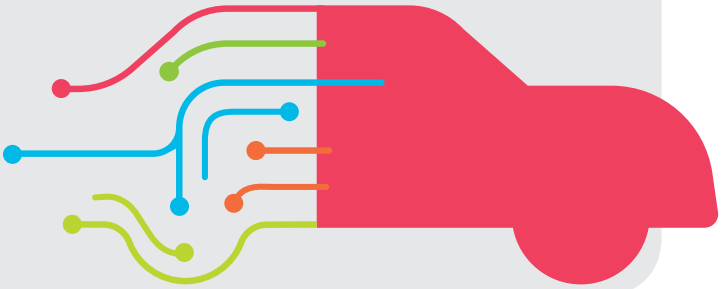
There are a number of factors that could be contributing to this performance:

- Roadblocks to technology transformation are still significant, such as legacy IT systems that do not talk to each other, question marks over availability and accuracy of data, and lack of skills[7]. Organizations identify integration challenges with existing systems and tools (38%), lack of knowledge and awareness of next-gen AI tools (36%), and lack of training data (35%) as top technology challenges hindering scaling of AI.
- The hype and high expectations that initially came with AI may have turned into a more downbeat and pragmatic view as companies confronted the reality of implementation. Difficulty in proving the benefits and return on investment at pilot stage (45%) and difficulty in selecting the use cases to scale (43%) are biggest organizational hurdles.

A significant development is in the number of organizations that said they are not implementing AI today (39% today versus 26% in 2017). This trend is more pronounced at smaller organizations – 43% of organizations with less than $10 billion annual revenues are not implementing AI, but this drops to only 19% in organizations in the $10 billion to $20 billion bracket. The drop in the share of organizations experimenting with AI (41% to 26%) shows a clearer focus in selection and scaling of use cases. It is also indicative of an uphill battle for organizations since AI, just like other digital technologies, has been more difficult for organizations to master than they initially perceived. Now, companies have developed their understanding of AI and where it can bring benefits, becoming more selective in terms of scaling AI engagements.

What is AI?

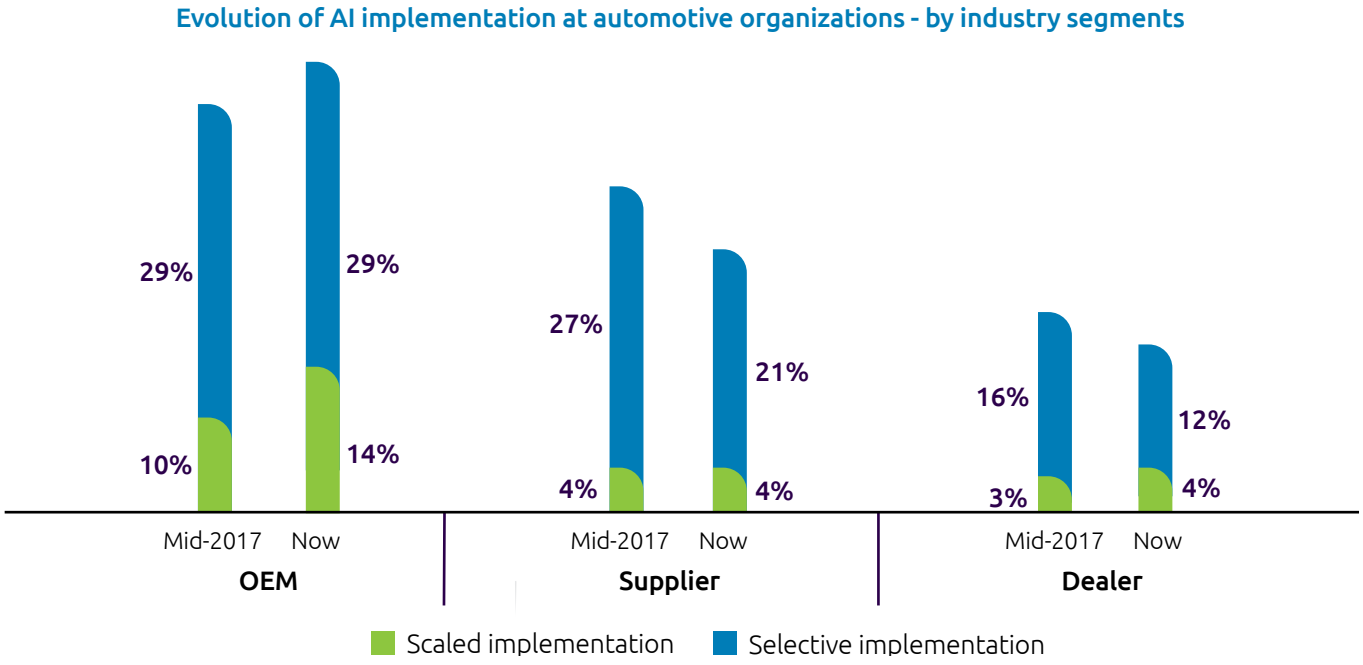
Artificial intelligence (AI) is a collective term for the capabilities shown by learning systems that are perceived by humans as representing intelligence. Today, typical AI capabilities include speech, image and video recognition, autonomous objects, natural language processing, conversational agents, prescriptive modeling, augmented creativity, smart automation, advanced simulation, as well as complex analytics and predictions.



OEMs are more advanced than their supplier and dealer counterparts

Our research shows that OEMs are making better progress than their supply chain peers –including parts suppliers and dealers – in scaled AI deployments. We found that 43% of OEMs are implementing AI at scale or selectively, compared to 25% of suppliers and 16% of dealers (see Figure 2).

Figure 2: AI implementation in the automotive industry – by industry segment



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.
Stages of AI implementation as defined in the research:
Scaled implementation = ongoing implementation across all sites/enterprise wide with full scope and scale;
Selective implementation = ongoing implementation at multiple sites in various parts of an organization, but not at an enterprise level.
"Now" refers to December 2018 – January 2019, the period during which the survey was conducted.

US, UK, and German automotive companies lead in implementing AI at scale

The US leads the way in terms of progress, with 25% of companies implementing AI at scale and 25% at a selective level (see Figure 3). The UK and Germany follow America's lead, but China has also nearly doubled its share of scaled AI implementations (from 5% to 9%). This increase in China is the most pronounced growth trend across all countries.

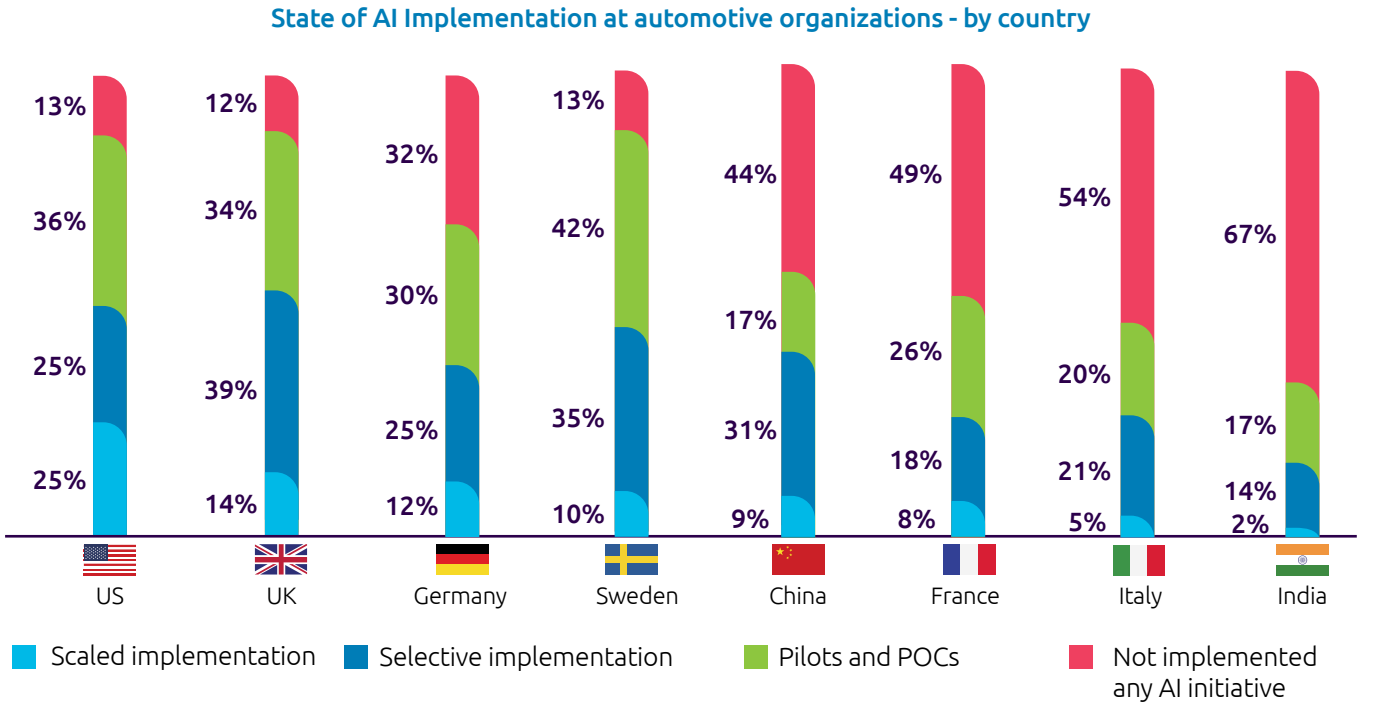
Dr. Kai-Fu Lee, chairman and CEO of Sinovation Ventures – and former president at Google China – alludes to this emerging Chinese capability in his recently published book, AI Superpowers: China, Silicon Valley, and the New World Order. In a recent interview with us, Dr. Kai-Fu Lee says,

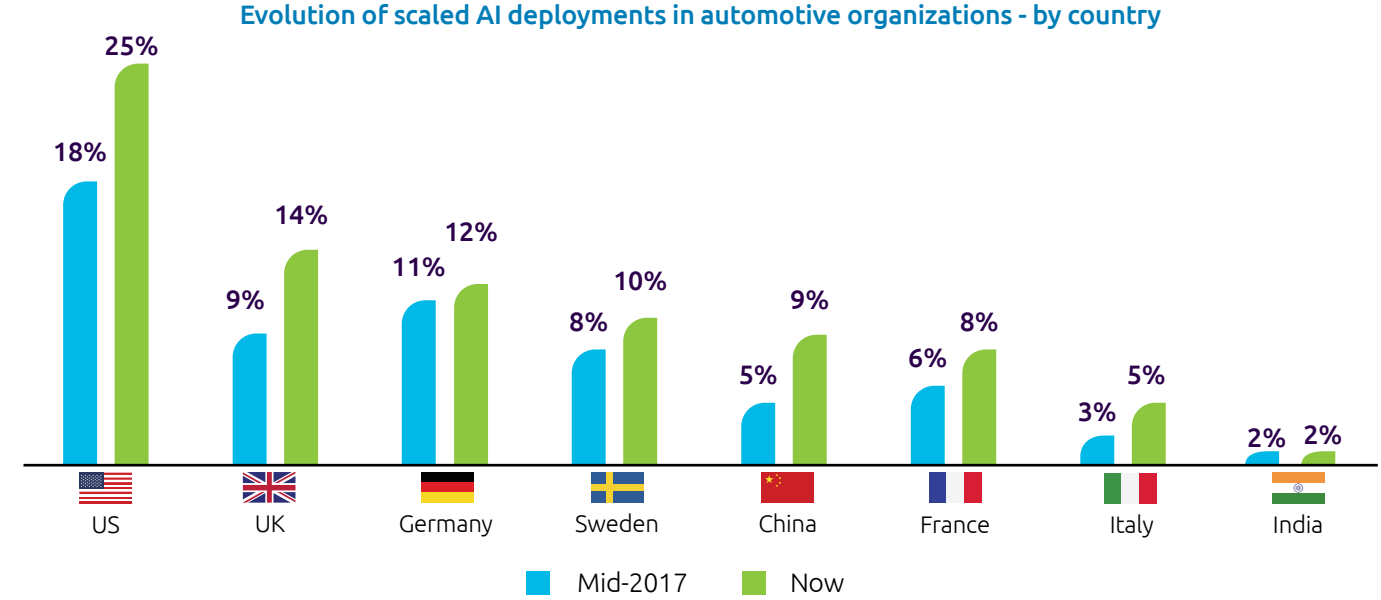
"I think China will be as strong as the US ... the two worlds exist in parallel universes. It's not very easy to cross but, at the same time, there are many very clever uses of AI in China that could be inspirational for American organizations."[8]

To accelerate AI innovation, China's automotive and mobility technology companies are following an open platform approach. This is in contrast to other automotive players, who are focused on keeping their platforms proprietary. For example, Baidu, a technology company and a leading self-driving player in China, launched Apollo, an open-source autonomous driving platform, which partnered with over 130 OEMs, suppliers and chipmakers in less than two years.[9] Similarly, China's leading electric OEM, BYD, opened access to data and controls of its vehicles for third-party developers,

becoming the first OEM to do so.[10] In addition, the country has been home to pioneering innovations in mobility services. For example, ride-hailing service Didi Chuxing offers its customers an augmented reality (AR) indoor navigation service that allows customers at airports, train stations, and malls to easily reach a vehicle pick-up location. It leverages computer vision positioning and 3D scene reconstruction technologies to enable the service.[11]

Figure 3: Status and evolution of AI implementation in the automotive industry – by country





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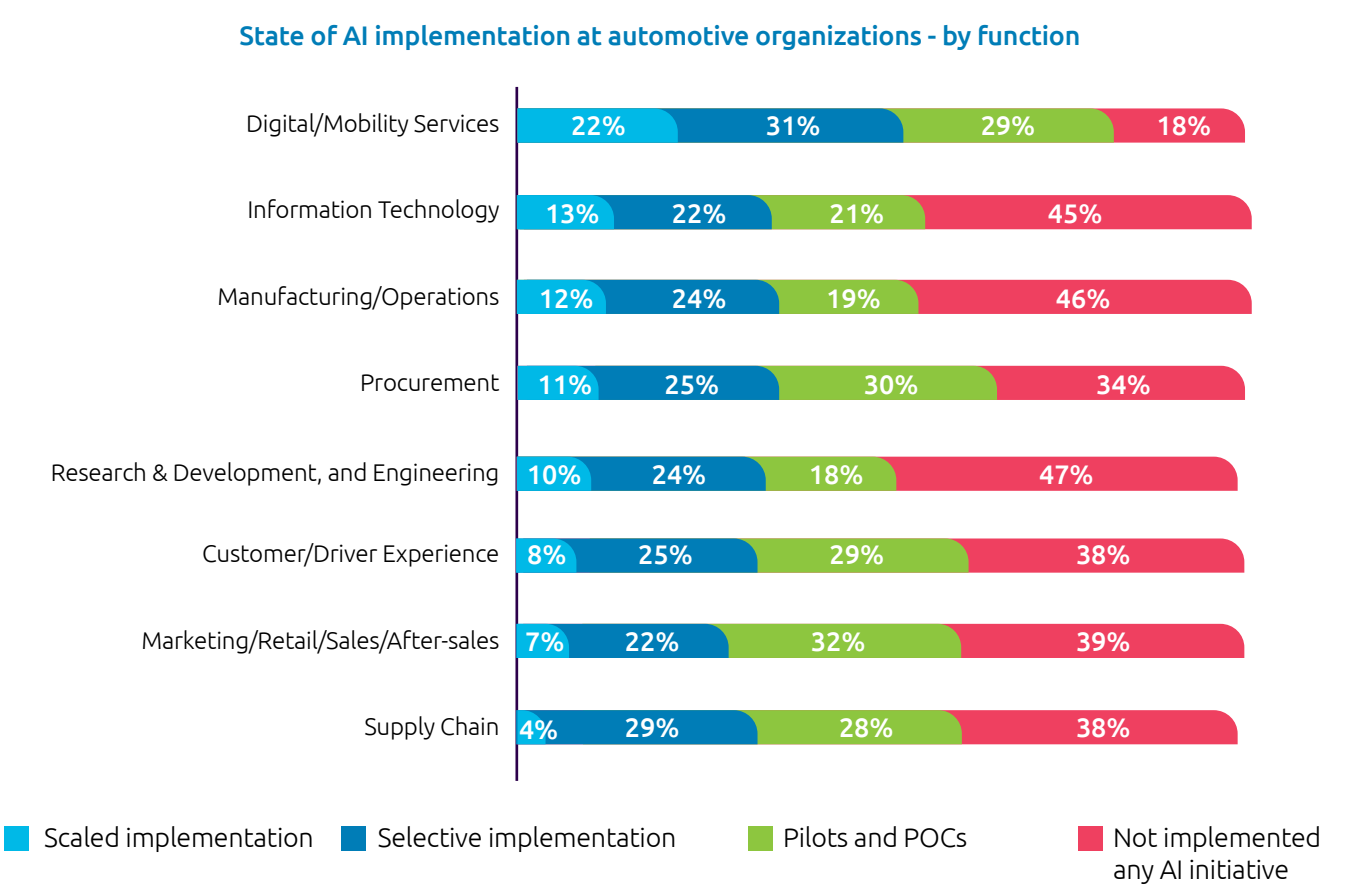
Scaled implementation is highest in Digital/Mobility Services, followed by Information Technology and Manufacturing.

Few functions have implemented AI at scale

Scaled implementation in different functions – from mobility services to R&D – is relatively rare, as Figure 4 shows. In supply chain, for instance, it stands at only 4%. One challenge is the number of players that make up a supply chain ecosystem, meaning that systems integration is complex. Functions where workflow and processes are more standardized – such as manufacturing/operations – have made relatively greater progress. In "AI use cases in action," we highlight some real-life examples of function-based use cases.

Figure 4: Few functions have implemented AI at scale



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.
Scaled implementation = ongoing implementation across all sites/enterprise wide with full scope and scale;
Selective implementation = ongoing implementation at multiple sites in various parts of an organization, but not at an enterprise level;
Pilots = initial roll out with limited scope at one site.

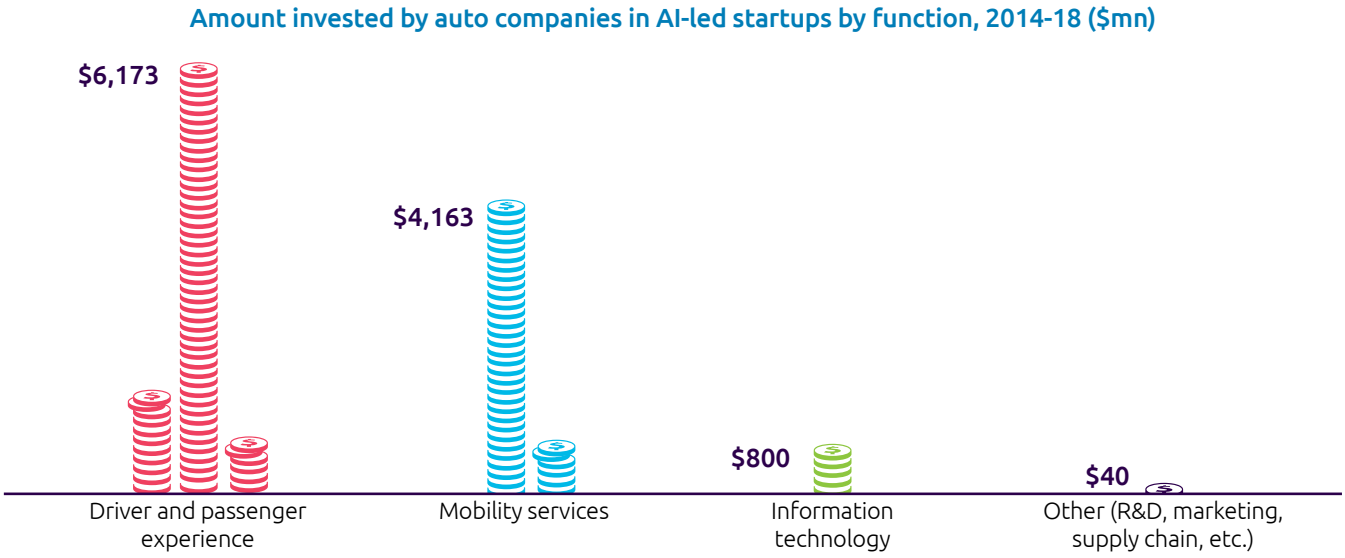
Functional area (Percentage of organizations deploying AI at scale)	**AI use cases in action**
Research & Development, and Engineering (10%)	• Prototyping: **General Motors** has applied machine learning to design products more economically and at greater speed through its "Dreamcatcher system." The solution was recently tested by generating designs for a seatbelt bracket part. This resulted in 150 designs, including one that involved a single piece rather than the eight piece original part, and which proved to be 40% lighter and 20% stronger.[12] • Advanced Driver-Assistance System (ADAS): **Continental** developed a highly scalable and modular virtual simulation program that can generate 5,000 miles of vehicle test data per hour compared to 6,500 miles of physical test driving per month.[13]
Supply Chain (4%)	• Quality control of supplies: **Audi** is testing an AI-based system that employs smart cameras with image recognition software to test and identify tiny cracks in sheet metal. The system can potentially detect the finest of cracks using millions of images, automating visual quality inspection. The sample images are marked down to the pixel level to achieve the highest level of accuracy in detecting defects.[14]
Manufacturing and operations (12%)	• Predictive maintenance: **General Motors** deployed a cloud-based image classification tool on nearly 7,000 robots. This pilot experiment was intended to detect component failures before they happened. It was able to detect 72 instances of component failure that could have led to unplanned downtime.[15]
Marketing/ sales (7%)	• Sales planning and forecasting: **Volkswagen** is making use of machine learning to make accurate predictions of vehicle sales across 250 car models in 120 countries. The AI system can use context-based information, such as growth forecasts, economic sanctions, and weather conditions. This solution puts forward several scenarios that sales planners can choose from to inform their strategic decisions.[16] • **Volkswagen** has unveiled a showroom of the future where it uses AI and Virtual Reality technology to understand customers' likes and preferences and recommend car models that meet their needs.[17]
Customer/driver experience (8%)	• Connected car experience: On some of its latest models, **Toyota** offers a "Data Communication Module" on-board device that provides a variety of connected services, such as: – A voice assistant: can be used to operate the navigation system, audio system, and access instructions to use the car's equipment. – Hybrid navigation: harnesses cloud-based map data and on-board navigation system to automatically switch between the two and provide optimum route information.[18]
Mobility services (22%)	• Improved fleet management: **Michelin** has developed a tire-monitoring system using telematics and predictive analytics, providing a real-time view into performance and wearing of specific tires on individual trucks to anticipate problems before they occur.[19] • Last-mile delivery: **Mercedes-Benz** has tested a computer-vision based system to recognize and register parcels automatically in a last-mile delivery vehicle, reducing the time to load the vehicle with parcels by 15 percent.[20]

Source: Company websites and media reports.

The automotive industry is looking to startups to plug capability and skills gaps

Automotive companies are looking to boost their AI capabilities and implementations by investing in startups. Investments are focused on areas where they want to aggressively build scale to stay competitive, including the customer/driver experience and mobility services. We can see this focus when we look at the top AI-led startups in terms of investment from automotive organizations. As Figure 5 shows, the industry has invested more than $10 billion in these two areas alone in the last five years.

Figure 5: Most of the automotive investments in AI-led startups are concentrated in mobility services and customer experience

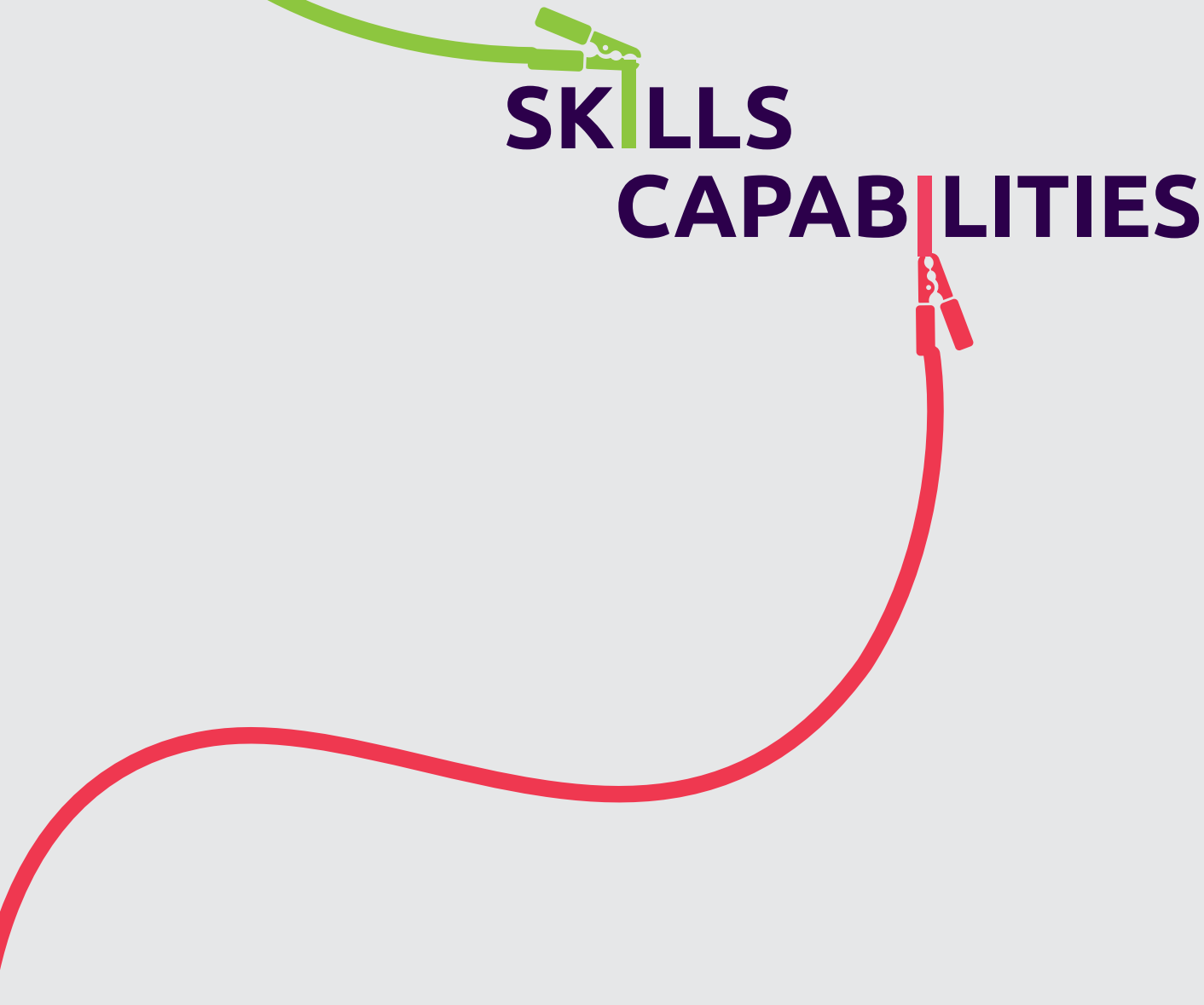


Top AI-led startups with investments from automotive firms

Startup	Automotive investors	Startup country	Startup's area of expertise
HERE Global BV	BMW, Audi, Daimler	Netherlands	Driver/passenger experience – Mapping, simulation, image recognition
Cruise Automation	GM, Honda	United States	Driver/passenger experience – Full-fledged automation system
GrabTaxi Holdings	Toyota, Hyundai, Kia Motors	Singapore	Mobility services – Ride-hailing
Argo AI	Ford	United States	Driver/passenger experience – Full-fledged automation system
Renesas Electronics Corp	Denso	Japan	Information technology – NextGen processor to process sensor data
Lyft	GM, Magna, Tata Motors	United States	Mobility services – Ride-hailing
Matternet	Daimler	United States	Mobility services – Autonomous drone delivery
Uber	Toyota	United States	Mobility services – Ride-hailing
nuTonomy	Aptiv	United States	Mobility services – Robo-taxis
Gett	Volkswagen	Israel	Mobility services – Robo-taxis

Source: Capgemini Research Institute Analysis based on Bloomberg, Quid, and Crunchbase.
Amount invested in AI-led startups include deals in startups where AI is key part of the company's business model/offerings or the where acquirer mainly intends to use the target's AI technology.

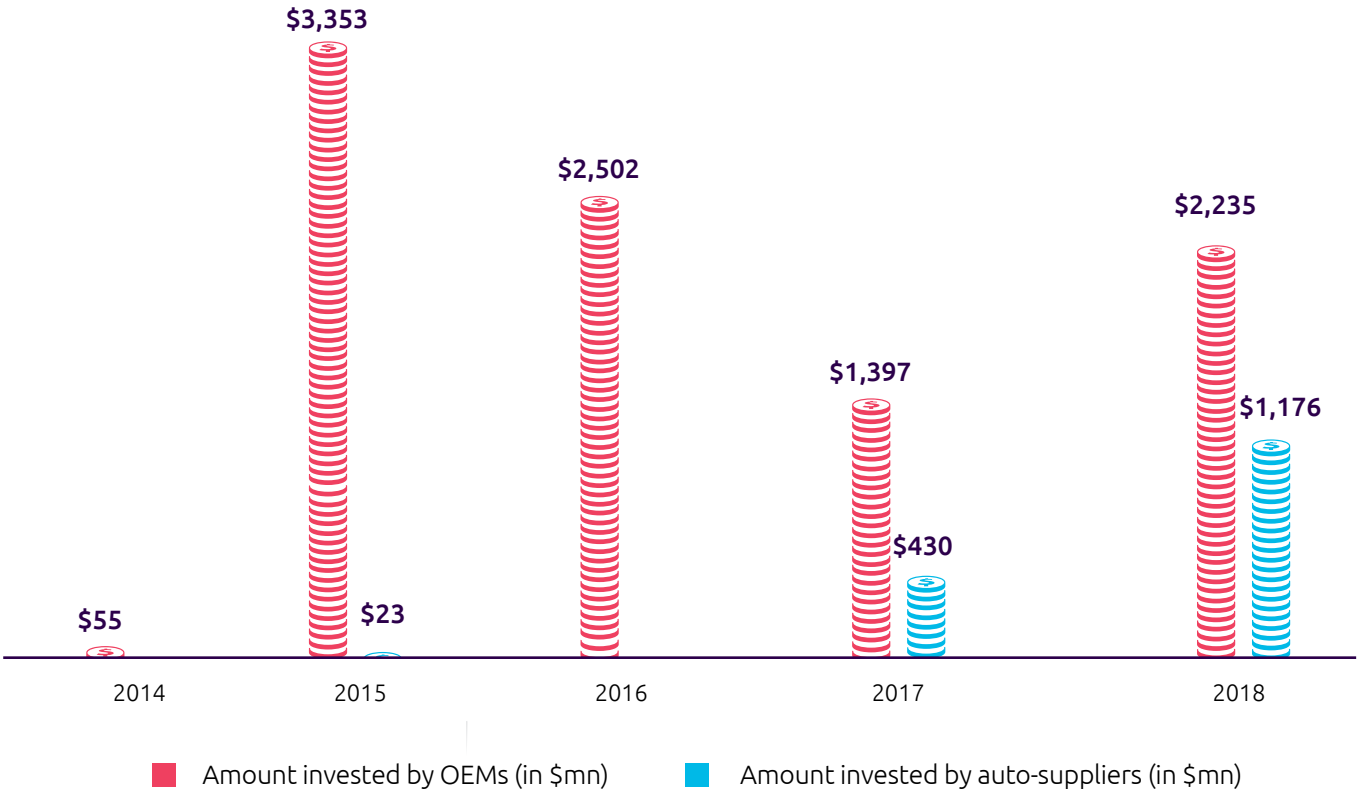
In the last five years, the industry has invested more than $10 billion in AI-led startups in areas of customer/driver experience and mobility services - the highest across all areas of investment.



This strategy reflects the industry's need to build capability outside its traditional core competencies. *"In product and services innovation, as well as in process automation, we are always scanning startups to check out if they have interesting and ready-made solutions for our issues,"* says Demetrio Aiello, head of the AI & Robotics Labs at Continental.

While investment in AI-led startups declined from 2015 peak, it is now back on an upswing (see Figure 6). While OEMs account for a large share of these investments, automotive suppliers are playing an increasingly prominent role.

Figure 6: Automotive companies have invested $11.2 billion in AI-led startups since 2014

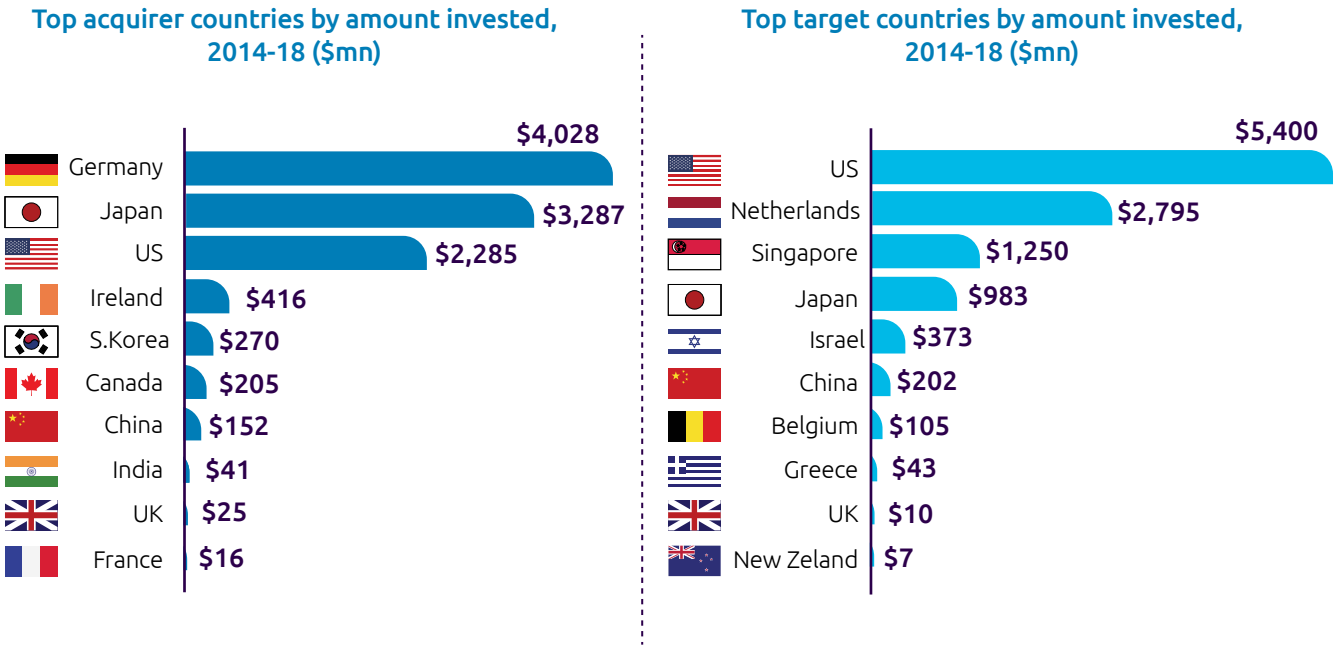


Source: Capgemini Research Institute Analysis; Bloomberg, Quid, Crunchbase.
Includes deals where at least one auto company is involved; Amount invested includes the contribution of auto companies (OEMs and suppliers) but excludes that of non-auto firms such as technology companies, venture capital funds etc.

Investment by OEMs in AI-led startups increased 60% year-on-year in 2018

German, Japanese and US based automotive companies are making the greatest investments, with AI startups in the US, Netherlands and Singapore are attracting the greatest interest (see Figure 7). China-based automotive AI startups are also attracting huge amounts of capital from technology companies and private equity/venture capital firms, although our data captures only the deals where at least one automotive company was involved.

Figure 7: Automotive companies from Germany, Japan and US lead in investing in AI-led startups



Source: Capgemini Research Institute Analysis based on Bloomberg, Quid and Crunchbase.
Country names represent the headquarters of only auto companies participating in the deal. The data excludes almost 15% of cases where auto companies from different geographies are part of the same deal. Dollar amounts represent the sum invested only by auto companies in a deal.

As we saw earlier, German companies are lagging behind their American and Chinese counterparts in terms of driving AI to enterprise scale. This perhaps reflects the fact that their traditional organizational structures make it difficult for the parent company to absorb the innovations of its startup partners and innovation centers. Dr. Christian Müller, senior researcher at DFKI (the German Research Center for Artificial Intelligence) – a public-private partnership for research on AI – says: *"European organizations, and the German automakers in particular, are trying to overcome the slower pace of adoption of disruptive technologies. It's harder for them owing to regulations, greater costs of operation, and a mindset of following well-defined processes. Despite this, over a longer time horizon, I believe that their process-oriented approach might yield them greater dividends from AI,"*

Traditional mindsets, and inflexible processes, are a barrier to AI for the industry as a whole. According to Alfredo Perez Pellicer, head of R&D at MAHLE Electronics, a large automotive parts manufacturer: *"The biggest roadblocks that AI finds in the automotive industry is rigidity and inflexibility in structures and policies. In large organizations, this can create a vicious circle of lack of experimentation, development, and loss of customer interest and, ultimately, the loss of business. The industry will need a lot of top-down training across its managerial levels to create the understanding, training, and knowledge that's needed to fulfill AI's potential."*

Automotive organizations can drive significant reward from scaled AI

Large automotive OEMs can boost their operating profits by up to 16% by deploying AI at scale

To estimate the financial benefits of successfully scaling AI implementation, we took a typical top-50 OEM (by revenue) and assessed the impact of implementing AI on its operating costs. This category has an average revenue of approximately $79 billion and pre-tax operating margins of 6%. Then, drawing on our survey data, we estimated the cost-saving impact of implementing AI on various operational costs, assuming other P&L items remain unchanged.

We constructed two scenarios – conservative and optimistic – corresponding to gains of 10% and 33% respectively (see Figure 8). In this model, we have not included the gains from productivity improvements or revenue gains from a better customer experience. The analysis showed that:

- In the conservative scenario, we believe that OEMs would be able to increase their operating profit by up to $232 million – a 5% increase from current levels. This gain would accrue from an average 0.2% reduction in operating costs, such as labor, raw materials, logistics, administration, inspection, and maintenance.
- In the optimistic scenario, the gain more than triples to $764 million. This assumes that only 33% of financial impact materializes, delivering a 16% boost to operating profits.

Figure 8: Large OEMs can boost their pre-tax operating profit by 5%–16% from scaling up AI Implementation

Factors	Scenarios based on industry estimates		
	Present day ($bn, % of revenue)[2]	Conservative improvement from AI ($bn, % of revenue)[1,2]	Optimistic improvement from AI ($bn, % of revenue)[1,2]
A. Revenue	$79.4	$79.4	$79.4
B. Direct costs (material, labor, etc.)	$50.8	$50.6	$48.4
C. Selling & distribution, R&D, administration, etc.	$9.7	$9.7	$9.6
D. Other indirect costs including maintenance and inspection	$7.5	$7.5	$7.4
E. Others (depreciation and amortization)	$6.7	$6.7	$6.7
F. Total costs	$74.7	$74.5	$73.9
G. Operating profit	$4.7	$4.9 **($232mn or 5% increase from current level)**	$5.4 **($764mn or 16% increase from current level)**
H. Operating margin (A-F)	5.9%	6.2%	6.8%

1 A conservative estimate takes into account 10% of estimated improvement from our survey results translate into actual efficiency gains; whereas an optimistic estimate implies that 33% of estimated improvement from our survey results translates into cost and efficiency gains. Note that in both scenarios, we assumed only a fraction of benefits (as estimated by our survey data) translate to cost savings – to the extent of average AI implementation in 24% of processes across functions. Figures are rounded off to the nearest decimal.

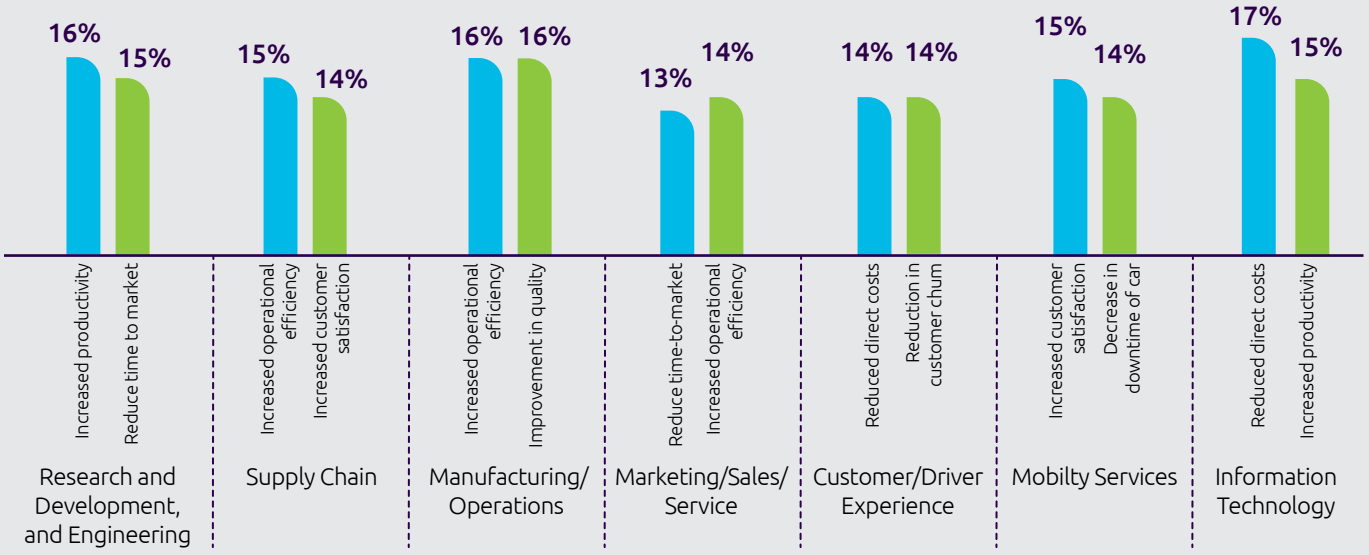
2 Assumed typical cost breakup of an automotive OEM: Direct costs (material, labor, etc.) – 64%; selling and distribution, R&D, administration, etc.) – 12%; Other indirect costs (including maintenance and inspection) – 9%; Other costs (including depreciation and amortization) – 8%. We considered investments in AI resources and skills as well, however they were fairly small in comparison to the overall cost base of large OEMs to have a substantial impact on P&L.

Source: Capgemini Research Institute Analysis; Bloomberg.

Every function has high-benefit use cases

All functions we surveyed have high-benefit use cases that drive significant benefits. For example, AI's use in the R&D function has seen productivity increase by 16% and time to market reduce by 15% (see Figure 9).

Figure 9: AI implementation yields big benefits across functions



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.

"With AI-empowered visual inspection we have sensibly reduced the ratio of false positives with respect to the previous systems," explains Demetrio Aiello, head of the AI & Robotics Labs at Continental. *"I'm very confident that if we can deploy AI to its fullest potential it would have an impact on performance equivalent to almost doubling our capacity today."*

Stefan Von Czarnecki, Director Sales & Business Development, KTM Technologies – an Austrian provider of engineering, prototyping and consulting services provider to the automotive industry, outlined how AI can have a significant impact on product design and development. *"AI helps us significantly in reducing the time to identify and evaluate the right concepts by a multi-dimensional optimization of technical tasks. Especially for our challenges in developing new products and new concepts on a white piece of paper AI helps us massively to understand the solution space. We need to understand concept performance first and then zero in on the right design features."* he says. *"Then we work on the design to make it feasible and commercialized. This makes the process very proactive. Before the introduction of AI, it was the other way around. First, a "good design" was produced based on experienced. Then it was prototyped and simulated to test functional effectiveness to optimize it further. AI is able to cut down 30 to 40% of the time involved in this process and is enabling new solutions."*

Jonathan Peedell, head of strategy at a large European OEM, is optimistic about AI's potential in transforming supply chain performance, outlining how these technologies will play an increasingly important role in an "Industry 4.0" world. *"We will be sharing common platforms,"* he explains. *"For instance, our quality systems will talk to our tier 2 and tier 3 supplier's quality tools. Further augmentation of this process with AI will identify and predict quality issues in advance, preventing downtime and disruptions downstream."*

He also sees AI playing a significant role in organizations replicating best-practice operations across their networks. *"With plant operations, AI is here and now,"* he says. *"We don't just build the same car in one plant, in one place. Now, we replicate that part in two and in some cases three plants around the world. Using AI enables us to scan the facilities, scale what we do very successfully in one plant and exactly replicate it in another. AI gives us the ability to conceptually prove that operations will fit into the new space, that we can still deliver parts and cars and we can still manage the environment very well."*

Where should auto manufacturers focus their AI investments?

"Artificial intelligence is the next springboard that I see: it isn't merely playing a main role in autonomous driving; it is woven across domains into the process and IT landscape, and naturally in the R&D field as well," –
Jan Brecht, CIO, Daimler AG[21]

We analyzed 45 AI use cases across different functions – from R&D to customer/driver experience – to assess which provided the greatest benefits. Figure 10 shows these high-benefit use cases by function, from R&D to IT.

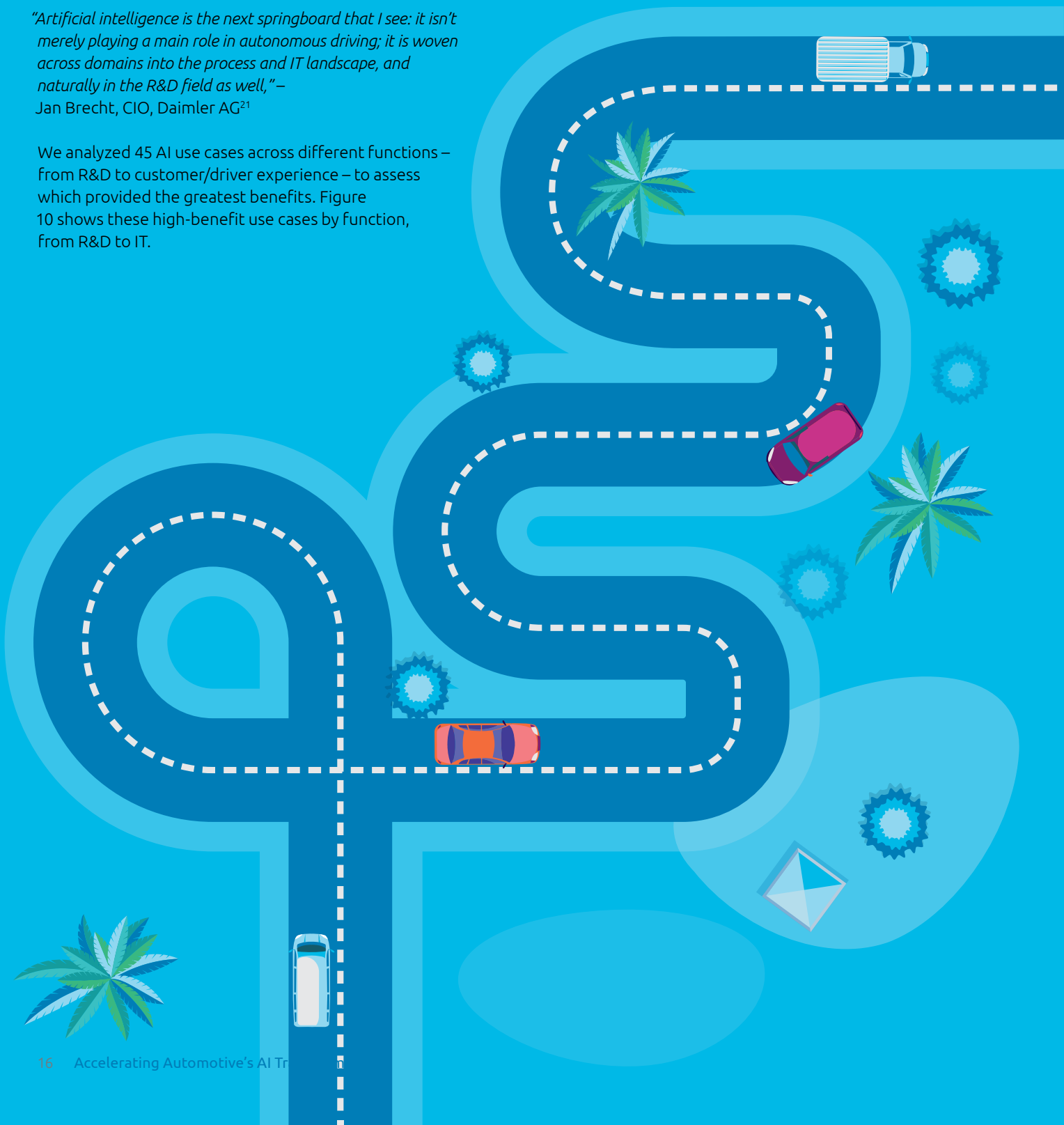
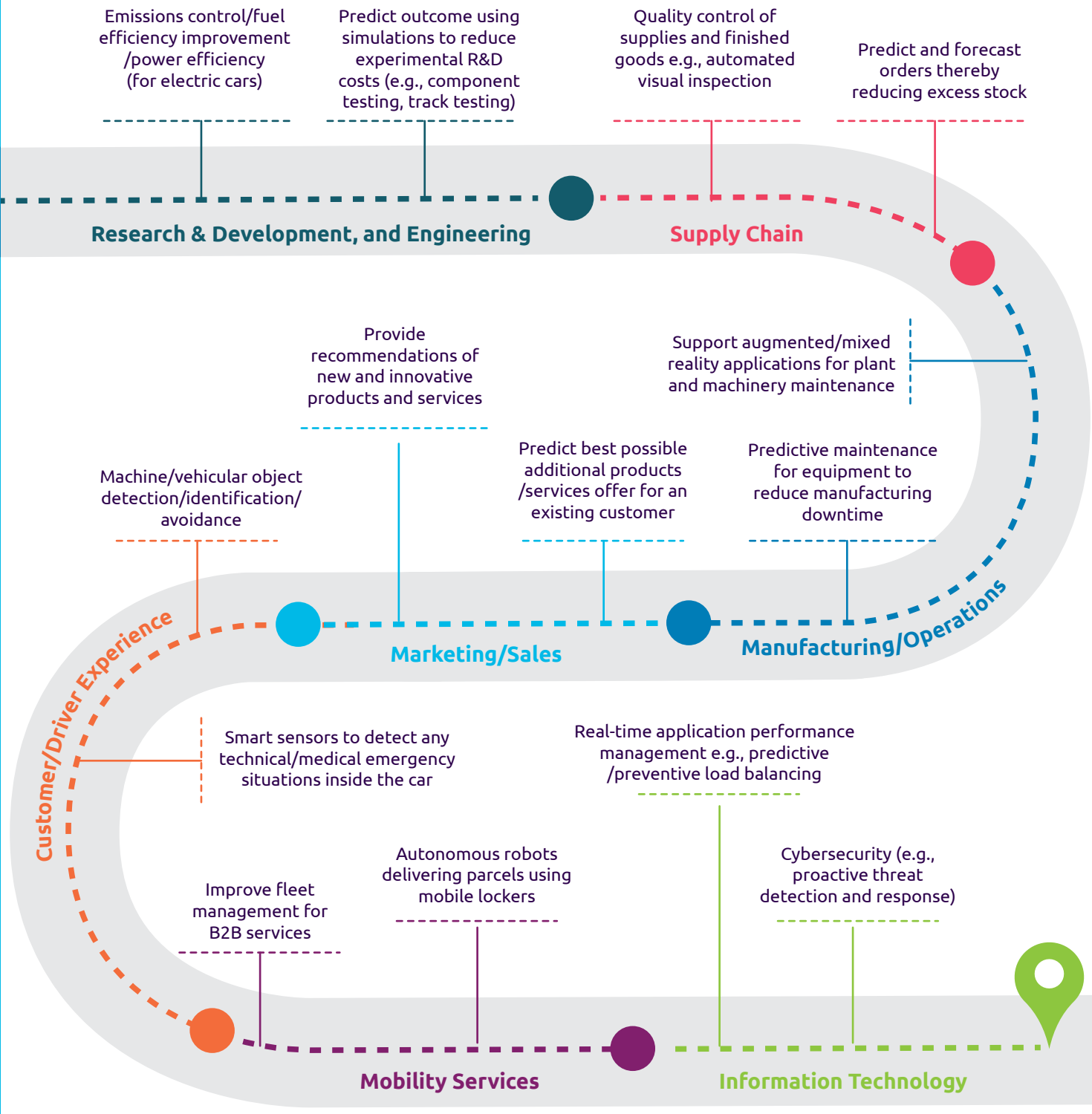


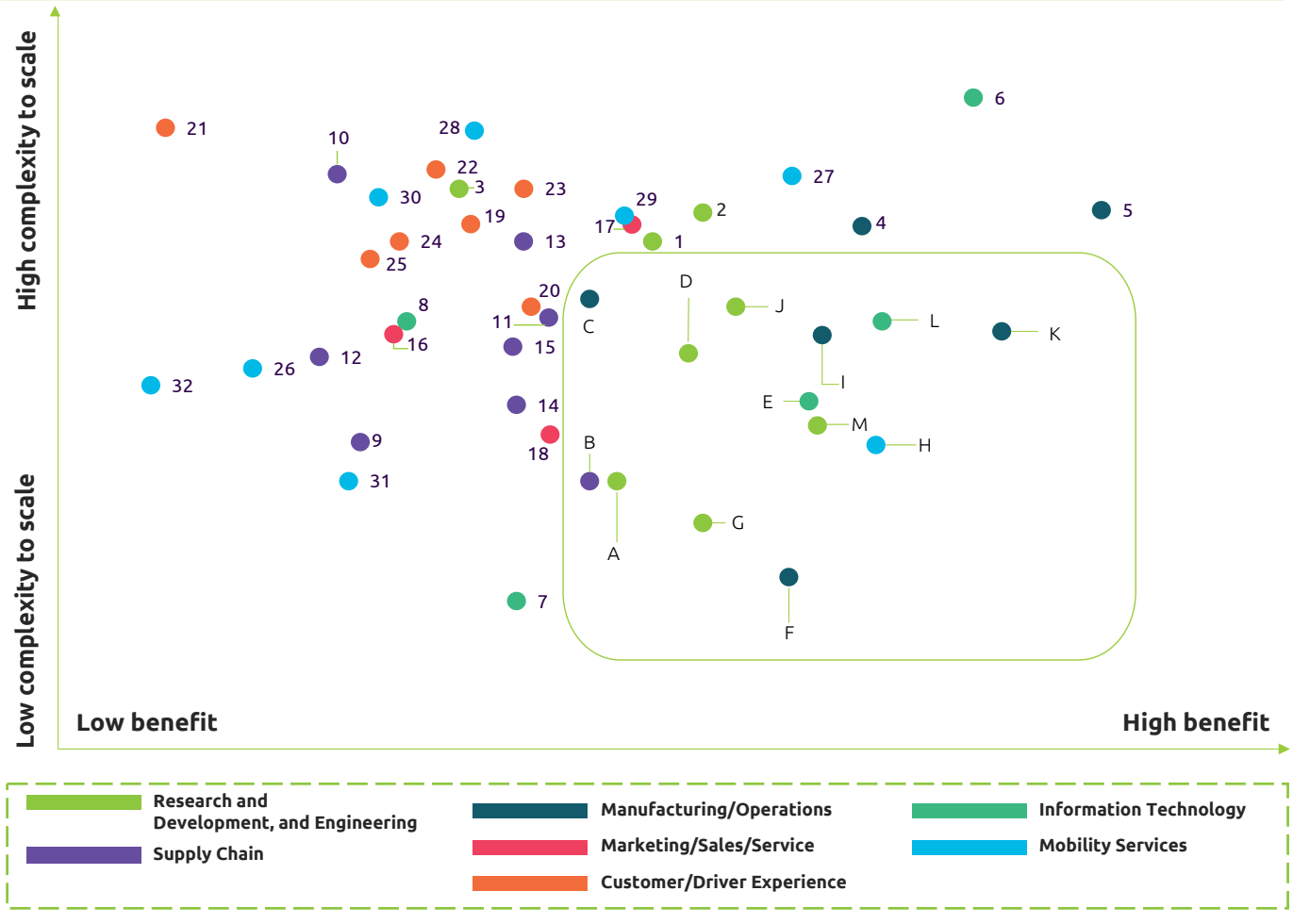
Figure 10: High-benefit AI use cases for the automotive industry – by function



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018-January 2019, N=500 automotive companies.

To get an ever more nuanced view of what use cases to focus efforts on, we also looked at the complexity of delivery. As Figure 11 shows, once we assess use cases against these two dimensions – the relative complexity to deliver a scaled solution and the scale of benefits on offer – we find thirteen ideal candidates for companies' efforts (see Figure 11).

Figure 11: AI use cases with high benefit and low complexity – by function



Use cases in high benefit-low complexity area

A	Predict outcome using simulations to reduce experimental R&D costs (e.g., component testing, track testing)	H	Improve fleet management for B2B services
B	Predict and forecast orders thereby reducing excess stock	I	Energy consumption management in plant operations/warehouses
C	Smart asset management using AI	J	Automated, in-line quality control (i.e. robotics checking the paint job, welding quality, AI software working on videos, images, sound, etc.)
D	Virtual prototyping of new product models	K	Predictive maintenance for equipment to reduce manufacturing downtime (e.g., robotic arm failure)
E	Autonomous self-heal systems (decide on network re-optimization based on conditions not yet occurred)	L	Cybersecurity (e.g.,. proactive threat detection and response)
F	New visualization and productivity optimization options to improve Overall Equipment Efficiency (OEE) in production	M	Emissions control /fuel efficiency improvement /power efficiency (for electric cars)
G	Analyze real-time diagnostics from the vehicle for continuous improvement of future models		

Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018-January 2019, N=500 automotive companies.

S.No.	Use cases not in high benefit-low complexity area	Function
1	Modeling the end-to-end engineering process i.e., digital twin	Research and Development, and Engineering
2	Development and testing of an autonomous driving system	
3	Leveraging customer information for optimizing product design	
4	Advanced process control using AI	Manufacturing/ Operations
5	Support augmented/mixed reality applications for plant and machinery maintenance	
6	Real-time application performance management e.g., predictive/preventive load balancing	Information Technology
7	Event correlation to detect errors and patters to forecast issues	
8	Energy management in data centers and server cloud	
9	Adjusting routes and volumes to meet predicted demand spikes, or re-routing in case of unforeseen events	Supply Chain
10	Supplier selection based on the ability to meet specific requirements and track their performance	
11	Quality control of supplies and finished goods e.g., automated visual inspection	
12	Robots for warehouse management and inspection using AI	
13	AI in reverse supply-chain and returns management	
14	Use AI for inventory optimization	
15	Assortment and storage level optimization for spare parts	
16	Analyze the online behavior of shoppers on different channels (websites, social media, etc.) to personalize offerings/promotions	Marketing/Sales/Service
17	Use AI to predict best possible additional products/services offer for an existing customer	
18	Provide recommendations of new and innovative products and services	
19	Use AI-powered virtual sales assistants/chat bots for sales support, schedule service appointments, cut wait times, and better communicate with customers	
20	Machine/vehicular object detection/identification/avoidance	Customer/Driver Experience
21	Voice assistants to access any customer/digital service and support	
22	Assessing traffic and road conditions in real time by crowdsourcing sensor information from connected vehicles	
23	Smart sensors to detect any technical/medical emergency situations inside the car	
24	Assisted driving features such as – self parking, lane departure, drowsiness and emotion detection, driver face analytics	
25	Predicting vehicle/component breakdown and alerting user/driver in advance	
26	Predicting demand for car/ride sharing or hailing	Mobility Services
27	Autonomous robots delivering parcels using mobile lockers	
28	Detecting and averting frauds in aftermarket and resale	
29	Predictive maintenance of fleet of vehicles using advanced analytics	
30	Supporting multi-modal travelling e.g., delay management, recommending alternative modes of transport	
31	Dynamic pricing to best determine price for each ride	
32	Dynamic routing based on traffic flow	

For high benefit-low complexity use cases by industry segment (OEM, supplier, or dealer), please see appendix. With a clear view of what use cases to focus on, in the next section we look at some of the delivery best practices that characterize automotive organizations that are making significant progress in terms of delivery.

AI seen more as a job creator than a job replacer

Despite concerns about the negative impact of AI on jobs in the industry, the effect so far seems to be muted. As Figure 12 shows, among organizations deploying AI, only around one in five executives (18%) say that AI has replaced jobs in their function – nearly the same number as we reported in 2017 (20%). In fact, the industry has become more positive about AI's job-creation potential – 100% of executives say that AI is creating new job roles, up from 84% in 2017.

Figure 12: Automotive executives' views on AI's impact on jobs have remained unchanged since 2017

Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018-January 2019, N=500 automotive companies. "Now" refers to December 2018 – January 2019, the period during which the survey was conducted.

Artificial intelligence in the automotive industry is often conflated with the use of robotic automation, as the industry is a pioneer in this field. However, significant job losses from robotics are less of an issue today than they were in the past. *"I think that in the automotive industry, the amount of jobs being replaced by robots has peaked already,"* says Alfredo Perez Pellicer, head of R&D at MAHLE Electronics. *"I don't see more factories being closed because of loss of human jobs from robotic automation. Likewise, I don't see AI as a big risk to jobs in the industry. The main driver to implement AI is not to cut jobs or save costs, but to create more value for the customer."*

Dr Martin Hofmann, chief information officer, Volkswagen Group reaffirms Volkswagen's commitment to augmenting, and not replacing, humans with AI. *"AI must always help humans in a meaningful way,"* he says. *"Intelligent robots will learn to optimize themselves, but always to support the human being. In our body shop, we have a high degree of automation with robots, but now we're talking about using human and robot collaboration for the assembly of very critical vehicle components, for example. It's a true collaboration."* [22]

How can automotive organizations effectively scale AI?

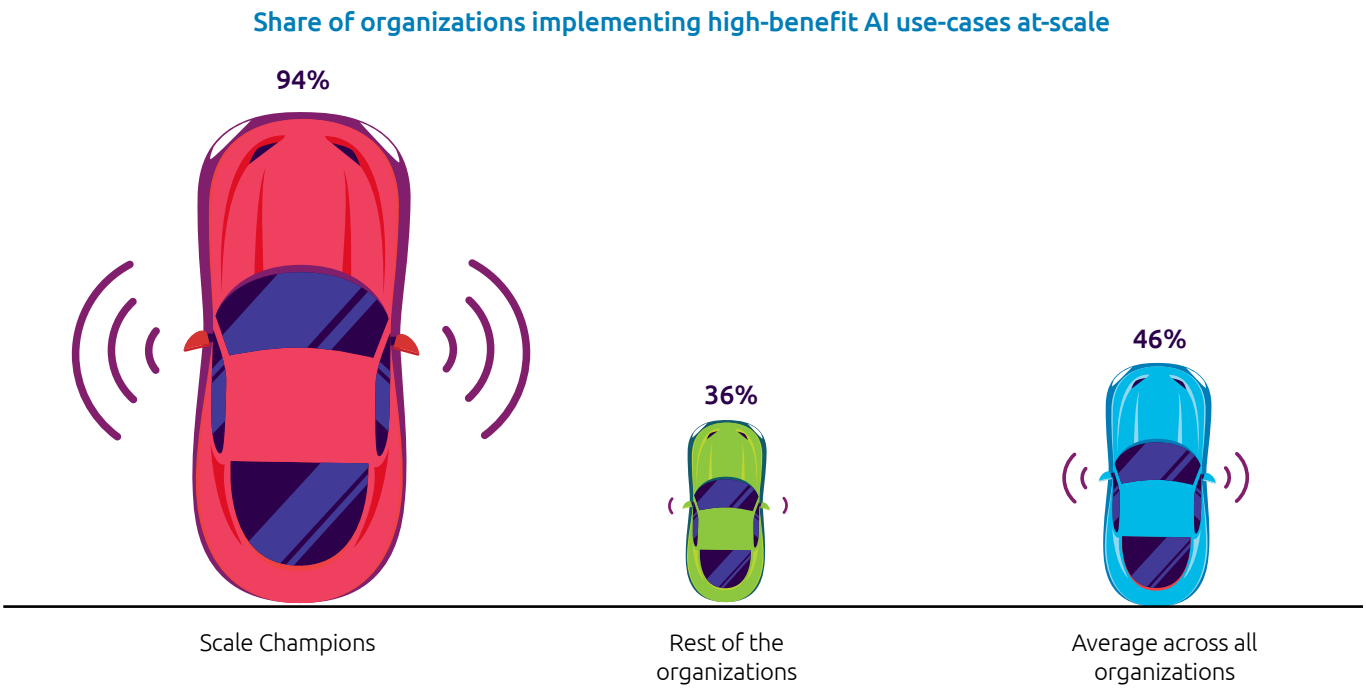
We wanted to understand the characteristics of those organizations that are successfully scaling AI use cases. Taking all 45 use cases, we found a group that are making significant progress in driving use cases at scale, with three or more successfully scaled. This group, which we call the "Scale Champions," displays a number of characteristics that provide an insight into best practice. They:

- Focus on high-benefit use cases
- Have put in place strong AI governance
- Invest more
- Hire AI expertise and proactively upskill their employees
- Develop the maturity of enterprise IT and data practices.

Focus on high-benefit use cases

Scale Champions are highly focused on implementing high-benefit use cases – those that we found yield an above-average benefit level for their function (see Figure 13).

Figure 13: Scale Champions are heavily focused on implementing high-benefit use cases



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.

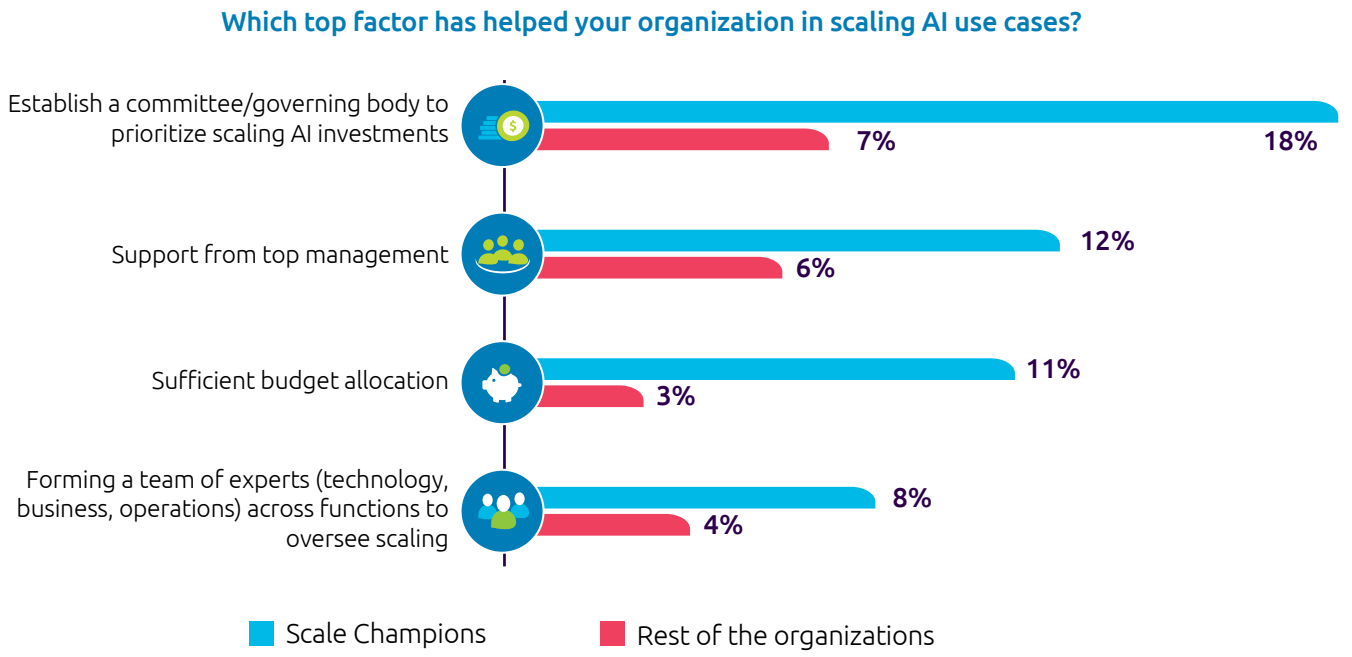
Who are the Scale Champions?

- They are implementing at least three or more AI use cases at scale
- They represent 73 of the 500 automotive organizations that we surveyed for this research
- 44% are from the US, 15% from the UK, and 10% from Germany
- They include a significant proportion of large organizations: 64% have annual revenues of more than $10 billion
- 84% are implementing AI at full scale.

Have put in place strong AI governance

Scale Champions have put in place governance frameworks that allow them to accelerate progress, because they are able prioritize AI investments, secure support from top management, and align the expert resources needed (see Figure 14).

Figure 14: Top governance factors help Scale Champions scale AI use cases



Percentages represent the share of organizations that rate the option as the top factor helpful in scaling AI use cases.
Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.

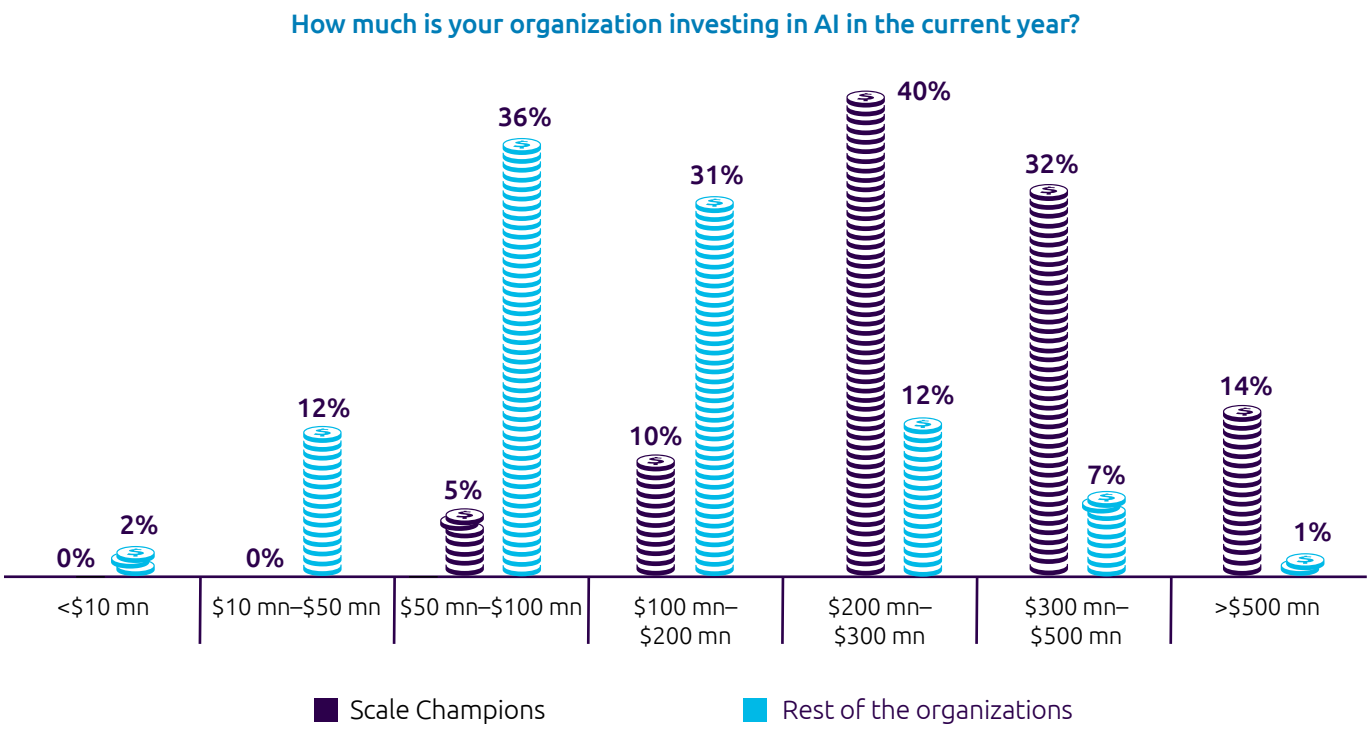
For a senior executive at a large automotive OEM in Europe, the involvement of leaders early on in the process is critical to building momentum. *"We challenged each of the business leaders with finding a use case in their specific business domain,"* he says. *"We prioritized 12 use cases out of over 30 based on how fast we can deploy them, how much value they add, how much cost they will cut, or how much quality will they improve. Further, we balanced that with our ability to execute, given the limited size of the team. Early involvement of the leaders ensured that there is clear consensus and commitment."*

For Continental's Demetrio Aiello, governance approaches should be driven by one priority – the potential value to the customer. *"In one approach, a centralized governing body develops pilots and POCs for various parts of the organization and prioritizes resource allocation depending on the observed benefits and the urgency the internal customers have to implement those use cases,"* he explains. *"In the second, more decentralized approach, each function or business unit augments existing processes with AI, based on customer requirements and market potential. They then scale them using resources at the unit's disposal with some support from central teams. At the end what matters at traditional organizations is the right level of disruption that creates the most value for your customer."*

Invest more

We found that 86% of Scale Champions are investing over $200 million in AI, but this drops to just 20% for the rest of the organizations (see Figure 15).

Figure 15: Most Scale Champions are investing more than $200 million in AI this year



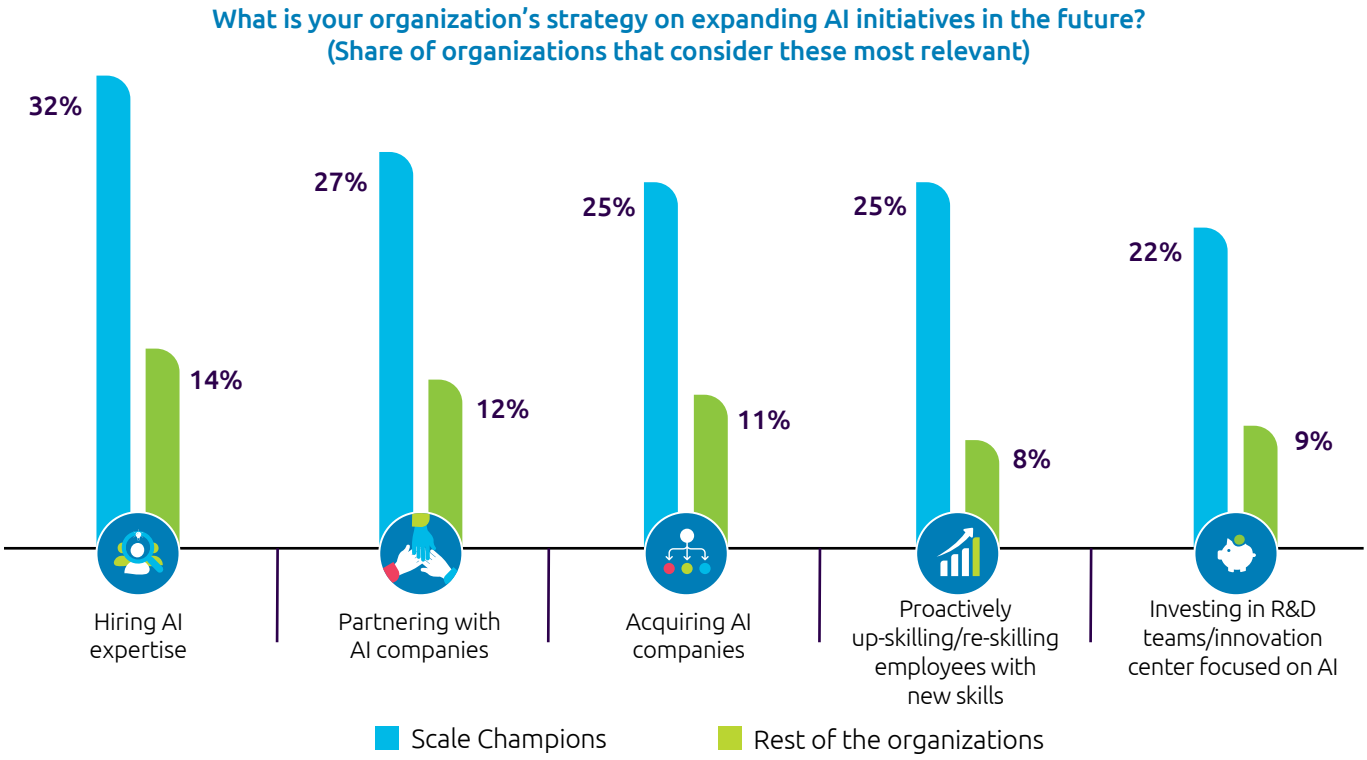
Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018– January 2019, N=500 automotive companies.

Scaling AI use cases requires significant resources, ranging from skills to software. Skills and expertise are in high demand because they are scarce and tend to be concentrated in innovation hotbeds and cities with a thriving startup ecosystem. Solving this issue can requires significant investment, with automotive firms "acqui-hiring" AI skills through acquisition of start-ups.

Hire AI expertise and proactively upskill employees

As Figure 16 shows, Scale Champions are more focused on building their AI talent pool, from hiring AI expertise to upskilling and reskilling their employees.

Figure 16: Scale Champions have a greater focus on skill development as a key strategy to scale AI



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018 –January 2019, N=500 automotive companies.

A senior engineering & quality leader at a European luxury automotive OEM outlines how building skills involves strong collaboration with start-ups and academic institutions, saying: *"We have set up a wholly-owned subsidiary of our firm to work with a number of startups, suppliers and engineering universities, and we are investing heavily within those companies to get access to that engineering development expertise for areas that they are specialized in."*

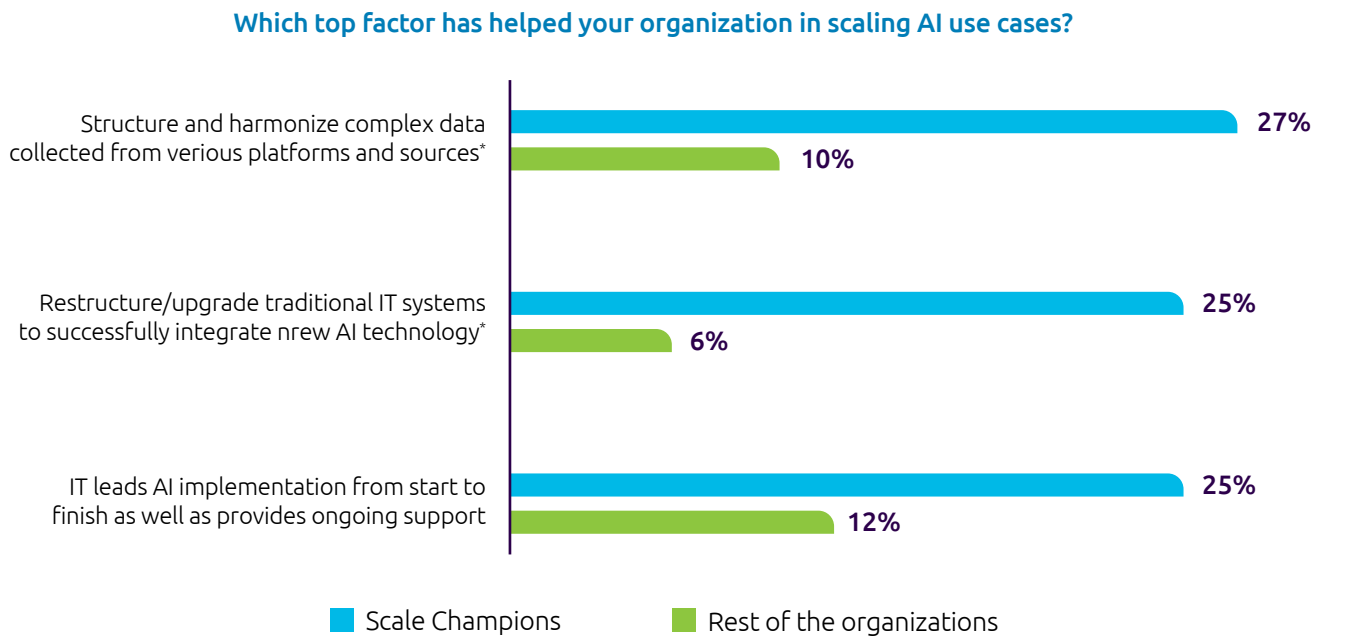
This sort of proactive strategy is critical to building the skills necessary to drive long-term competitive advantage. It can also unlock a performance boost, with our recent research showing that those organizations with scaled upskilling programs report higher levels of workforce productivity.[23] To address the skills shortage in the short run, organizations could look at assessing and piloting processes and tools such as AutoML (Automated Machine Learning) to boost the productivity of AI/analytics experts. AutoML automates the various steps and activities involved in applying machine learning to solve business problems and helps in producing solutions faster.

Leading organizations ensure that not only their workforce – but also their leaders – are up to speed with the latest in technology. *"When it comes to digital we are enabling our leaders with new skills and deeper understanding of technology,"* says Rahul Welde, EVP Digital Transformation at Unilever *"For example, our leaders are enrolled in a reverse-mentoring program, where some of our younger digital-native employees act as mentors to these very senior leaders. And it is very exciting for both these groups."*[24]

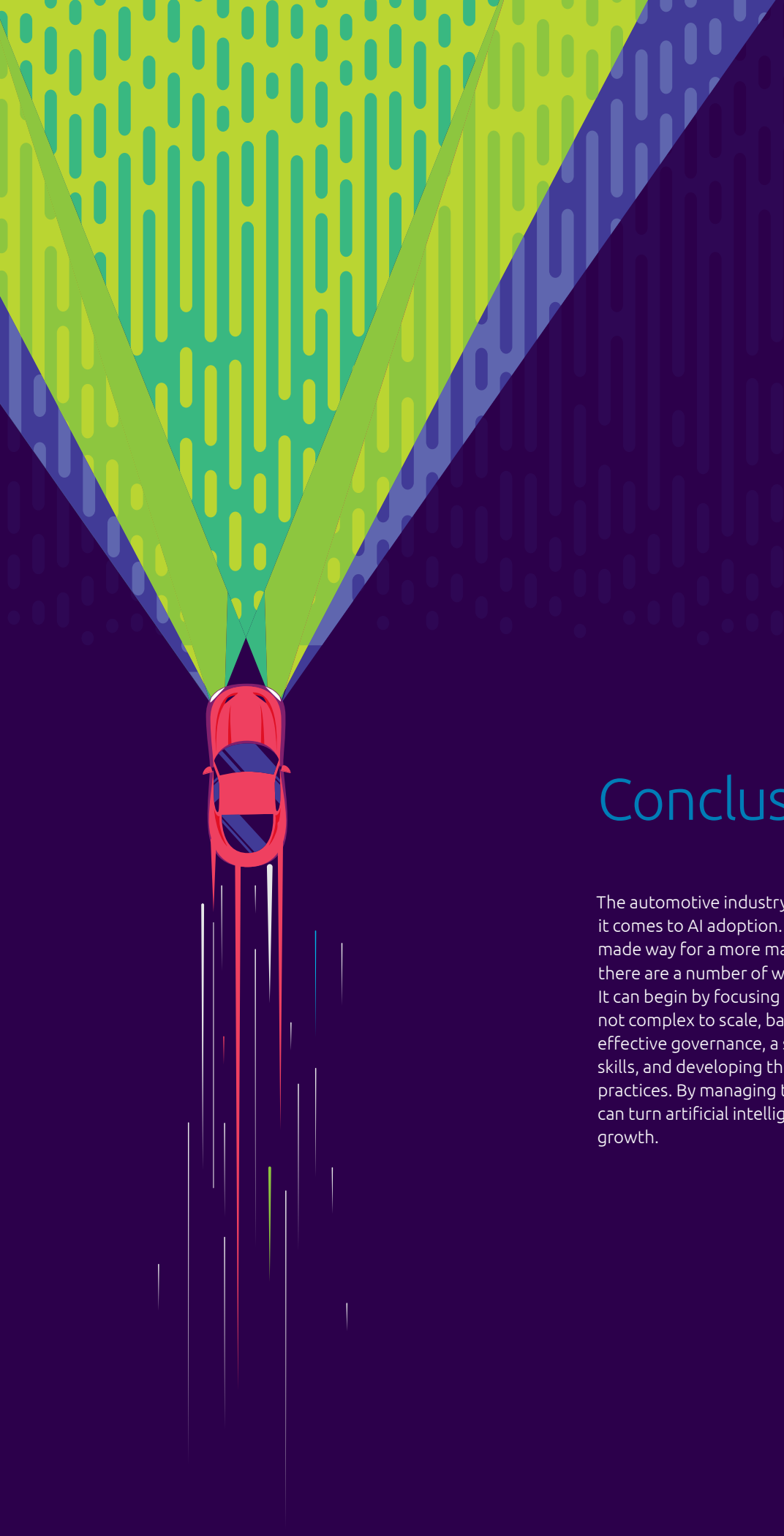
Develop the maturity of enterprise IT and data practices

As Figure 17 shows, Scale Champions have more mature IT and data practices, for instance, harmonizing data collected from a variety of sources, upgrading traditional IT systems to successfully integrate AI, and having IT teams lead AI implementation from start to end.

Figure 17: Scale Champions have more mature IT



Source: Capgemini Research Institute, AI in Automotive Executive Survey, December 2018–January 2019, N=500 automotive companies.
* Identified as a top 3 factor to have helped in scaling AI use cases.



Conclusion

The automotive industry has made moderate progress when it comes to AI adoption. Excessive experimentation has made way for a more mature and calculated approach. But there are a number of ways that the industry can accelerate. It can begin by focusing on high-benefit use cases that are not complex to scale, backed up by committed investment, effective governance, a strategy for building the required skills, and developing the maturity of enterprise IT and data practices. By managing these dimensions, automotive players can turn artificial intelligence into a powerful engine of growth.

Appendix

Top high-benefit, low complexity AI use cases for automotive OEMs

Use cases	Function
Virtual prototyping of new product models	R&D
Automated, in-line quality control (i.e. robotics checking the paint job, welding quality, AI software working on video, images, sound, etc.)	R&D
New visualization and productivity optimization options to improve overall equipment efficiency (OEE) in production	Manufacturing/operations
Predictive maintenance for equipment to reduce manufacturing downtime (e.g. robotic arm failure)	Manufacturing/operations
Improve fleet management for B2B services	Mobility services

Top high-benefit, low complexity AI use cases for automotive suppliers

Use cases	Function
Predictive maintenance for equipment to reduce manufacturing downtime (e.g. robotic arm failure)	Manufacturing/operations
Cybersecurity (e.g. proactive threat detection and response)	IT
Emissions control/fuel efficiency improvement/power efficiency (for electric cars)	R&D
Automated, in-line quality control (i.e. robotics checking the paint job, welding quality, AI software working on video, images, sound, etc.)	R&D
Autonomous self-heal systems (decide on network re-optimization based on conditions not yet occurred)	IT

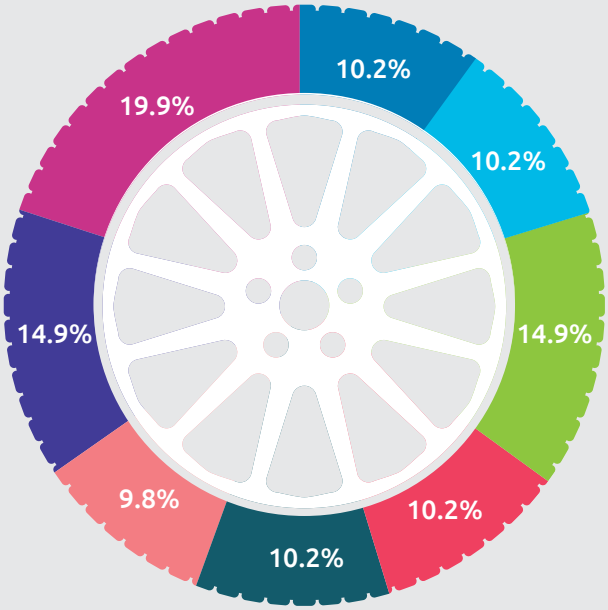
Top high-benefit, low complexity AI use cases for automotive dealers

Use cases	Function
Energy consumption management in plant operations/warehouses	Manufacturing/operations
Cybersecurity (e.g. proactive threat detection and response)	IT
Predict and forecast orders, thereby reducing excess stock	Supply chain

Research Methodology

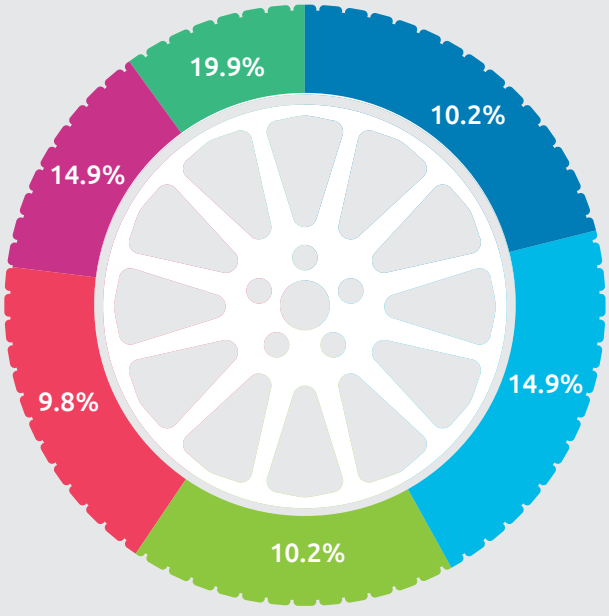
We surveyed 500 automotive executives from large automotive organizations in eight countries from December 2018 and January 2019, and also conducted in-depth interviews with a number of industry experts and entrepreneurs.

Organizations by Country



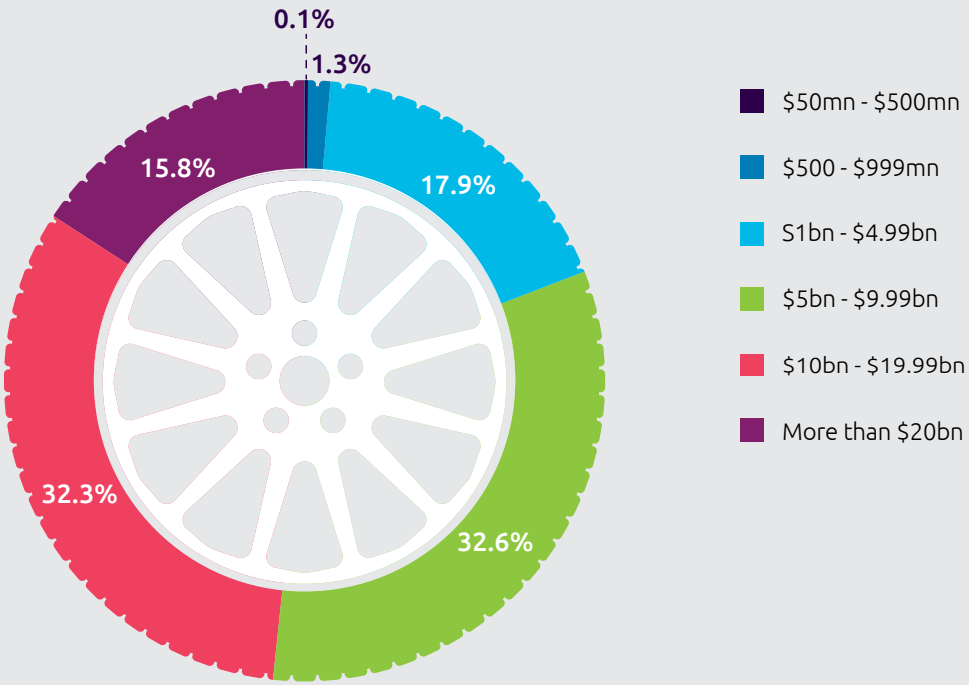
China
France
Germany
India
Italy
Sweden
UK
US

Respondents by Designation

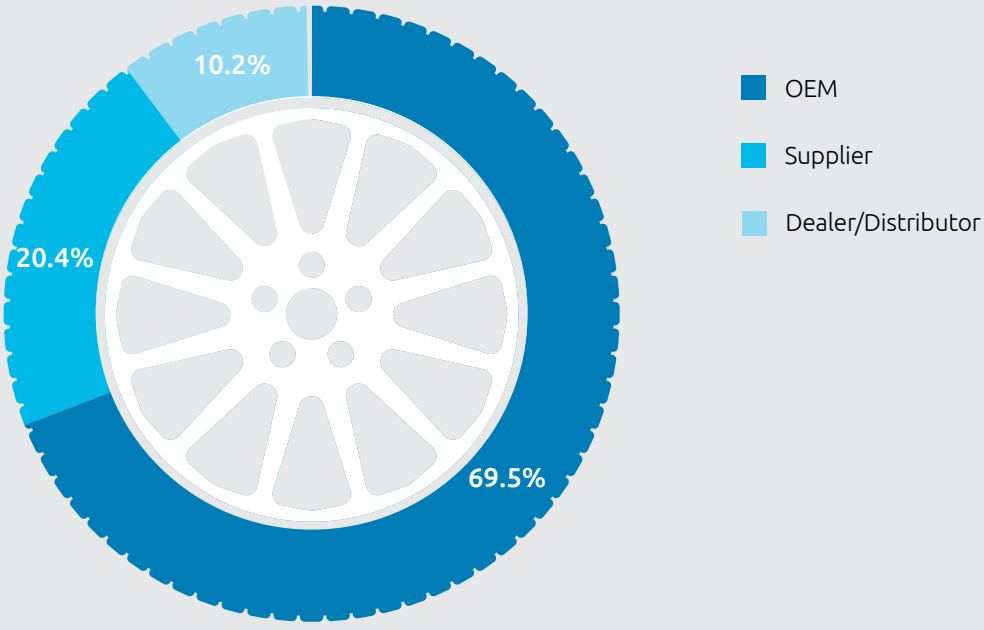


Associate Director
Senior Manager
Director
Senior Director
Vice President
Senior Vice President

Organizations by Revenue



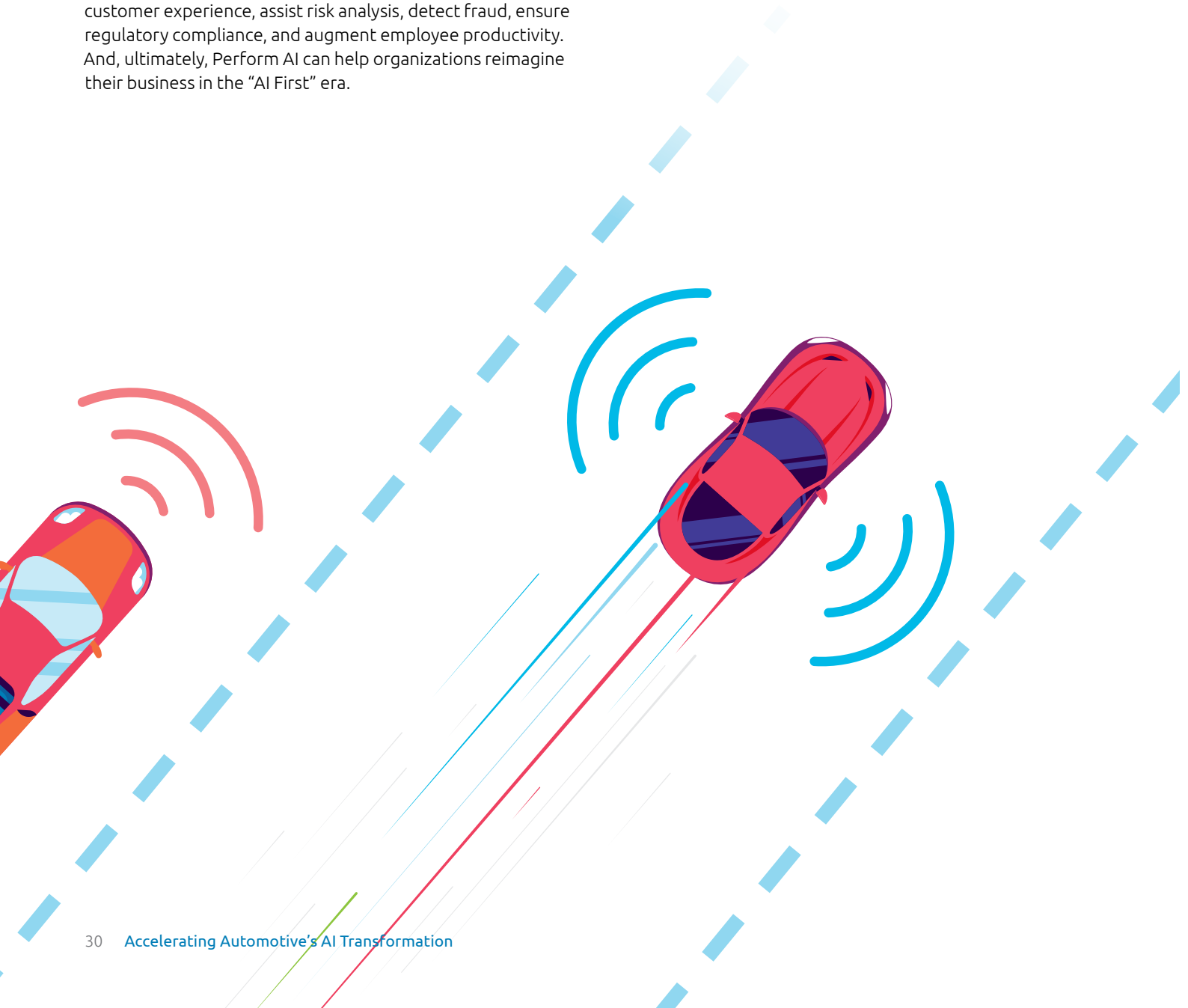
Respondents by Category



Capgemini propositions to address the AI challenge

Capgemini's **Perform AI**[25] is a complete portfolio of AI services enabling clients to move beyond proof of concept to pragmatic delivery at scale, with real-world impact – enhancing operational excellence, growth, performance, and business innovation. By responsibly and ethically infusing AI technologies across their business, organizations can achieve business transformation through greater operational efficiency, boost sales and loyalty through a human-centered customer experience, assist risk analysis, detect fraud, ensure regulatory compliance, and augment employee productivity. And, ultimately, Perform AI can help organizations reimagine their business in the "AI First" era.

Capgemini's **Smart Mobility Connect**[26] is a series of custom Automotive offers that utilize the benefits of AI. It empowers clients to digitalize their core business and customer-facing channels (connected customer), to monetize new growth potential (connected services and products), expand the profit pool with new partnerships (connected ecosystem) and transform to a customer-centric business, leveraging the overarching AI-enabled customer engine platform.



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The Capgemini Research Institute is Capgemini's in-house research center. The Institute publishes research on the impact of digital technologies on large traditional businesses. The team draws on the worldwide network of Capgemini experts and works closely with academic and technology partners. The Institute has dedicated research centers in India, the United Kingdom and the United States. It was recently ranked #1 in the world for the quality of its research by independent analysts.
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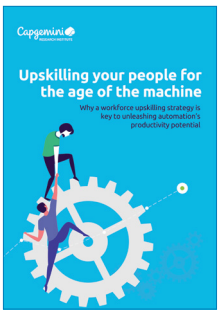

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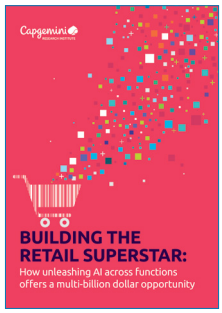

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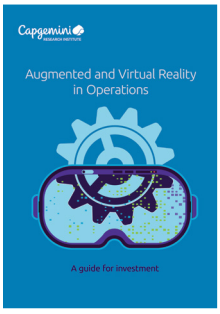
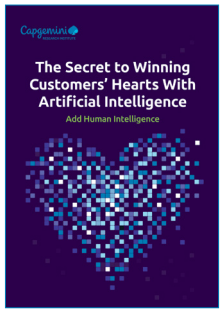


Augmented and Virtual Reality in Operations



The Secret to Winning Customers' Hearts With Artificial Intelligence

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