

Automotive Industry Agenda

Special Edition 2019



PRESIDENCY OF THE REPUBLIC OF TURKEY
INVESTMENT OFFICE



Building a better
working world





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Arda Ermut

President

The Presidency of the
Republic of Turkey
Investment Office

Dear Readers,

The automotive world is undergoing a significant transformation. Being one of the central players in the value chain, Turkey is closely monitoring the ongoing developments and is taking major steps to ensure its dominant position. As the Turkish automotive industry is reinforcing its international standing every day, all stakeholders in the ecosystem need significant resources to take advantage of emerging opportunities. We believe that one of the prerequisites for capturing these opportunities that are transforming the automotive industry, especially with regard to electric and autonomous vehicles, is to have access to the right sources of information.

In the second issue of our "Turkish Automotive Industry Agenda" study, we, **The Presidency of The Republic of Turkey Investment Office** and **EY Turkey**, have curated another detailed and comprehensive report for the benefit of all stakeholders in the automotive industry. Following our first study, in which we outlined the recent developments unfolding in the industry, we have emphasized the subjects of digitalization and electric vehicles in this issue. On top of these issues deemed of immediate relevance to the automotive ecosystem, we are offering incentive certificate statistics, legislative changes, and success stories of leading companies in the industry for our readers' appreciation. Furthermore, in addition to the Turkish automotive industry's 2018 year-end and 2019 Q1 performance, we have also included in this issue our analysis "Global Automotive Industry and Comparison of Turkey", which we believe is slated to reflect properly the competitive environment of Turkey.

While they have maintained a constant inflow since 2000, automotive investments shifted into higher gear in 2018. The Ministry of Industry and Technology announced that they issued approximately TRY 13 billion worth of incentive certificates for investment projects throughout the year. Approximately TRY 9 billion of the disclosed investments were received from foreign-capital companies. Local companies accounted for as much as TRY 3 billion worth of investments. This data alone indicates that Turkey's appeal to automotive companies remains unwavering.

I would like to express my gratitude to all those who have contributed to the preparation of this issue, especially EY Turkey, and all of relevant private sector representatives who have not spared any effort to support our endeavor to bring Turkey to the position it deserves in the international arena.

Arda Ermut

President

The Presidency of the Republic of Turkey Investment Office

Preamble



Serdar Altay

EY Turkey

Automotive Industry Leader

Distinguished stakeholders of the automotive industry and members of the sector,

As you may remember, "Automotive Industry Agenda / Special Edition 2018" has been edited in cooperation with the Presidency of the Republic of Turkey Investment Office and presented to the attention of our distinguished stakeholders a few months ago. We feel so glad to share the second issue we prepared on the great interest and positive feedback from all.

Concepts such as e-mobility, autonomous driving and connected vehicles have just become concepts that the entire industry started to become much familiar. The sharing economy is now reducing the importance of owning a vehicle and beginning to change basic income models altogether. The world's leading OEMs (original equipment manufacturer) and all stakeholders of this ecosystem are investing billions of dollars in this field so as to prepare themselves for the future, to get rid of the destructive effect of digitalization and not to be deprived of the latest opportunities.

Electric vehicles have just started to surround our lives as well. The world's major economies are changing their legislation in this direction, automobile manufacturers are making plans of the next 20-30 years and developing new models. During the transition period from internal combustion engines to electric vehicles, the demand for hybrid vehicles is increasing gradually. While this transition will eliminate many products from the industry, it will also add many product manufacturers as new players.

Therefore, in this issue, we decided to focus on 'digitalization and electric vehicle' that are at the top of the global and automotive sector agenda. We would like to share the precious information gathered by EY Global including the current state of the world market in terms of these elements and the direction it follows, predictions about the future and market research.

This special edition provides context on the following:

- Evaluation of the end of 2018 and the first quarter of 2019
- Changes introduced on various tax laws in Turkey
- Comparison of the global automotive industry and Turkey
- Automotive investments with incentive certificate in 2018
- Research on the automotive sector
- Digitalization in the automotive sector
- Global electric vehicle market analysis

As the members of the EY Turkey Automotive Sector team and Presidency of the Republic of Turkey Investment Office, let us thank you all for the interest and attention to this edition which we think that it will be useful for all our readers interested in the automotive industry.

Serdar Altay

EY Turkey Automotive Industry Leader

Executive summary

2018 year end and 2019 Q1 evaluation

- ▶ The auto market contracted at the close of 2018 after record sales figures in the previous 3 years.
- ▶ As the market narrowed throughout the year, local models reinforced their position in the passenger car market.
- ▶ In the commercial vehicle market, domestic models acquired 50% market share in 2018.
- ▶ Tendency to prefer premium brands (11%) did not show a notable change in 2018.
- ▶ The growth in the European vehicle market, the biggest market for Turkish automotive companies, was 0.4% throughout 2018. A drop of 200,000 and 70,000 units was observed in the UK and Italy respectively, due to political and economic developments.
- ▶ The turmoil in key export markets and the developments in the domestic market have also affected the production figures.
- ▶ 5% shrinkage was noted last year in global commercial vehicle production, where Turkey has attained a strong position.
- ▶ The share of sales of Turkish domestically manufactured vehicles has significantly increased in terms of exports.
- ▶ Along with the dip on the production side, a drop of 5% was noted in passenger vehicle export.
- ▶ Due to the growth in the European auto market and the diversification of models, Turkish passenger vehicles increased their exports on a value basis in 2018 and reached the level of 12.5 billion dollars.
- ▶ A record increase has been witnessed in commercial vehicle exports together with the development achieved by Ford and Mercedes-Benz.
- ▶ In 2018, in addition to quantities, the 7 billion dollar threshold was also surpassed with a 10% value increase in exports.
- ▶ Turkey again this year maintains the position of being the biggest vehicle manufacturer in its territory.
- ▶ The losses, which were more pronounced in the second half of 2018, have maintained their effect during the first quarter of 2019.
- ▶ The European auto market, which is among the key export markets of the Turkish automotive industry, narrowed by 2.1% in the first quarter of 2019 compared to the same period of last year.
- ▶ According to the results of the first quarter in 2019, the production in the industry dropped by 16%.
- ▶ Ford, Mercedes, and other commercial vehicle manufacturers have maintained their levels of 2018 during the first quarter of this year.
- ▶ During the first 3 months of the year, passenger vehicle exports were realized as 210,000 units. Renault is leading this increase with 12%.
- ▶ A record increase has been witnessed in commercial vehicle exports together with the development achieved by Ford and Mercedes-Benz.

Automotive industry in a timeline perspective

- ▶ In the years after 2000, in line with the changes in supply and demand profiles of world markets, the automotive industry restructured its production capacity and network worldwide. While the vehicle production increased from 56 million to 97 million units in less than 20 years, the production network of international manufacturers have also diversified.
- ▶ In this period, the North America - Western Europe axis lost its dominance as a production location and the East emerged as the new dominant region. Besides China, various regions have taken their position in the production network of global companies.
- ▶ Between 2000 and 2017 China, Turkey, Slovakia, Czech Republic, and Hungary are the first five countries having the highest export growth rate. With CAGR of 20%, Turkey has the second highest growth rate.
- ▶ Capacity in Turkey has increased from 800k in 2000 to 1.9 million units in 2017. In line with this, production increased from 468k to 1.69 million vehicles.
- ▶ Following the new capacity set-ups of OEMs and the investment of the supplier industry triggered by these new capacities, the total revenue of the automotive industry in Turkey increased from 17.6 Euro to 37.7 Euro from 2009 to 2017.

Digitalization

- ▶ This exponential growth has generated four forces of business disruption: de-materialization, decline of transaction costs, de-centralization of decision-making, and information availability and accessibility.
- ▶ Digital is a fundamental part of the major drivers of change shaping the global automotive ecosystem over the next decade.
- ▶ Developing and owning an ongoing relationship with both customers as well as consumers and retaining loyalty are the biggest challenges.
- ▶ New business models require close integration of both manufacturing and supply chain operations.
- ▶ Today's automotive innovation is pioneered by start-ups; ignoring them could be a loss of innovative and creative ideas.
- ▶ Collaboration in the ecosystem is the new normal and is replacing traditional automotive value chain dynamics.
- ▶ With digital leading to an exponential surge in the volume of data generated, analytics could transform how business decisions are made in the automotive industry.
- ▶ Relevance of cybersecurity has increased with connected car initiatives that link vehicles with surrounding networks. Blockchain emerges as a potential tool to improve transparency and provenance across the system.

Electric vehicles

- ▶ OEMs are showing a renewed interest in the EV market and have set steep targets for EV penetration. Despite the automaker interest, most customers continue to avoid EVs.
- ▶ EVs are expected to witness rapid growth with BEVs (battery electric vehicles) and PHEVs (plug-in hybrid electric vehicle) gradually gaining share from HEVs (hybrid electric vehicle).
- ▶ Emission standards, declining battery costs, and charging infrastructure remain the determining factors for EV adoption rates.
- ▶ Transition from internal combustion engines to EVs will have a significant impact on suppliers in terms of content loss, opportunities, and technology shifts..



2018 YE and 2019 Q1 Evaluation

Global Automotive Industry vs Turkey

Investment incentives in automotive industry in 2018

Automotive industry research

Digitalization in automotive sector

Global EV market analysis

Automotive industry trend analysis

Automotive industry trend analysis

Market trend

Production performance

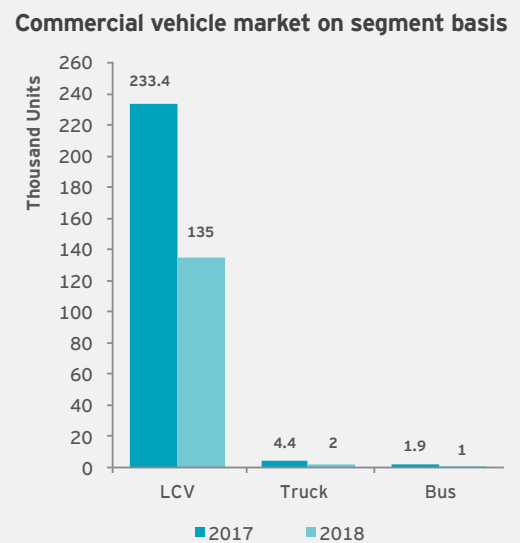
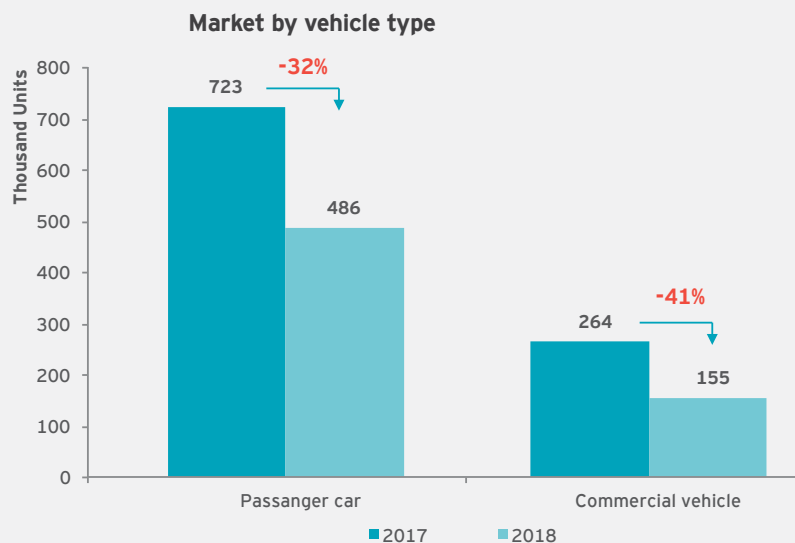
Export performance

Comparative analysis of production

1. Market trend

The auto market contracted at the close of 2018 after record sales figures in the previous 3 years.

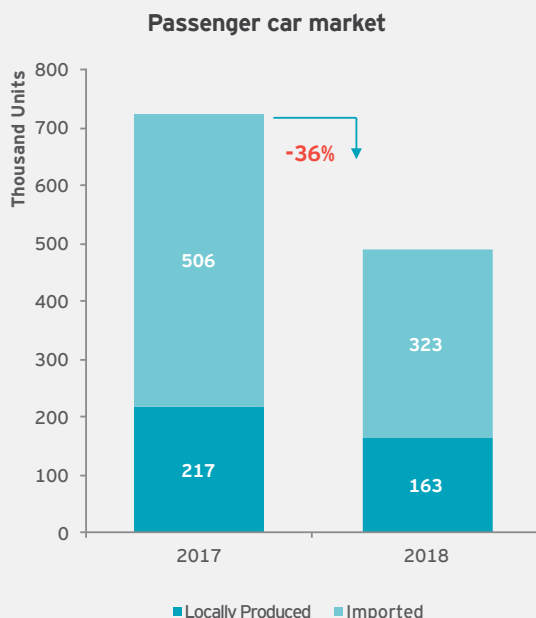
As you may be aware, Turkish auto market recorded a 1m-unit-growth per annum on average between 2015-2017. In 2018, a significant shrinkage has been noted particularly due to the impact of the macroeconomic developments in Q2 2018. The shrinkage in the auto market was 32% for passenger vehicles and 41% for commercial vehicles. A downturn in the light commercial vehicles (LCV) market, once regarded as one of the strongest areas in Turkey, has been influential in this overall decline. Industrial specialists project that the market will regain its previous levels with the rebound in economy in the long run.



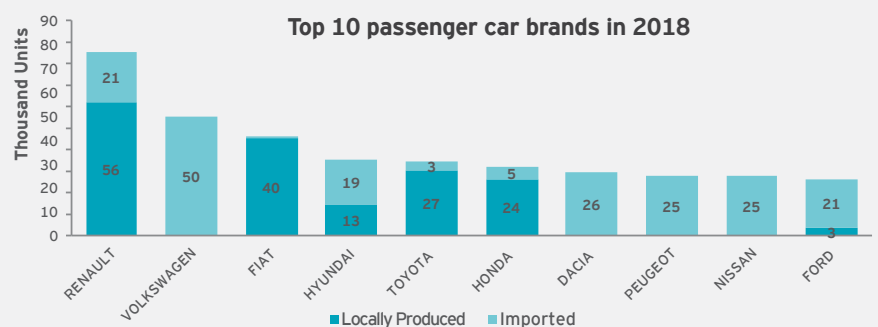
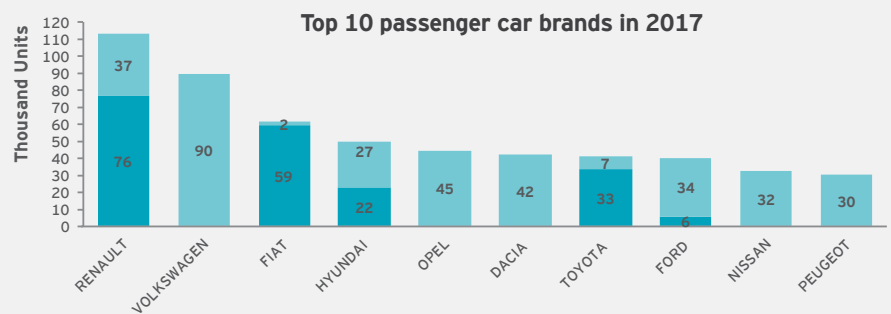
Source: Automotive Industry Association (OSD)

As the market narrowed down throughout the year, local models have reinforced their position in the passenger car market.

Compared to the same period of the previous year, Renault maintained its lead in passenger cars in 2018 despite the shrinkage in sales. Turkish-built models accounted for 73% of Renault's sales. The French brand was followed by Volkswagen, Fiat, and Hyundai respectively, thereby mirroring the same order as last year. Throughout this period, Toyota and Honda were seen rising in ranking as sales of other imported brands plummeted - a trend which further cements the view that a preference for locally-produced vehicles reigns supreme.

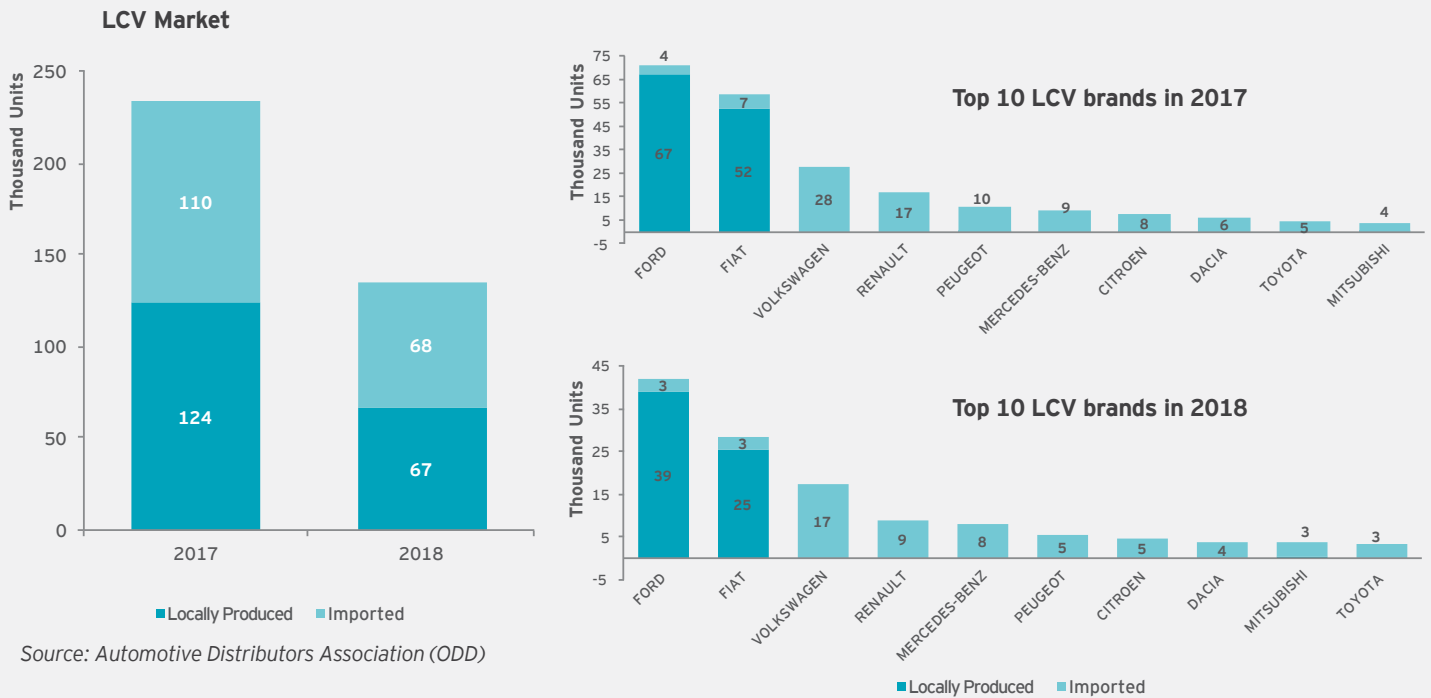


Source: Automotive Distributors Association (ODD)



In the commercial vehicle market, domestic models acquired 50% market share in 2018.

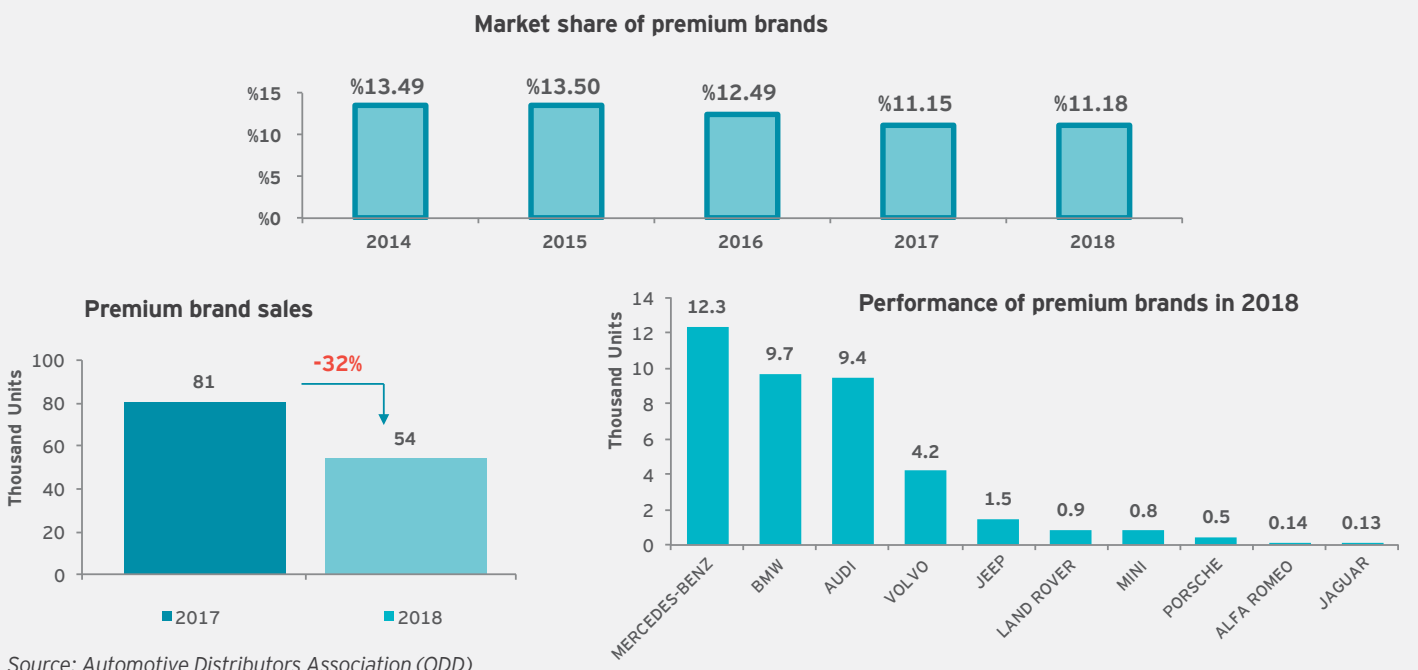
It is understood that the Special Consumption Tax discount and company campaigns in Q4 did not bring about a rebound in the LCV market. Nevertheless, Ford and Fiat maintained their hegemony over the market, thanks mainly to domestic LCV models. German and French automakers followed closely in 2018 with their imported models.



Source: Automotive Distributors Association (ODD)

Tendency to prefer premium brands (11%) did not show a notable change in 2018.

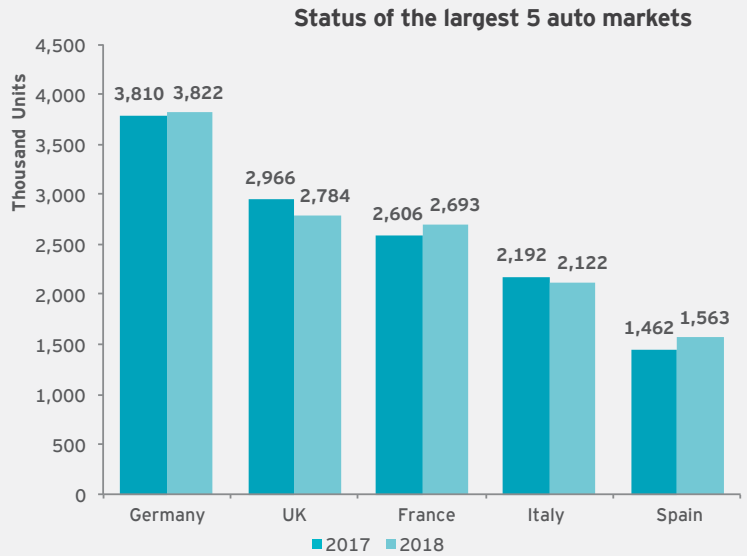
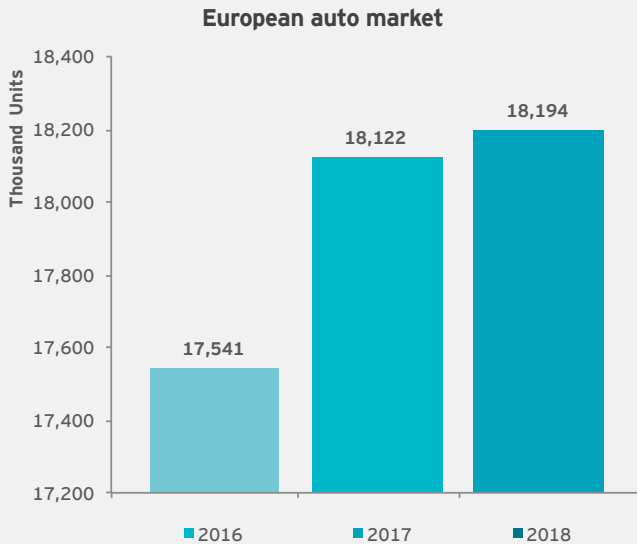
Upon examining passenger car sales data in 2018, it is safe to assume that marketed models of premium brands had a market share of over 11%. Similar to previous years, German brands have maintained their top place in this field. In total, a drop of 27,000 units shows that 2018 was challenging for luxury vehicle sales.



Source: Automotive Distributors Association (ODD)

The growth in the European vehicle market, the biggest market for Turkish automotive companies, was 0.4% throughout 2018. A drop of 200,000 and 70,000 units was observed in the UK and Italy respectively, due to political and economic developments.

Germany, the leading country among Turkey's vehicle importing destinations, registered a small growth of 12,000 units, whereas France and Spain had 87,000 and 101,000 units growth respectively. The slump in the UK market is blamed on Brexit during the same period. Italy's sluggish market is due to political, economic developments.



Source: ACEA

Automotive industry trend analysis

Market trend

► Production performance

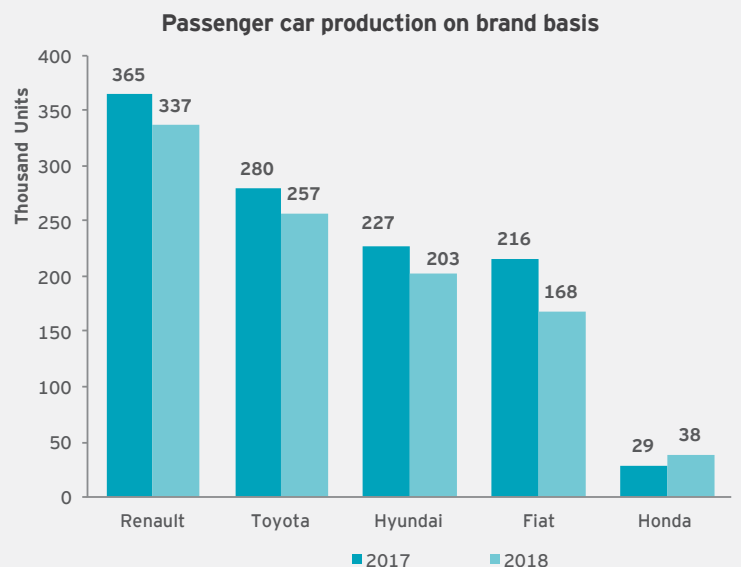
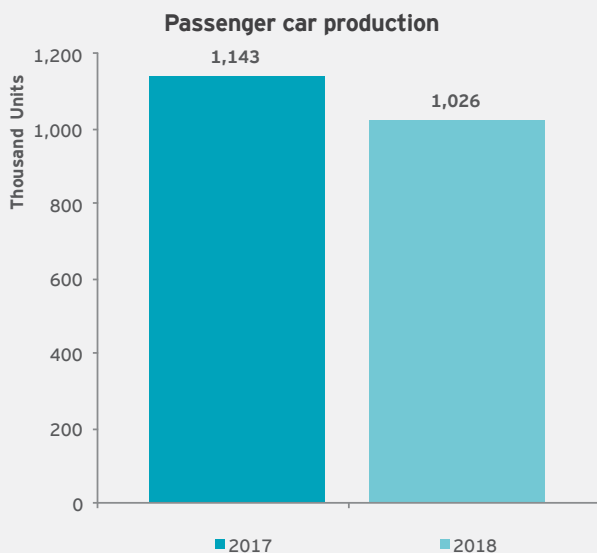
Export performance

Comparative analysis of production

2. Production performance

The turmoil in key export markets and the developments in the domestic market have also affected the production figures.

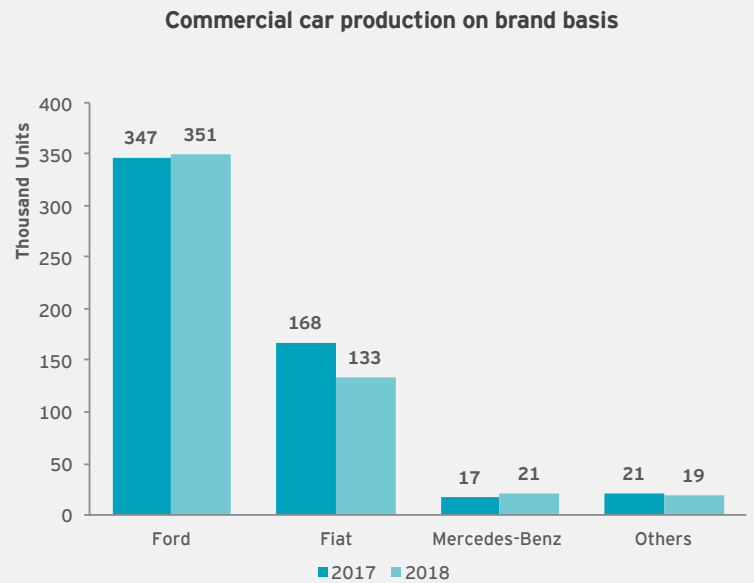
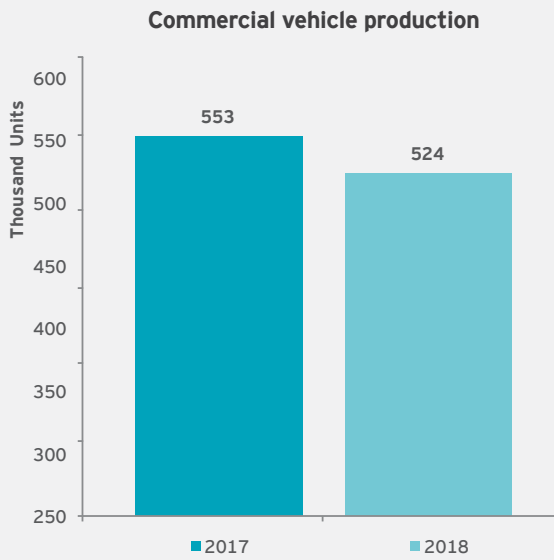
Throughout 2018, partial shrinkages have been noted in the production levels of 5 brands that manufacture passenger cars in Turkey. However, Honda has achieved up to 34% growth, attributed for the most part to the manufacturing of its diesel Civic model during the same period. Fiat's production dropped by 20%, while the average slump of the overall industry was 10%.



Source: Automotive Industry Association (OSD)

5% shrinkage was noted last year in global commercial vehicle production, where Turkey attained a strong position.

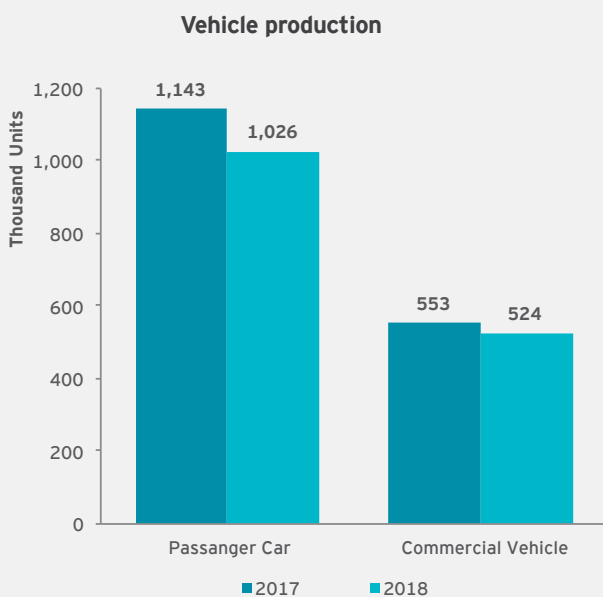
A 29,000-unit drop was observed in the production quantities of commercial vehicle manufacturers in 2018. On looking at the background of this statistic, it is possible to say that the production shrinkage experienced by Fiat could not be covered with the increase on Ford's and Mercedes-Benz's side; furthermore, other commercial vehicle manufacturers have also had a negative effect on this statistic..



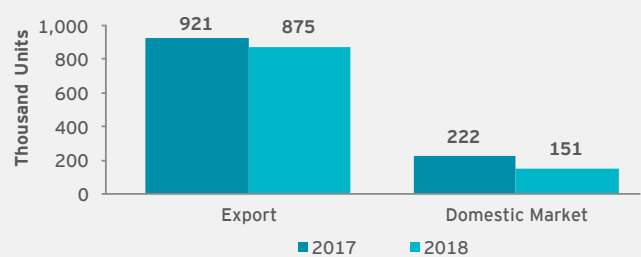
Source: Automotive Industry Association (OSD)

The share of sales of Turkish domestically manufactured vehicles has significantly increased in terms of exports.

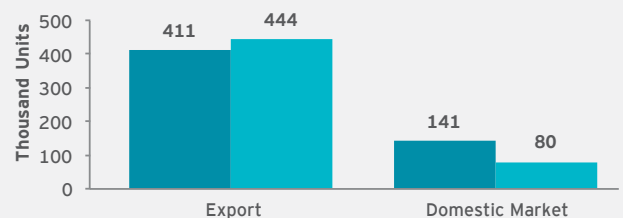
Throughout the years, OEM's have positioned Turkey as an export center. This year, manufactured vehicles' share in export to the target markets has also increased and showed that the same trend has continued. At the same time, manufacturers' export capability made it possible to mitigate the impact of negative developments in the domestic market. In 2018, the industry's export/production ratio was noted as 85%. This ratio was 78% in 2017.



Target markets for the passenger cars manufactured in Turkey



Target markets for commercial vehicles manufactured in Turkey



Source: Automotive Industry Association (OSD)

Automotive industry trend analysis

Market trend

Production performance

► **Export performance**

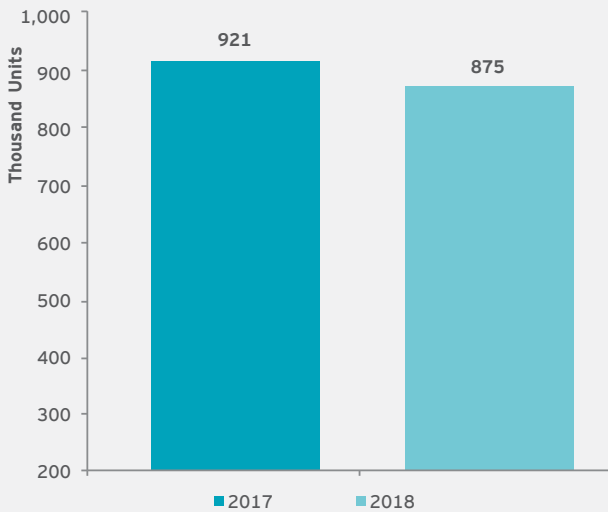
Comparative analysis of production

3. Export performance

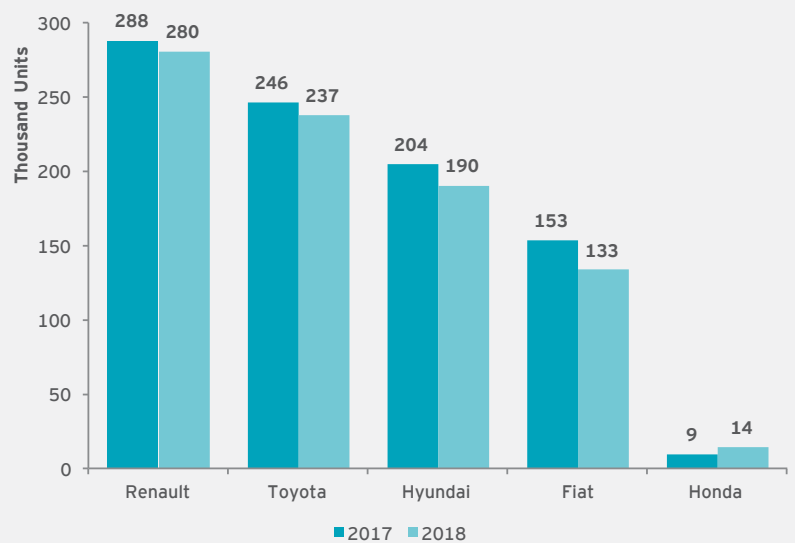
Along with the dip on the production side, a drop of 5% was noted in passenger vehicle export.

Passenger car exports slipped from approximately 921,000 units in 2017 to 875,000 units in 2018; with a 5% decrease. Main manufacturers of the passenger car industry have been influenced by this decline in similar degrees. Honda, which has manufactured Civic model's diesel version, has recorded an export increase of 45% with the influence of this model and the production quantities.

Passenger car export



Passenger car export on brand basis

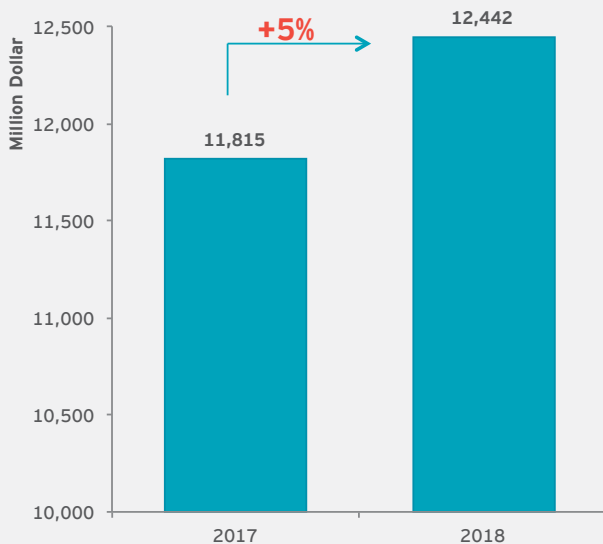


Source: Automotive Industry Association (OSD)

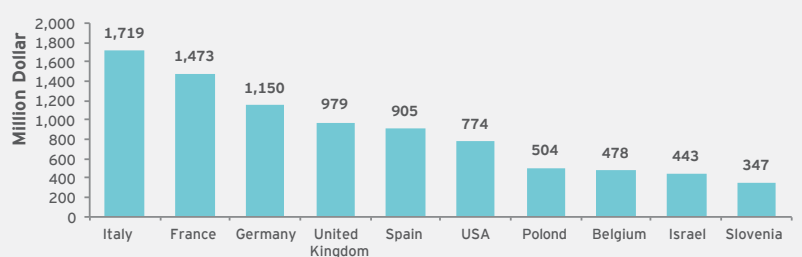
Due to the growth in the European auto market and the diversification of models, Turkish passenger vehicles increased their exports on value basis in 2018 and reached the level of 12.5 billion dollar.

The industry exported passenger cars north of \$12.4 billion last year, particularly with a significant increase in value for sales to the markets of France, Spain, the United Kingdom and Belgium. Turkey's passenger cars exports to Italy, where the domestic market has slowed down in terms of the number of units, maintained their previous level, and Turkish-origin vehicles reinforced their position in the United Kingdom.

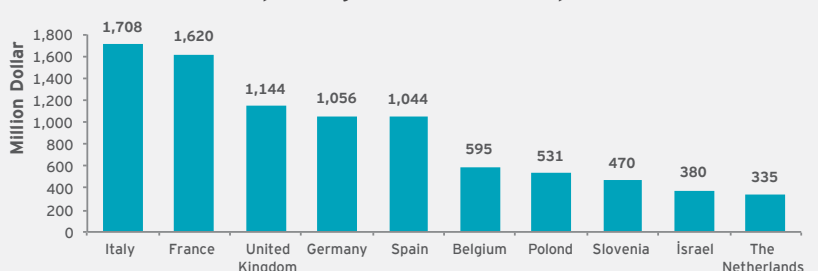
Total passenger car export revenue



10 countries to which passenger vehicles were exported most in 2017



10 countries to which passenger vehicles were exported most in 2018

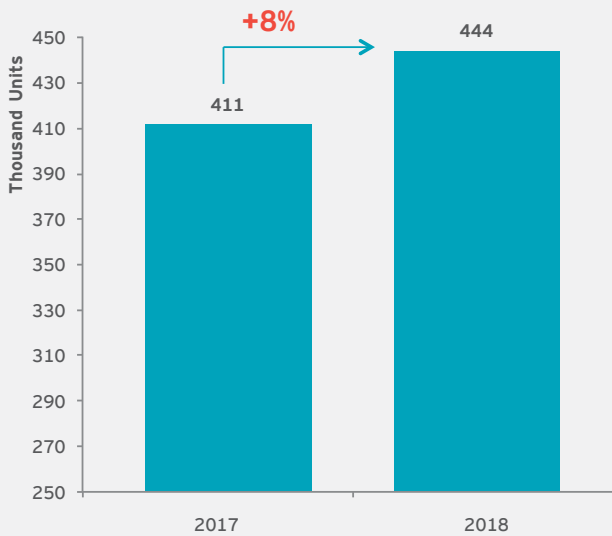


Source: Statistics Institution of Turkey (TUIK)

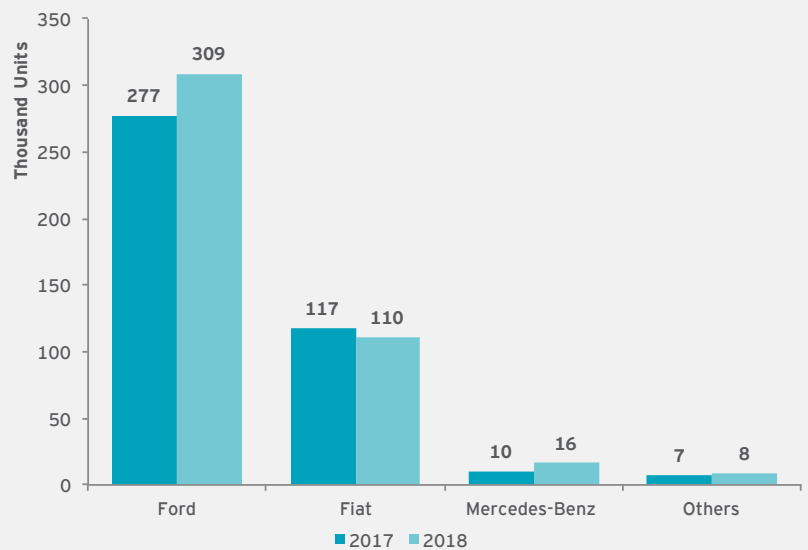
A record increase has been witnessed in commercial vehicle exports together with the development achieved by Ford and Mercedes-Benz.

Upon inspection of the data of 2018, commercial vehicle exports of 411,000 units in 2017 were surpassed by 444,000 units in 2018, representing 8% growth. Ford Otosan's impressive performance and Mercedes-Benz's completed capacity investments at the Aksaray truck facilities have been influential in this improvement. Following the developments experienced in the domestic market, commercial vehicle manufacturers saw a rapid development in foreign markets.

Commercial vehicle export



Commercial vehicle export on brand basis

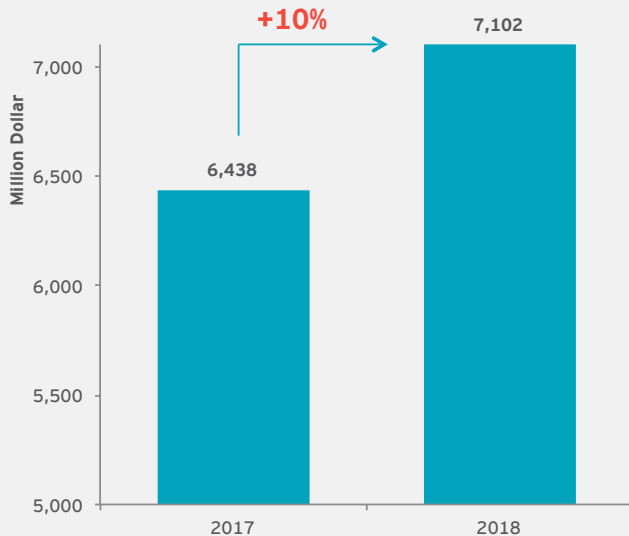


Source: Automotive Industry Association (OSD)

In 2018, in addition to quantities, the 7-billion-dollar threshold was also surpassed with a 10% value increase in exports.

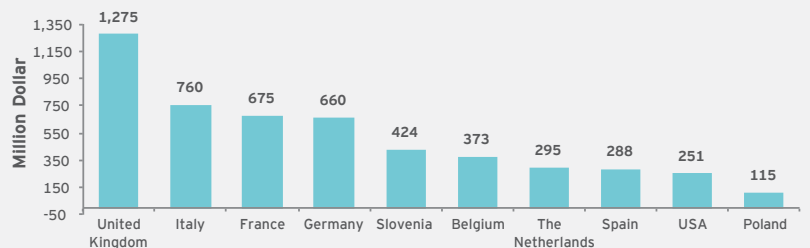
The 6.4-billion-dollar commercial vehicle export revenue in 2017 increased to 7.1-billion-dollar level in the end of 2018. A significant change was not noted in the revenue from the United Kingdom; meanwhile, the income from the other 9 countries showed significant increases, and the most noteworthy change in the list of 10 export countries was Romania, which entered the list at number 10. The mass transportation tenders won by Turkish companies has been influential in this increase noted in exports to Romania.

Total commercial vehicle export revenues

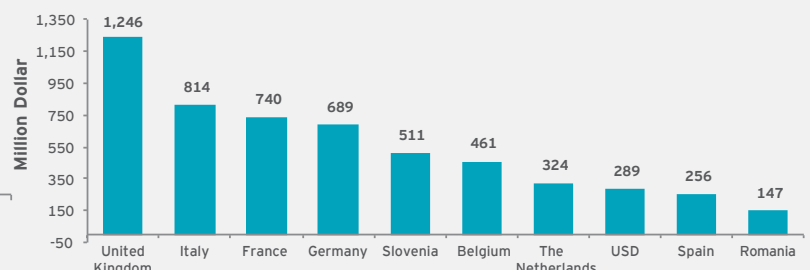


Source: Turkish Statistical Institute (TurkStat)

10 countries to which commercial vehicles were exported most in 2017



10 countries to which commercial vehicles were exported most in 2018



Automotive industry trend analysis

Market trend

Production performance

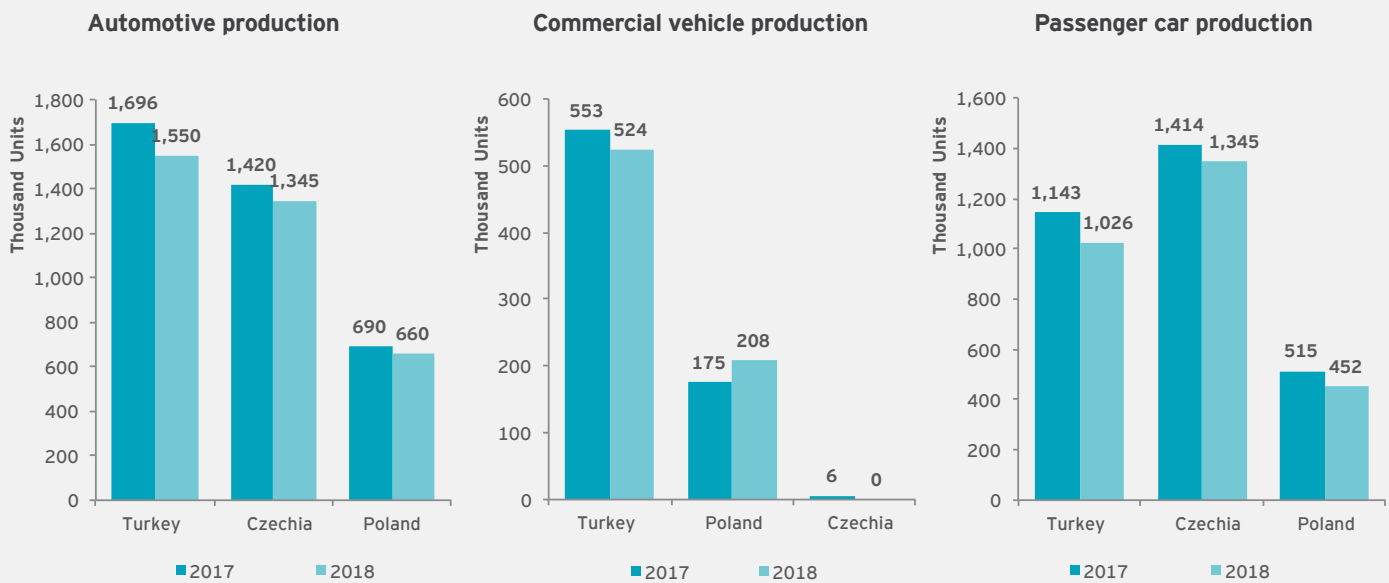
Export performance

▶ Comparative analysis of production

4. Comparative analysis of production

Turkey again this year maintains the position of being the biggest vehicle manufacturer in its territory.

2018 was a year wherein a negative change was experienced in production statistics in countries such as Czech Republic and Poland compared to the previous year. In this period, Turkey maintained its role of being the leading manufacturer in the region despite the relative loss it has experienced. According to the statistics of the International Motor Vehicle Manufacturers Association (OICA), 1,550,000 units of vehicles were manufactured in Turkey last year, and this statistic puts Turkey in front of the other 8 countries that have been manufacturing vehicles in the region.



Source: OICA

Summary First Quarter Evaluation of 2019

► **Market trend**

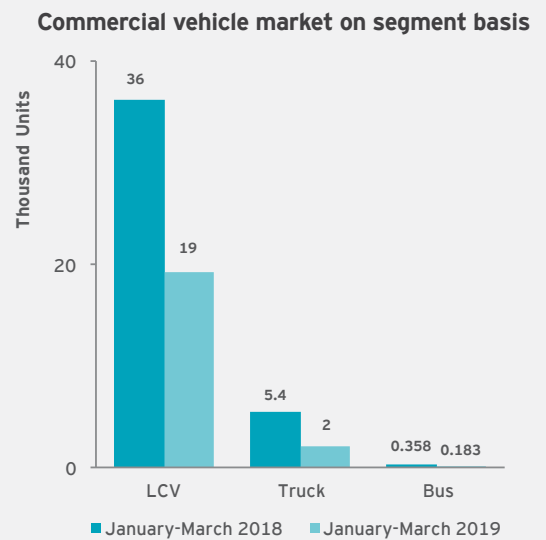
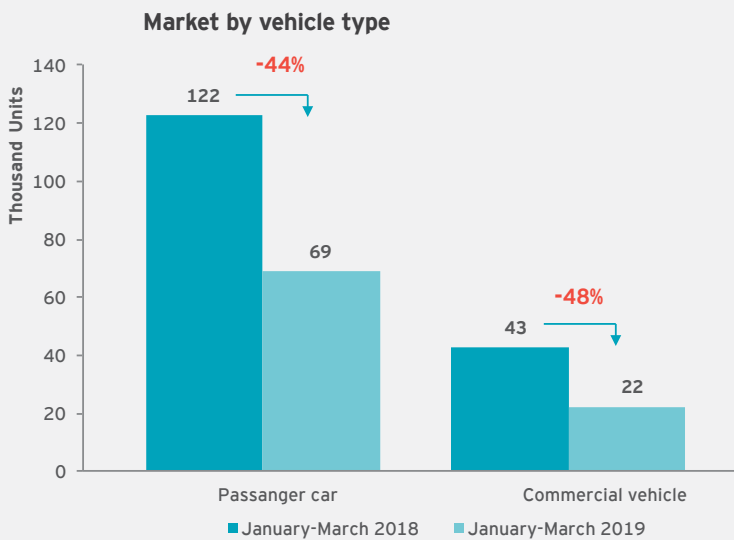
Production performance

Export performance

1. Market trend

The losses, which were more pronounced in the second half of 2018, have maintained their effect during the first quarter of 2019.

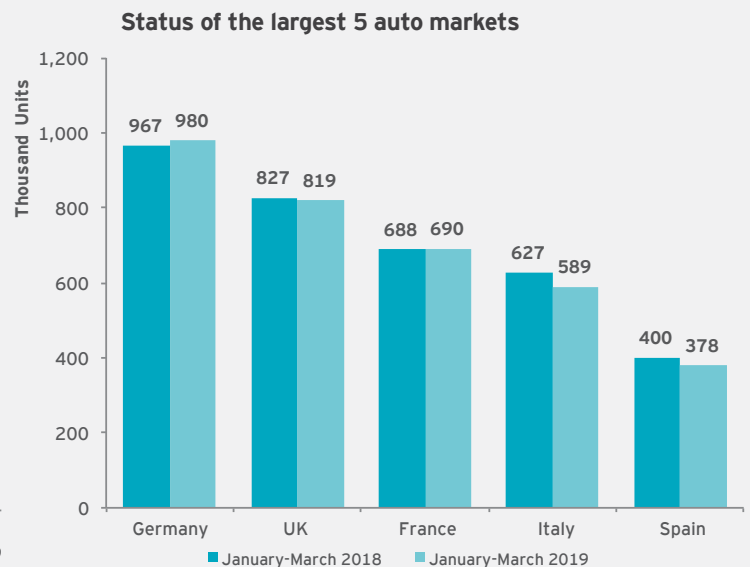
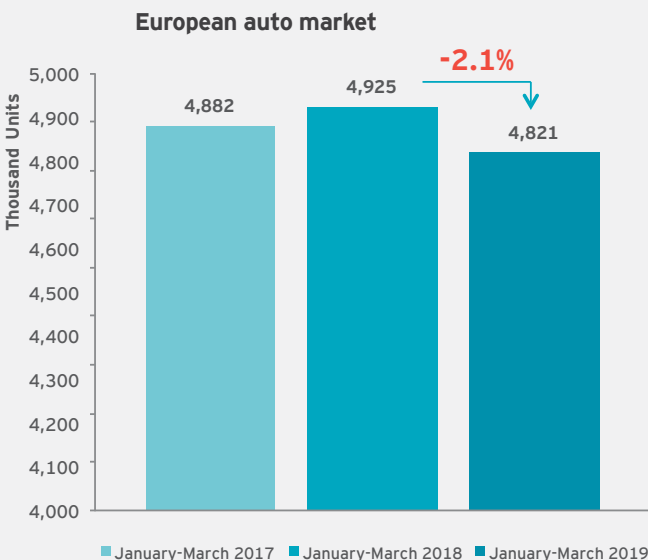
The market, which shrank significantly in 2018, with the influence of the macroeconomic developments particularly during the second half of the year also had losses during the first quarter of this year. The drop in the auto market was 44% for passenger vehicles, but sales figures were 48% less for commercial vehicles. The effects of the intense loss in the automobile and LCV market have been observed despite the special consumption tax discount and campaigns.



Kaynak: Otomotiv Sanayi Derneği (OSD)

The European auto market, which is among the key export markets of the Turkish automotive industry, narrowed down by 2.1% in the first quarter of 2019, compared to the same period of last year.

In Germany and France, two of the five biggest auto markets of Europe and which are the biggest export markets of the Turkish automotive industry, increases of 12,000 and 2,000 were experienced respectively. Meanwhile a shrinkage was registered in the Italian, British, and Spanish markets. Particularly, the 38,000 units shrinkage in the Italian market may be interpreted as an indicator of the ongoing negative mood in the country throughout 2018.

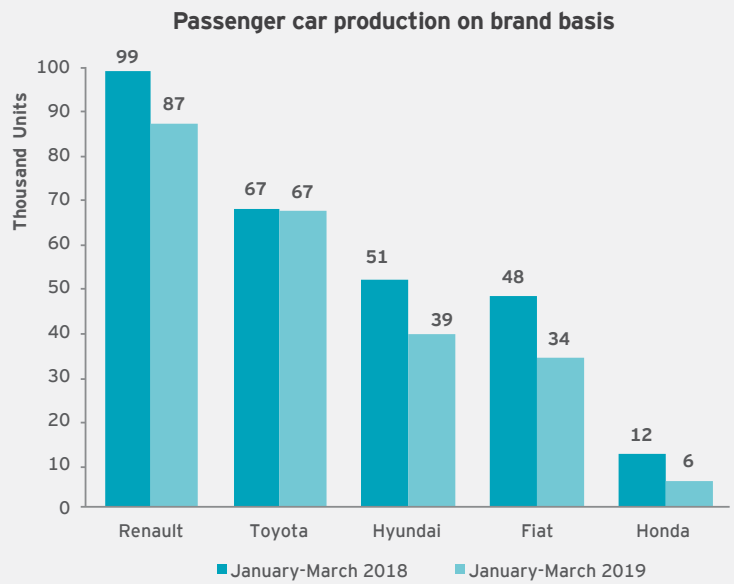
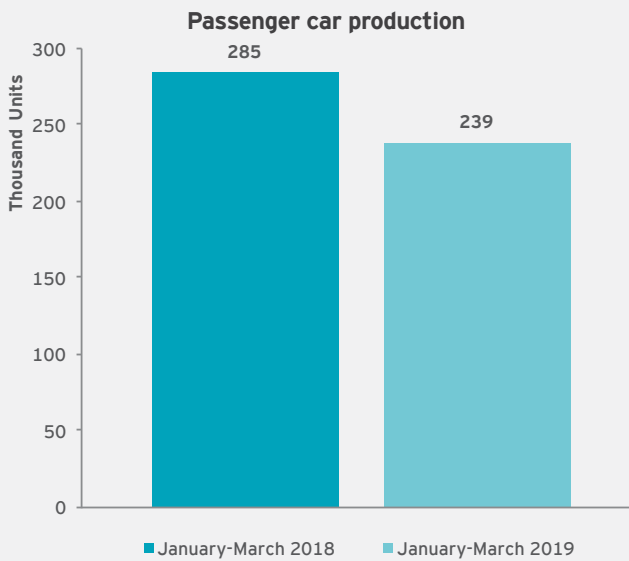


Source: European Automobile Manufacturers Association (ACEA), Automotive Distributors Association (ODD)

2. Production performance

According to the results of the first quarter in 2019, the production in the industry dropped by 16%.

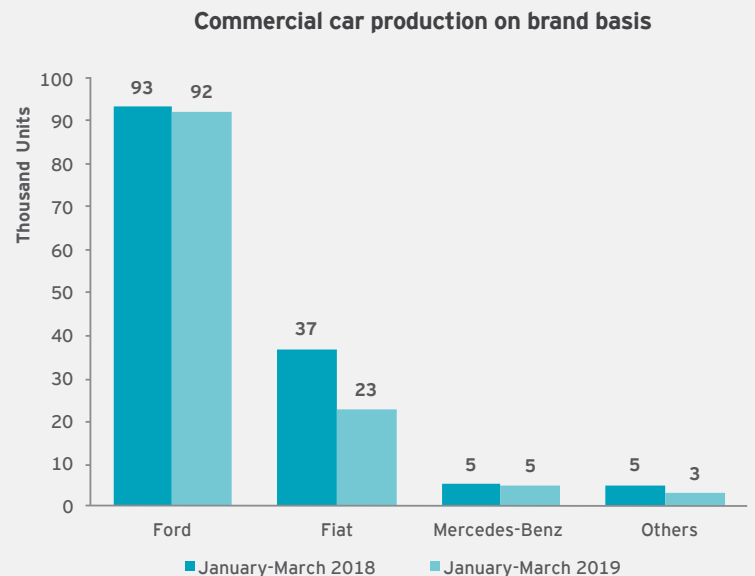
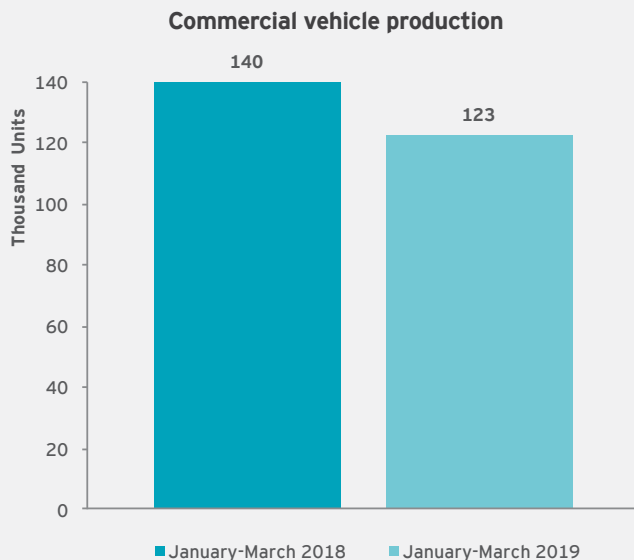
The losses of Hyundai and Fiat, exceeding 20%, is one of the key reasons of the drop in production figures during the first quarter of 2019. Most passenger vehicle manufacturers observed negative changes in production figures and were influenced by the domestic market developments in 2018, as observed by Toyota maintaining its level with the influence of its export performance while Renault and Honda also had losses.



Source: Automotive Industry Association (OSD)

Ford, Mercedes, and other commercial vehicle manufacturers have maintained their levels of 2018 during the first quarter of this year.

A 17,000-unit drop was observed in the production quantities of commercial vehicle manufacturers in the first quarter of 2019. On looking at the background of this statistic, it is possible to say that the production shrinkage experienced by Fiat was influential; meanwhile Ford, Mercedes-Benz, and other commercial vehicle manufacturers have mostly maintained their levels.



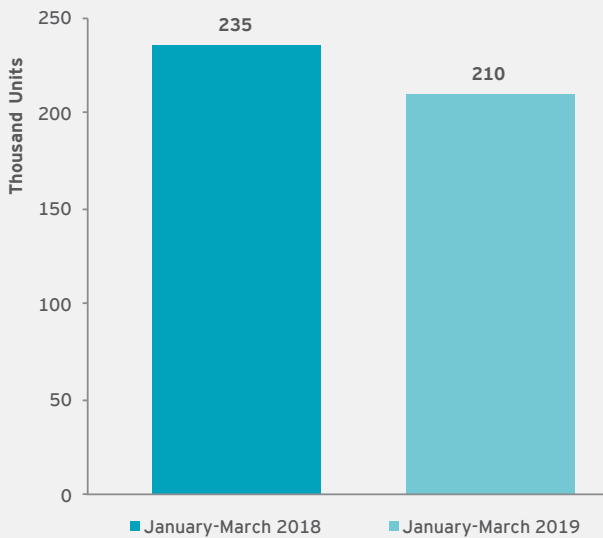
Source: Automotive Industry Association (OSD)

3. Export performance

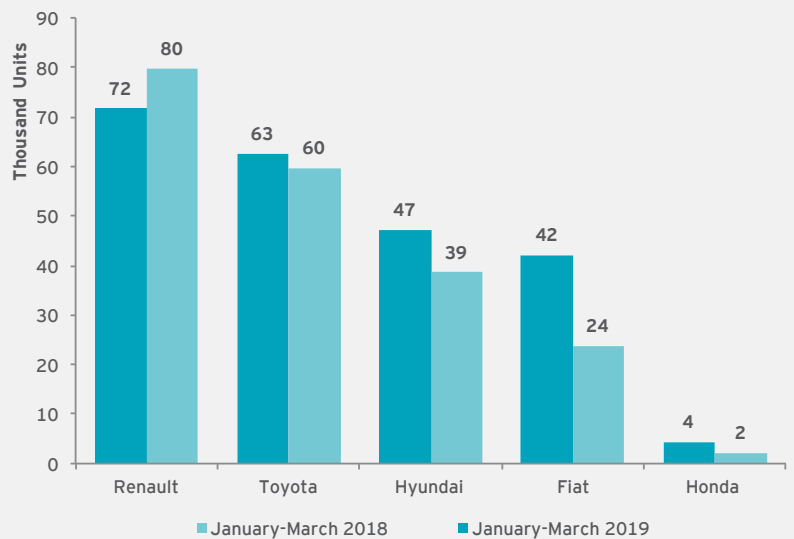
During the first 3 months of the year, passenger vehicle exports were realized as 210,000 units. Renault is leading this increase with 12%.

Passenger car exports slipped from approximately 235,000 units in Q1 2018 to 210,000 units in the first quarter of 2019; a nearly 10% decrease. In passenger vehicle exports, Fiat had a drop beyond projections; meanwhile, the passenger car export champion of last year, Renault, exported approximately 80,000 finished vehicles during the first quarter of the year, a 12% increase.

Passenger car export



Passenger car export on brand basis

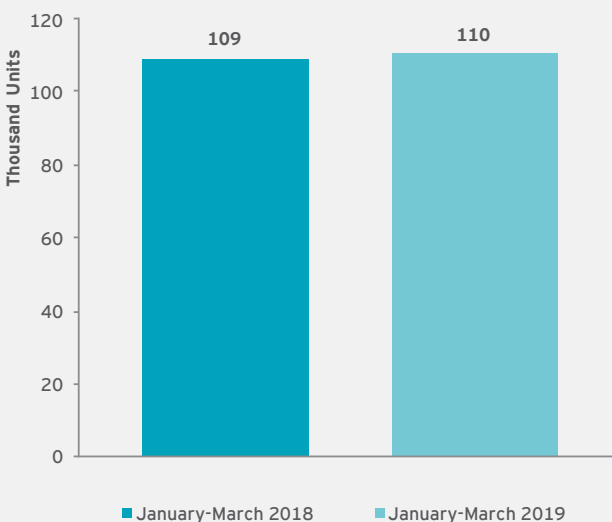


Source: Automotive Industry Association (OSD)

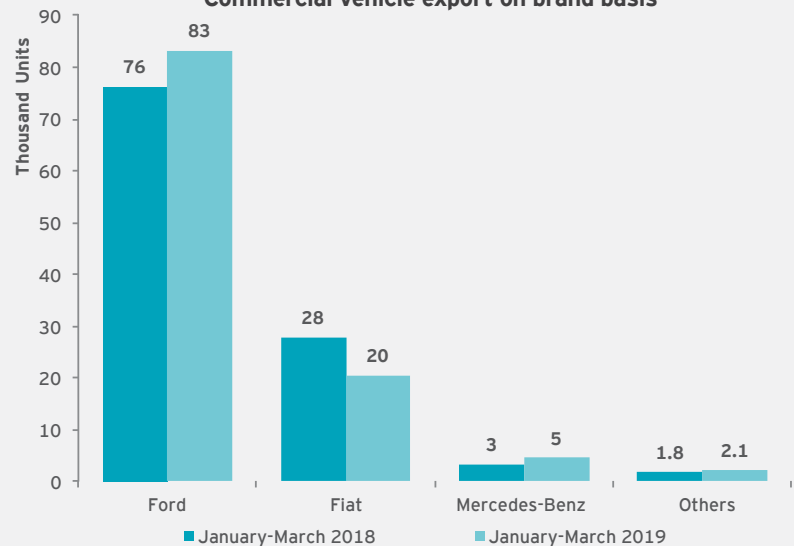
A record increase has been witnessed in commercial vehicle exports together with the development achieved by Ford and Mercedes-Benz.

Upon inspection of the data of 2018, commercial vehicle exports of 411,000 units in 2017 were surpassed by 444,000 units in 2018, representing 8% growth. Ford Otosan's impressive performance and Mercedes-Benz's completed capacity investments at the Aksaray truck facilities have been influential in this improvement. Following the developments experienced in the domestic market, commercial vehicle manufacturers saw a rapid development in foreign markets.

Commercial vehicle export



Commercial vehicle export on brand basis



Source: Automotive Industry Association (OSD)



2018 YE and 2019 Q1 Evaluation

Global Automotive Industry vs Turkey

Investment incentives in automotive industry in 2018

Automotive industry research

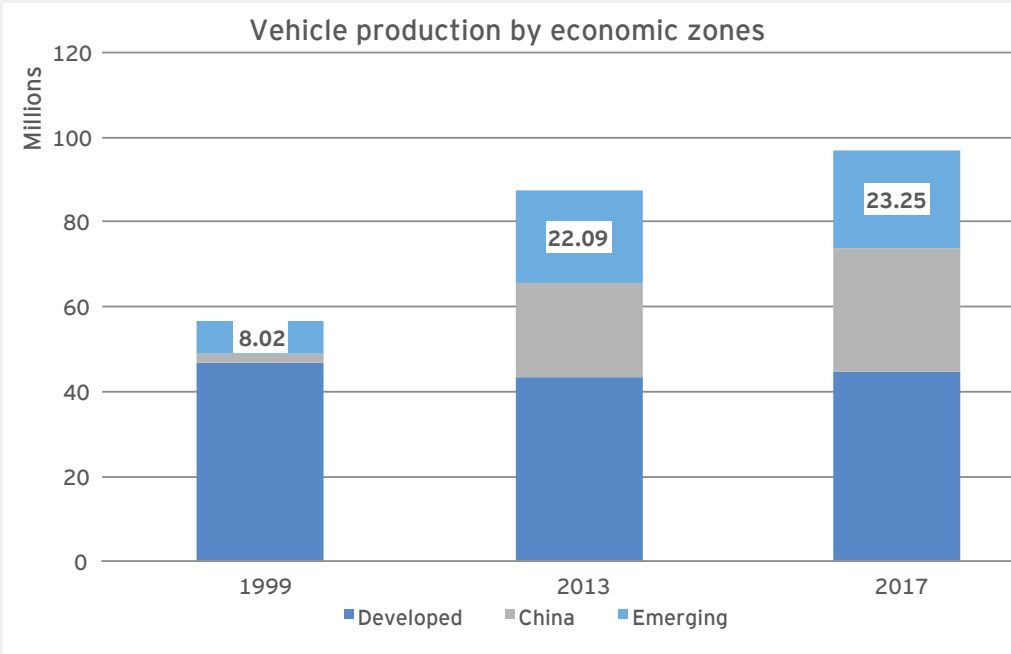
Digitalization in automotive sector

Global EV market analysis

Global Automotive Industry vs Turkey

Changing production network of global players

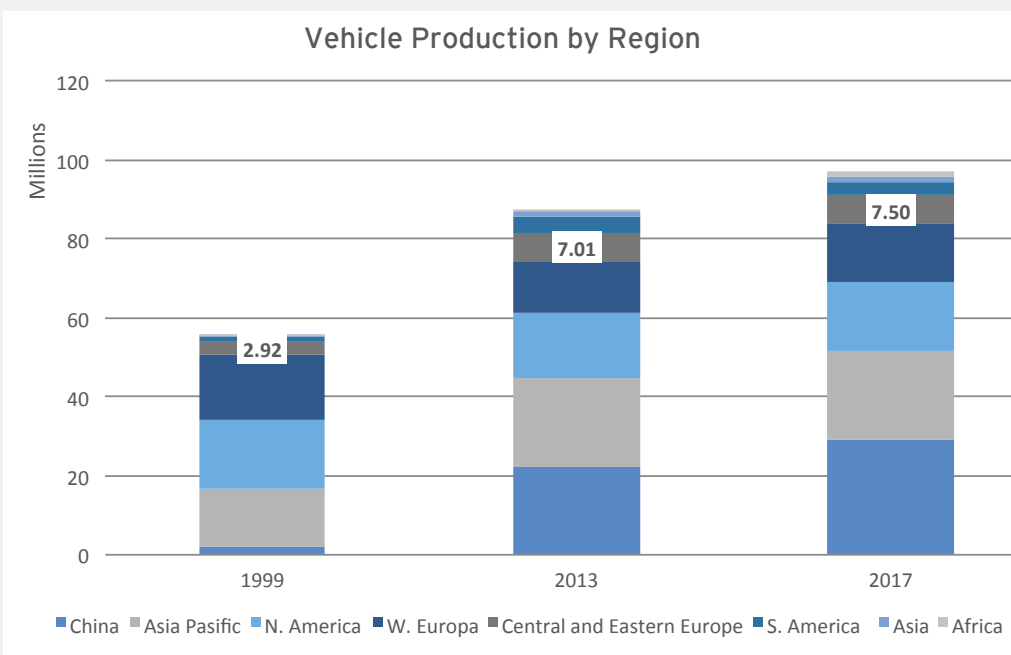
In the years after 2000, in line with the changes in supply and demand profiles of world markets, automotive industry restructured its production capacity and network worldwide. While the vehicle production increased from 56 million to 97 million units in less than 20 years, production network of the international manufacturers have also diversified.



- ▶ While share of developed world in production has been decreased from 83% to 46%,
- ▶ China's share has increased to 30% between 1999 - 2017.
- ▶ Also remaining emerging markets have emerged as strong production hubs and increased their share from 14% to 24%.

Source: International Organization of Motor Vehicle Manufacturers

In the period, the North America - Western Europe line has lost its dominance as production location and East emerged as the new dominant region. Beside China various regions have taken their position in the production network of global companies.

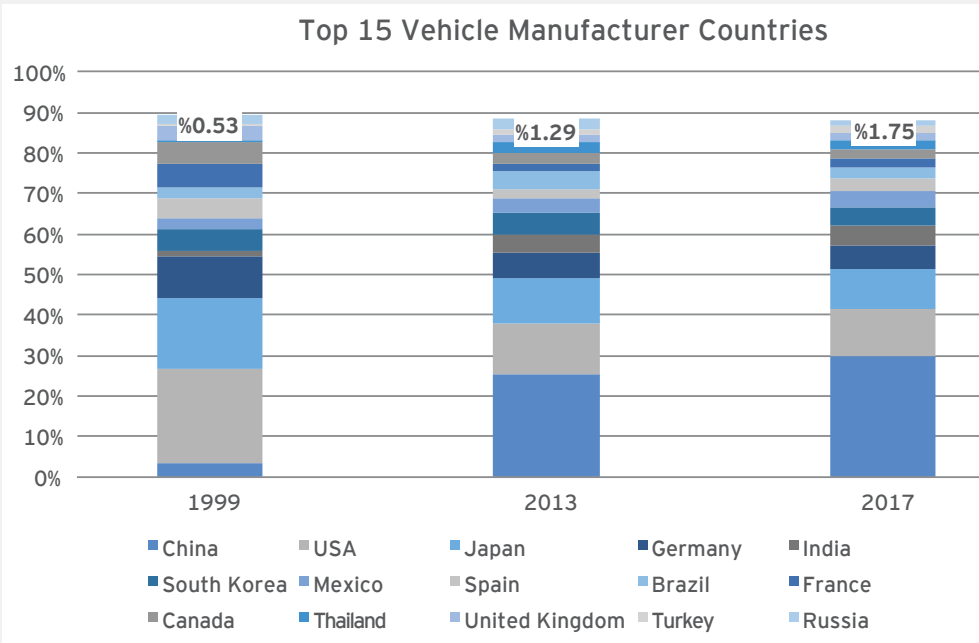


- ▶ The share of North America and Western Europa combined has decreased from 61 % to 33%.
- ▶ On the other hand China and Asia Pacific region share increased from 29% to 53%.
- ▶ Eastern Europa has also been a winner of this period and thanks to expansion and new capacity investment the production increased by 2,5 folds.

Source: International Organization of Motor Vehicle Manufacturers

Evolving position of Turkey in the global automotive industry

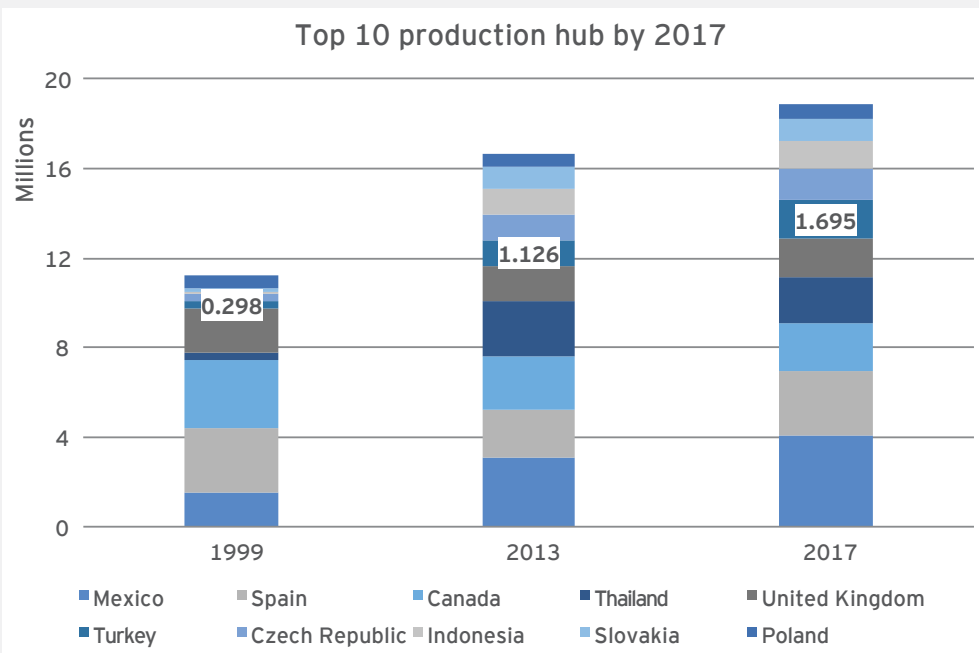
Currently while the list of top manufacturers are still dominated by the brand owner countries, countries positioned as production hubs in the value chain has been gaining ground.



- ▶ Thanks its local dynamics China enjoyed the immense volume of investment from the international firms.
- ▶ Turkey as one of the emerging production hubs, has been able to increase its share in vehicle production from 0,53% to 1,75% and is now among the top 15 countries.

Source: International Organization of Motor Vehicle Manufacturers

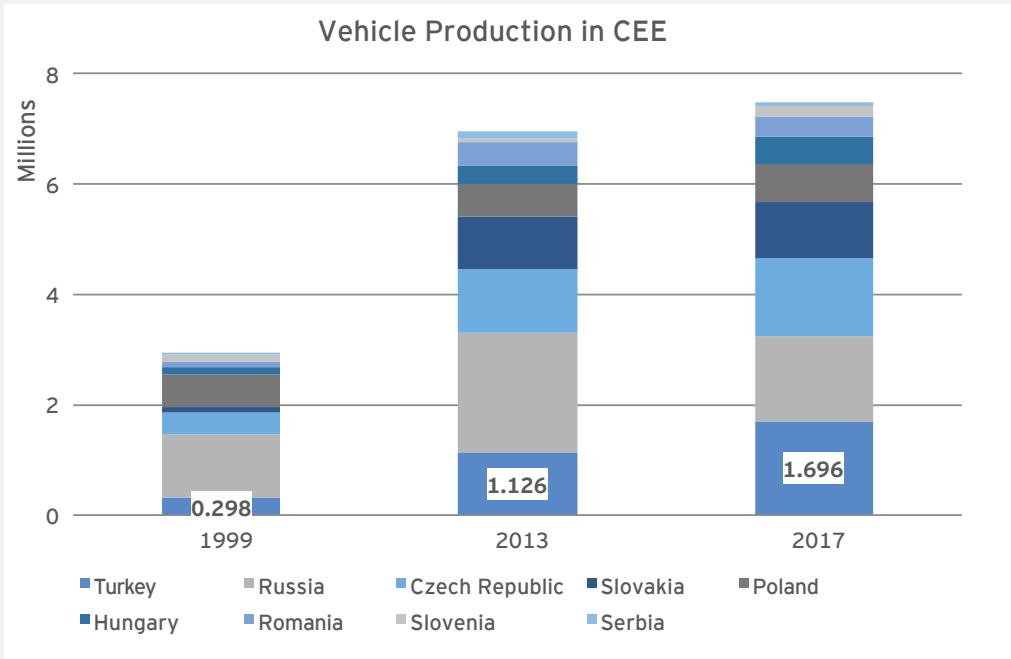
Dynamics like proximity to markets, cost optimization need has led the formation of new capacities in overseas rather than in brand owner countries.



- ▶ Despite decreasing production numbers UK, Spain and Canada are still protecting their strong position as important production hubs.
- ▶ Today however Mexico is leading the list of largest production hubs, and Thailand is the 4 largest hub in front of UK.
- ▶ With an investment of 13,3 billion USD (2003 - 16), global OEMs made Turkey both a strong part of their production network and 6 largest production hub worldwide.

Source: International Organization of Motor Vehicle Manufacturers

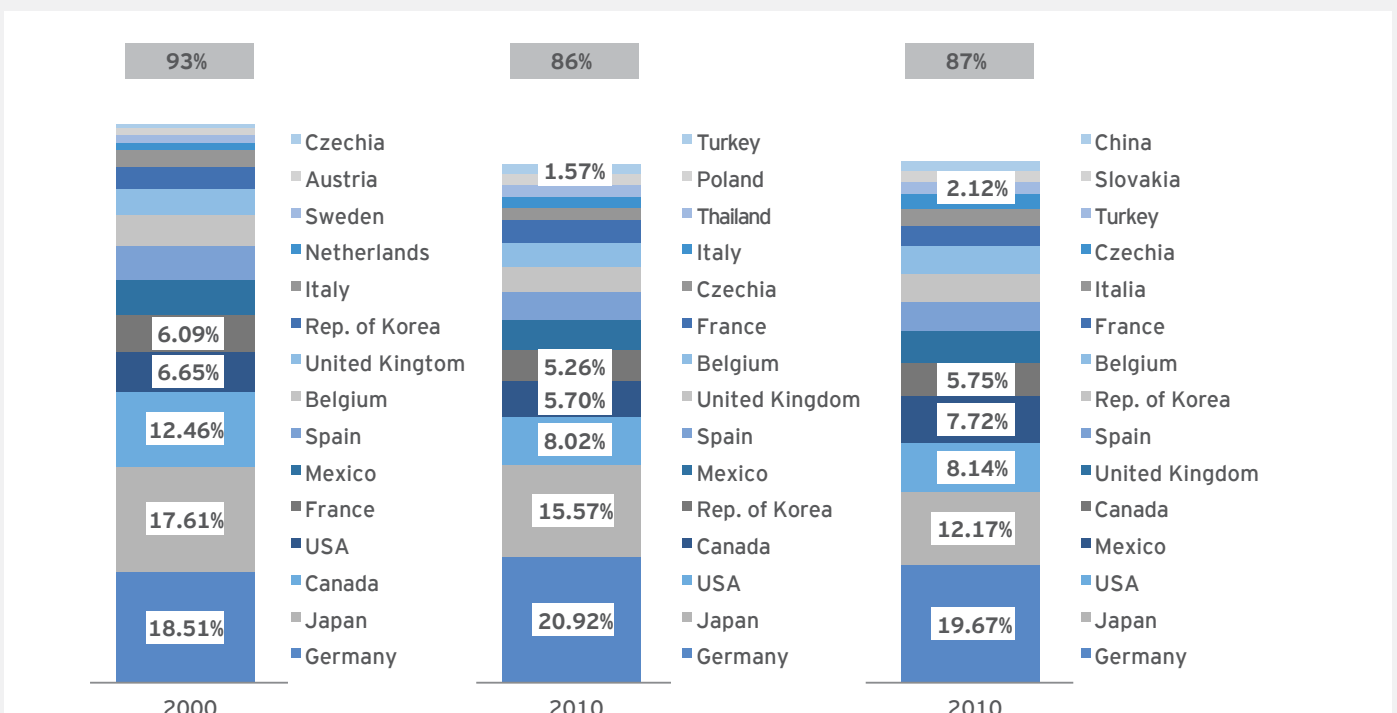
Central and Eastern Europe has become a solid part of the global producers' production network. Although the production has been decreasing in Western Europe, CEE has been able to production from continuously as region.



- ▶ In terms of production volume Turkey, Russia and Czech are the leading countries in the region.
- ▶ With its market potential Russia has been playing an other role compared to other countries in the region.
- ▶ With a production of 1,69 million vehicle in 2017 Turkey was the largest vehicle manufacturer of vehicles of CEE.

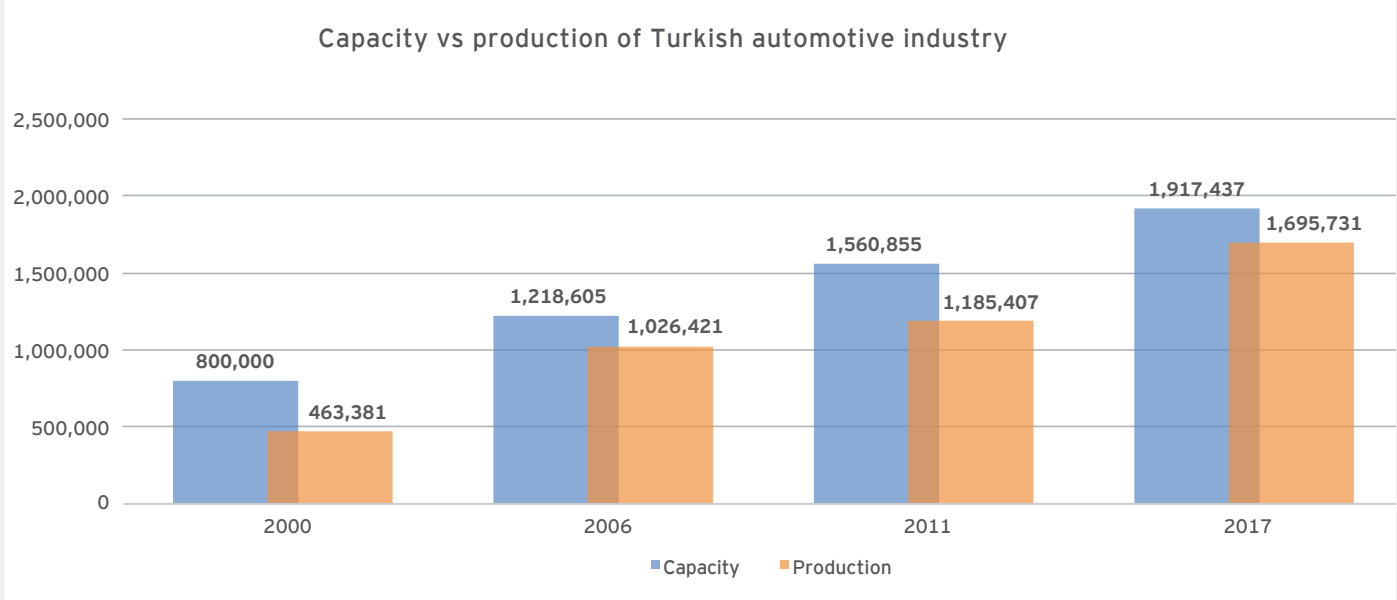
Source: International Organization of Motor Vehicle Manufacturers

Between 2000 and 2017 China, Turkey, Slovakia, Czechia and Hungary are the first five countries having the highest export growth rate. With CAGR of 20% Turkey second highest growth rate.



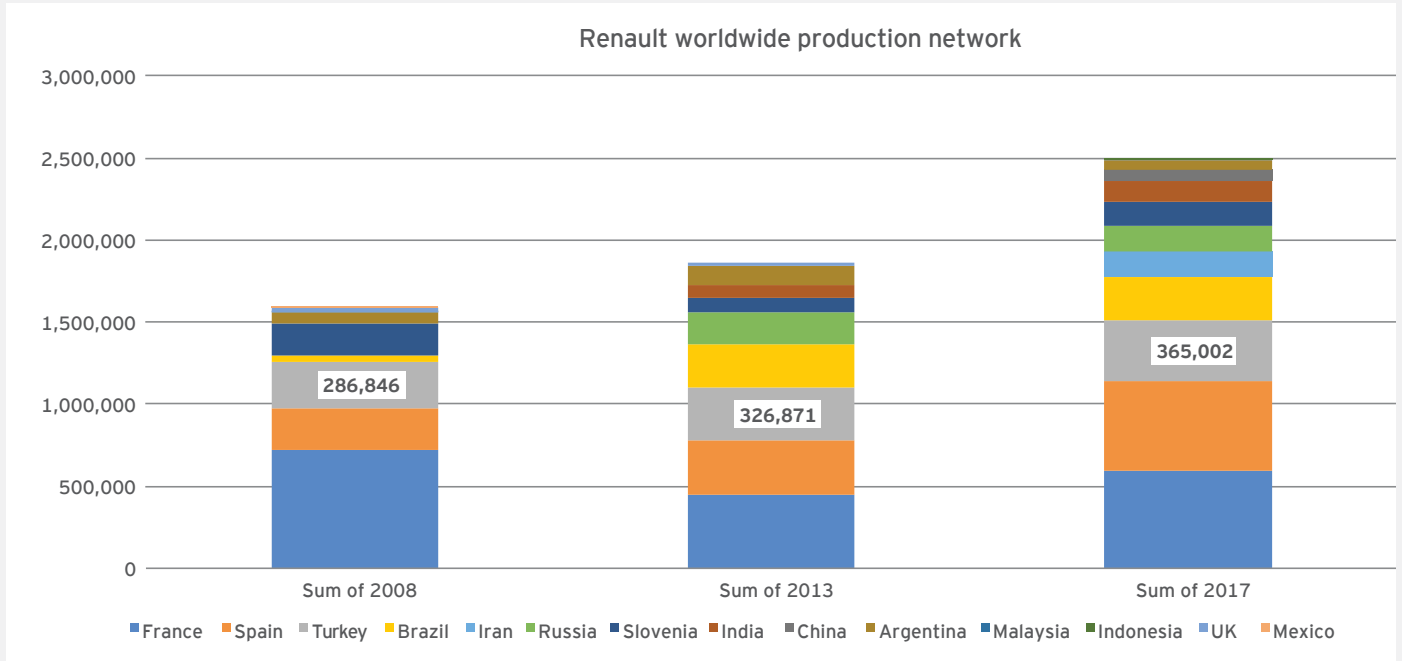
Source: Comtrade

Capacity in Turkey has increased from 800k in 2000 to 1,9 million units in 2017. In line with this, production increased from 468k to 1,69 million vehicles.

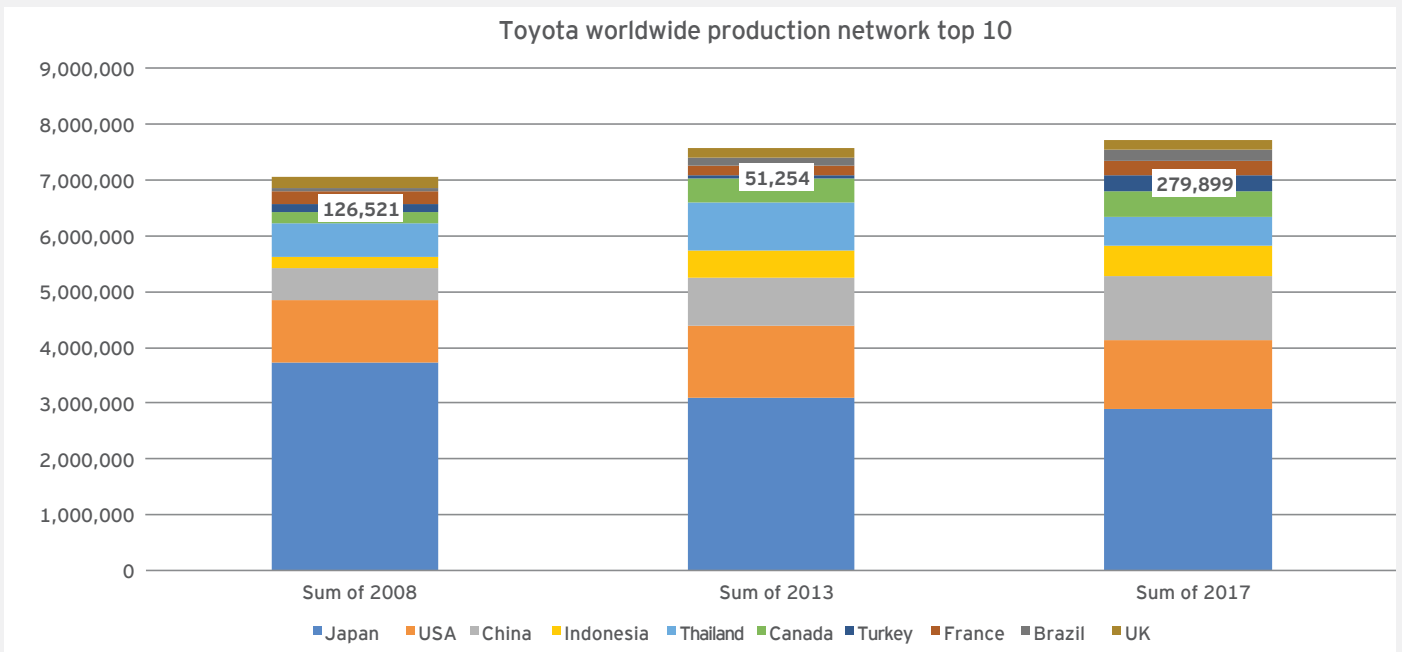


Source: The Automotive Manufacturers Association

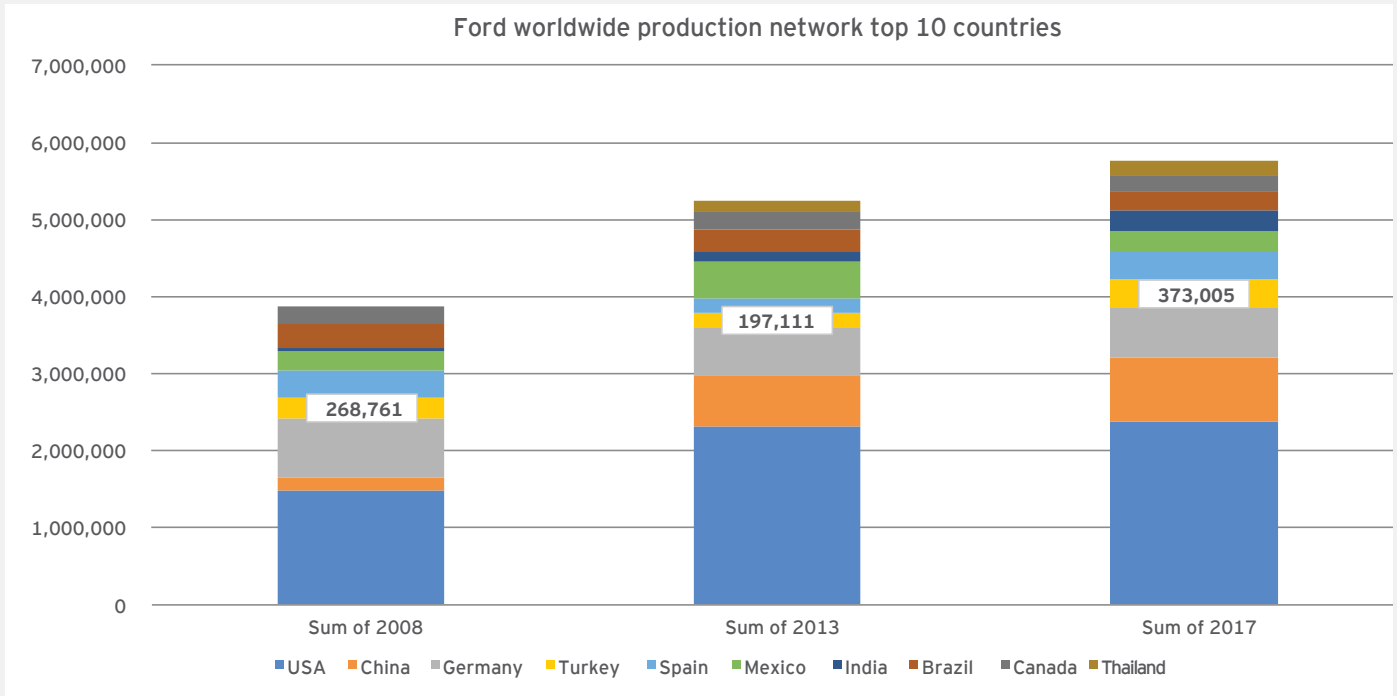
Companies & Capacities	2008	2012	2017
TOFAŞ Türk Otomobil Fabrikası A.Ş.	360,000	400,000	450,000
Ford Otomotiv Sanayi A.Ş.	315,000	330,000	415,000
Oyak-Renault Otomobil Fabrikaları A.Ş.	360,000	360,000	360,000
Toyota Otomotiv Sanayi Türkiye A.Ş.	150,000	150,000	280,000
Hyundai Assan Otomotiv San. ve Tic. A.Ş.	125,000	125,000	245,000
Karsan Otomotiv San. ve Tic. A.Ş.	28,000	75,300	52,225
Honda Türkiye A.Ş.	30,000	50,000	50,000
Mercedes-Benz Türk A.Ş.	13,200	18,500	22,000
Anadolu Isuzu Otomotiv San. ve Tic. A.Ş.	13,155	13,155	19,012
Temsa Ulaşım Araçları San. ve Tic. A.Ş.	10,500	10,750	11,500
Otokar Otomotiv ve Savunma Sanayi A.Ş.	7,550	8,800	10,300
MAN Türkiye A.Ş.	2,000	1,700	2,400



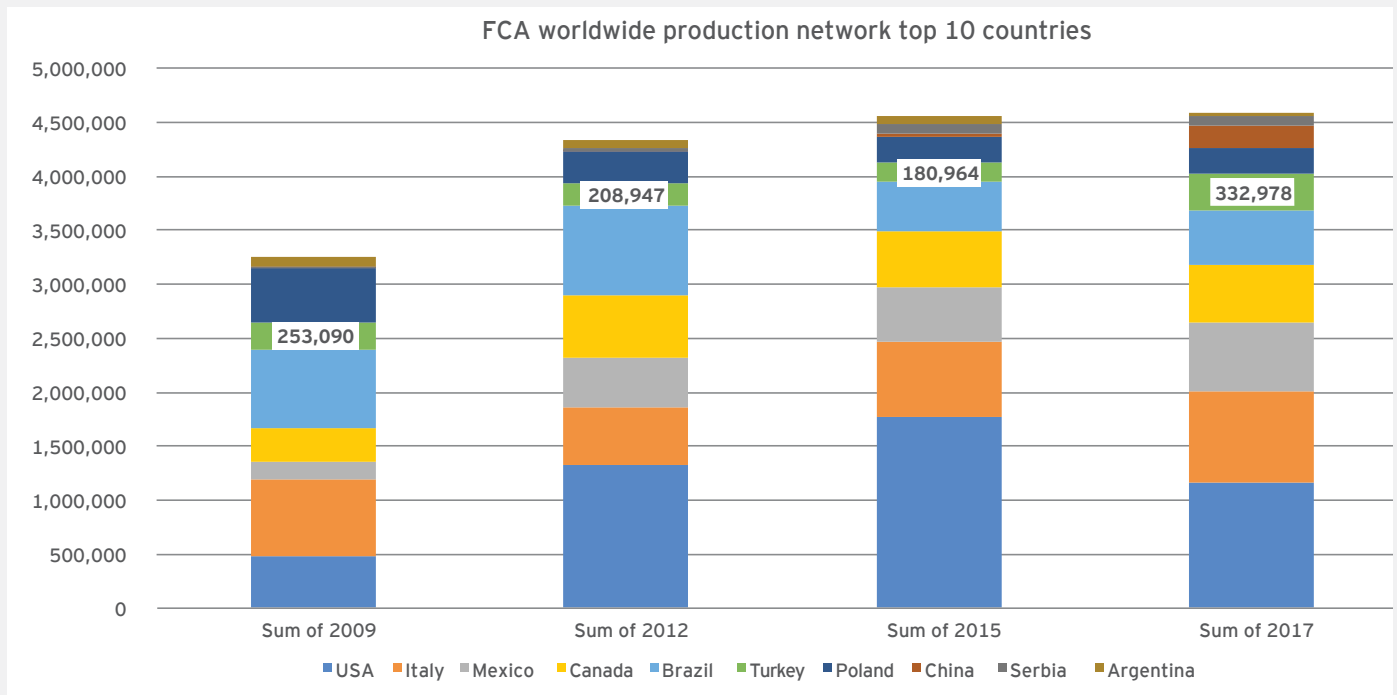
Source. Marklines



Source. Marklines



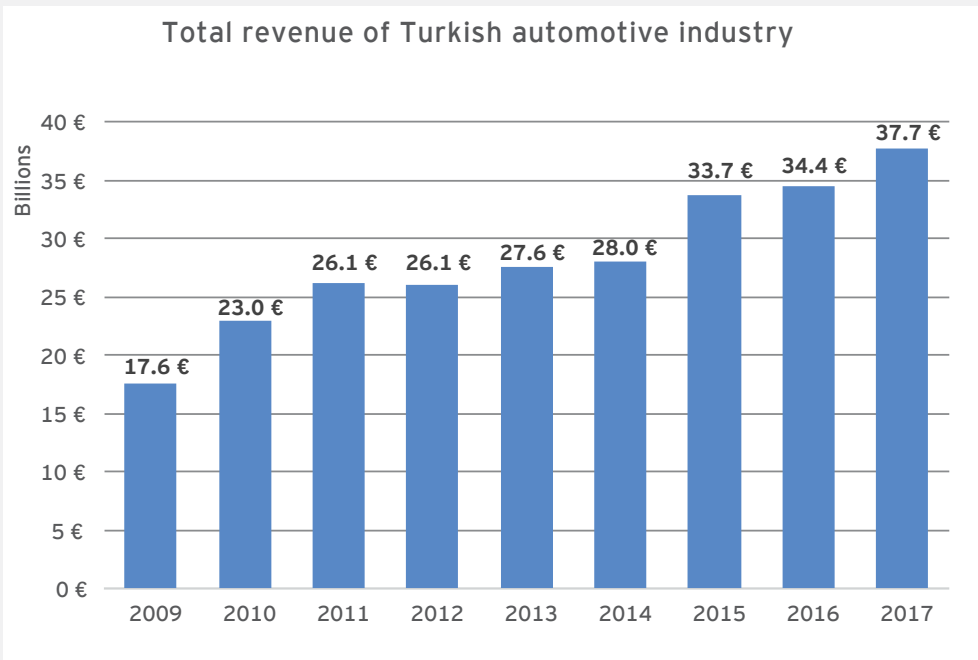
Source: Marklines



Source: Marklines

Performance of Turkish automotive industry in the recent years

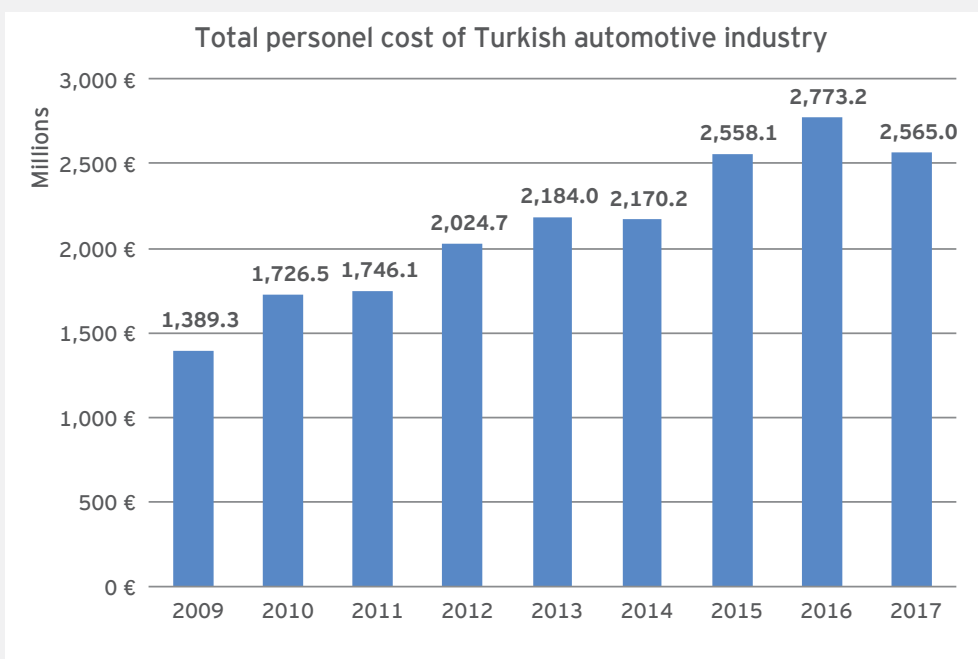
Following the new capacity set-ups of OEMs and investment of supplier industry triggered by these new capacities, total revenue of automotive industry in Turkey increased from 17,6 Euro to 37,7 Euro from 2009 to 2017.



- Revenue wise Turkish automotive industry grew by a CAGR of 10% between 2009 and 2017.

Source: Turkish statistical institution

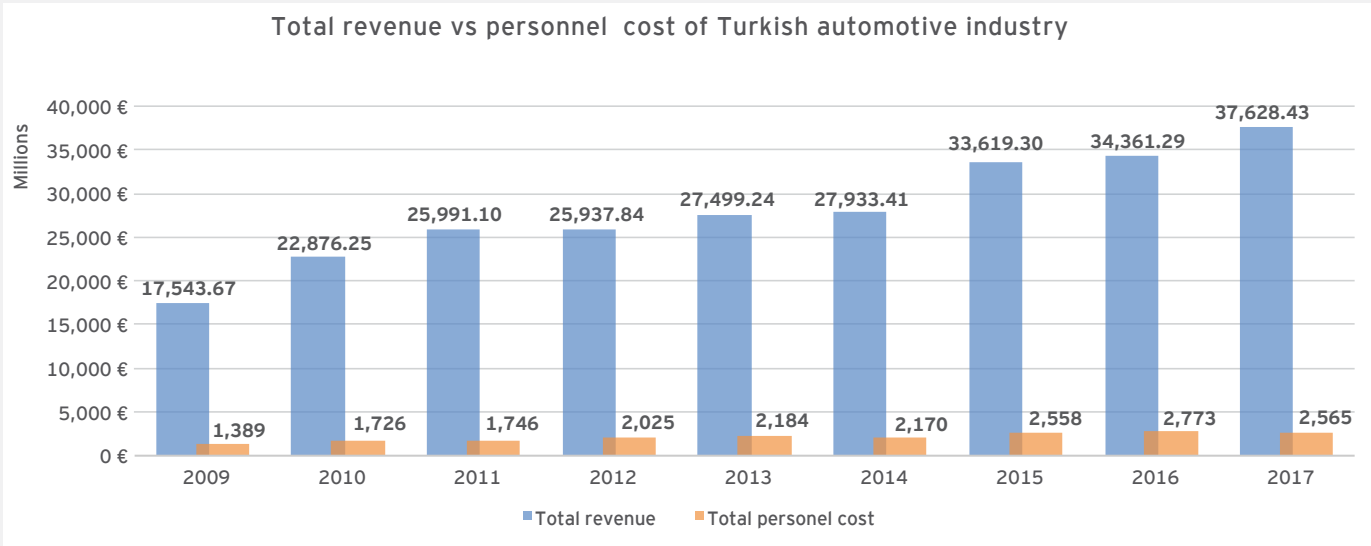
Higher volumes in production has led to increase in employment both in vehicle as well parts manufacturing companies. This in return increased total personnel cost burden of the industry.



- Personnel cost increased from 1,3 billion Euro to 2,6 billion Euro between 2009 -17.
- This means a CAGR of 8% in the given period.

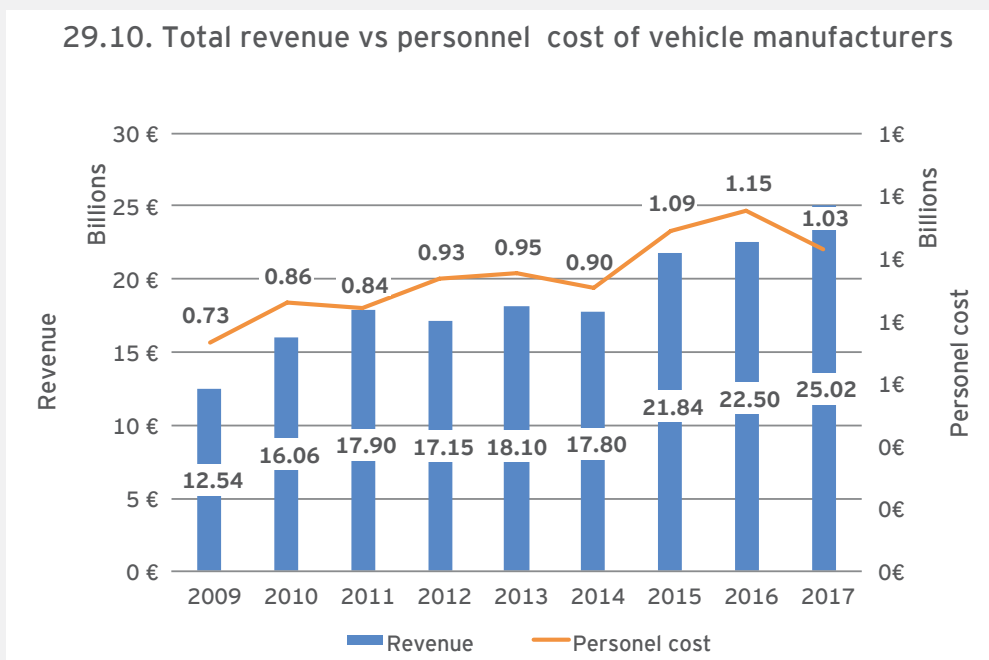
Source: Turkish statistical institution

Despite the increasing personnel cost, by having a stronger growth in revenue industry has been able to protect its competitiveness in the recent years.



Source: Turkish statistical institution

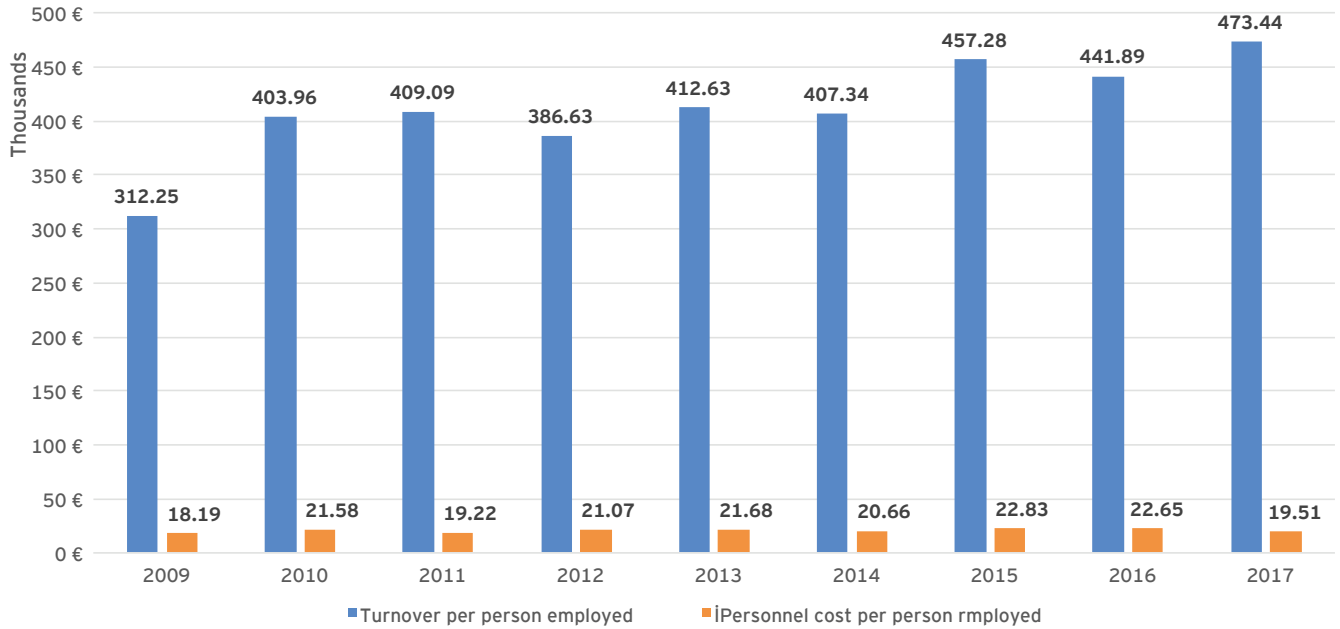
The revenue of vehicle manufacturers grew by two fold and increased from 12,5 billion Euro to 20,05 billion Euro from 2009 to 2017. In the same period personnel cost increased from 703 million to 1,03 billion Euro.



- ▶ The revenue of manufacturers has a growth rate of (CAGR) is around 10%.
- ▶ In the same period personnel cost grew by a CAGR of 4,5% in Euro terms.
- ▶ With this performance, the industry has been able to increase its competitiveness overall.

Source: Turkish statistical institution

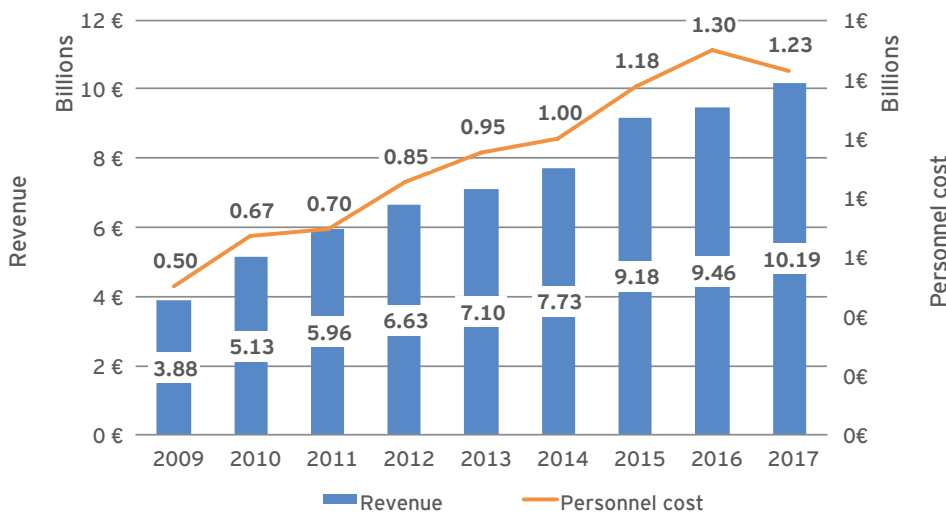
29.10 Turnover vs personnel cost of per person employed



Source: Turkish statistical institution

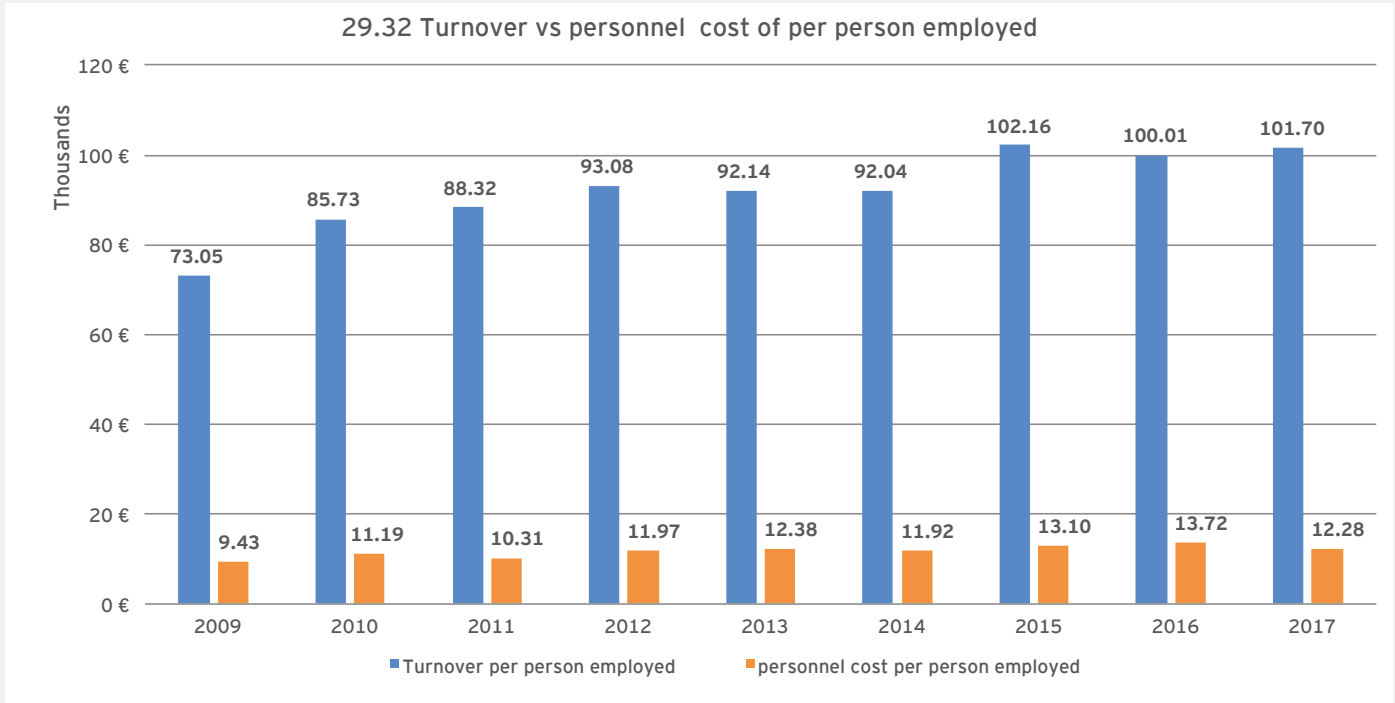
Supplier industry has been able to increase its total revenue from 3,78 billion to 10,09 billion Euro. On the other hand the personnel cost industry does carry increased from 555 million in 2009 to 1,23 billion Euro in 2017.

29.32 Total revenue vs personnel cost of part producers

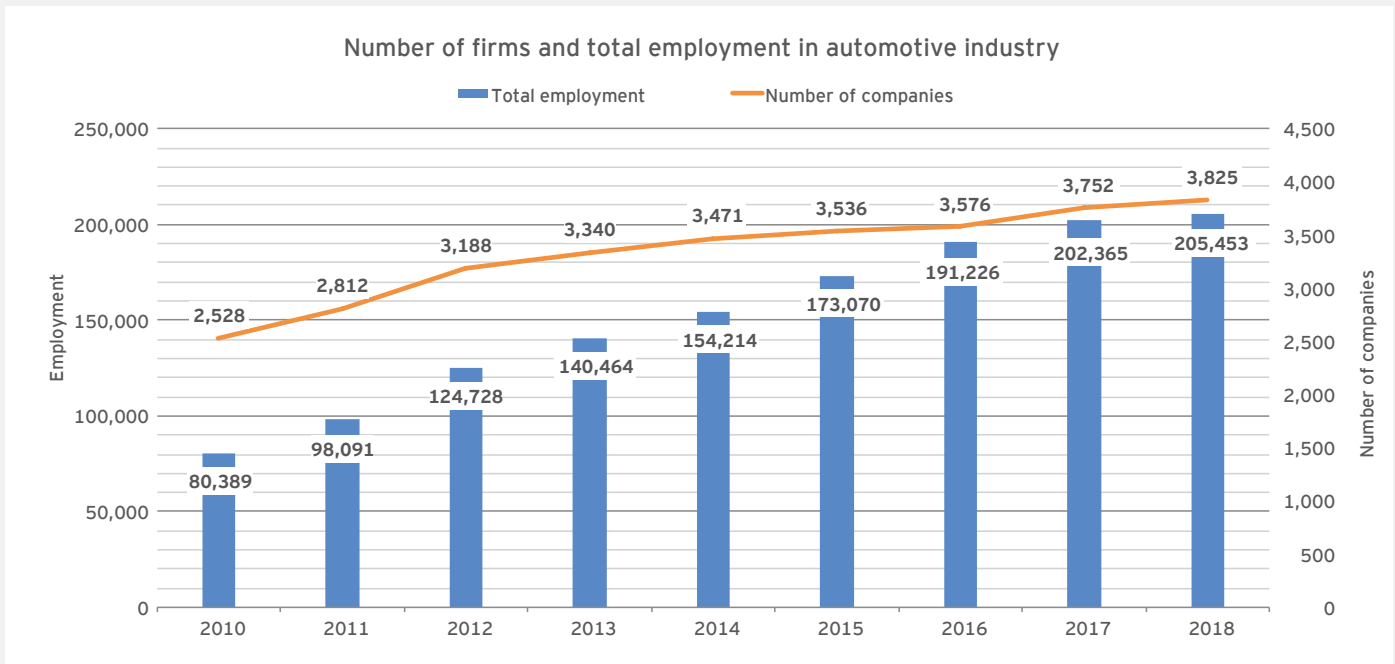


Source: Turkish statistical institution

- ▶ Revenue wise supplier has growth rate (CAGR) of 13% between 2009 - 2017.
- ▶ On the other side personnel cost grew by a CAGR of 12% in Euro terms.
- ▶ With this results the industry was successful in protecting its competitiveness.



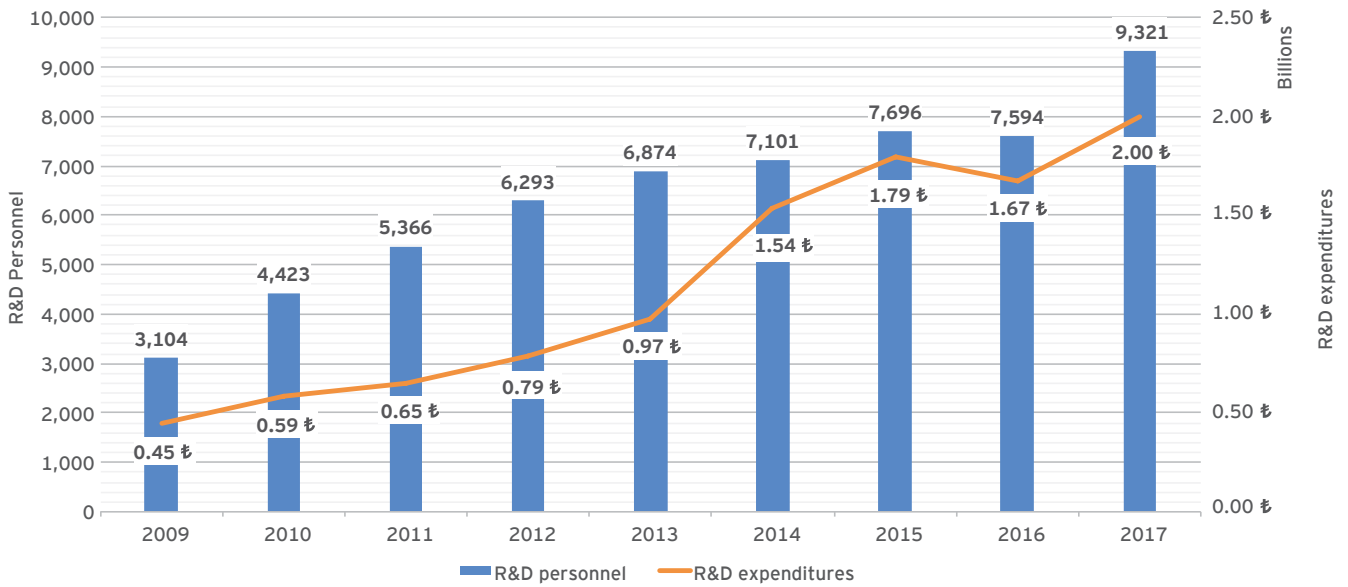
Source: Turkish statistical institution



Source: Turkish statistical institution

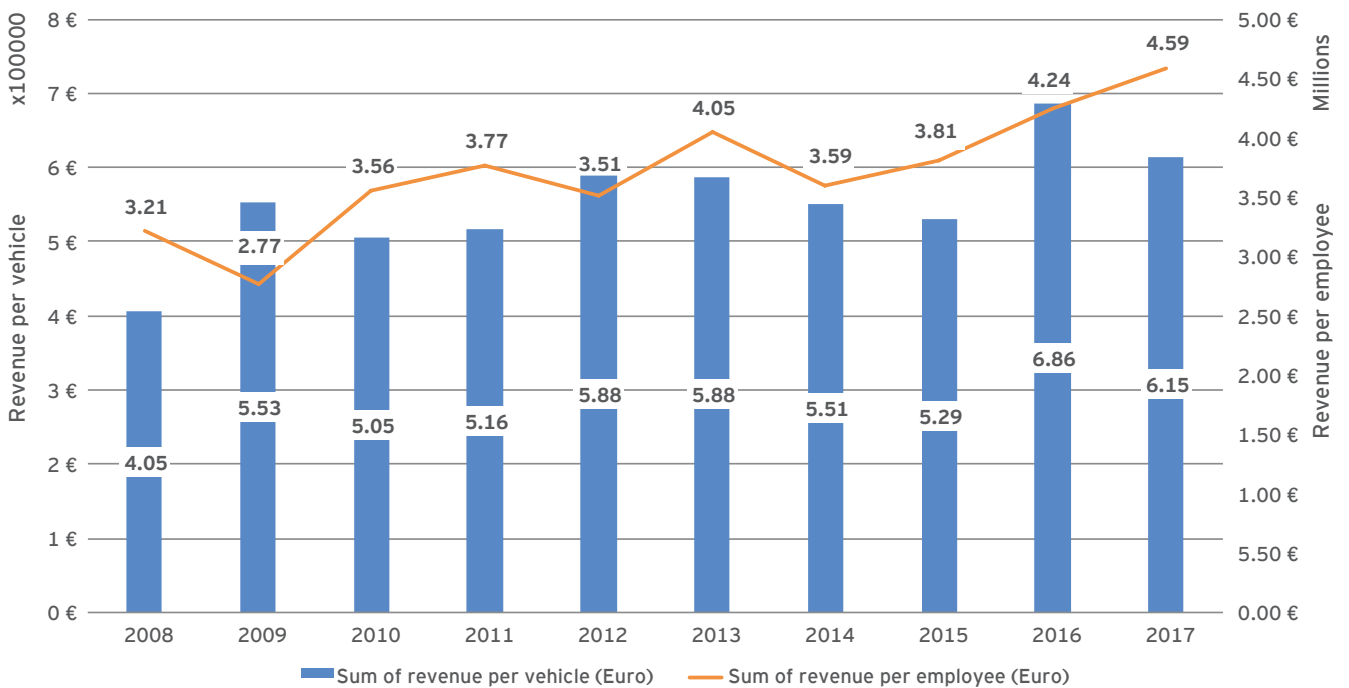


R&D expenditures and personnel



Source: Turkish statistical institution

Productivity performance of global OEMs in Turkey



Source: The Automotive Manufacturers Association

An aerial, top-down view of a multi-lane highway. The road is divided into several lanes by white dashed lines. In the center of the highway, a long, white train is moving horizontally across the frame. Several cars are visible in various lanes, some moving towards the viewer and others away. The overall scene is in grayscale, with the text overlaid in white and yellow.

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Automotive Projects that are Granted Investment Incentive Certificates in 2018

Based on origin of capital:

Type of capital	# of investment projects
Local	184
Foreign	45
Total	229

Investment types:

Investment type	# of investment projects
Expansion	163
Brand new	47
Modernization	19
Total	229

Investment amount based on origin of capital:

Type of capital	Total investment (TRY)
Foreign investment	9.624.244.271
Local investment	3.032.665.856
Total	12.656.910.127

Total investment amount based on investment type:

Investment type	Total investment (TRY)
Expansion	6.669.152.180
Modernization	5.202.641.292
Brand new	785.116.655
Total	12.656.910.127

Employment based on origin of capita:

Type of capital	Employment (person)
Foreign investment	1.819
Local investment	4.155
Total	5.974

Based on investment locations:

Investment Location	# of investment projects
Bursa	63
Kocaeli	30
Konya	28
İzmir	19
İstanbul	18
Ankara	16
Tekirdağ	9
Manisa	7
Düzce	5
Sakarya	4
Samsun	3
Bilecik	2
Elazığ	2
Eskişehir	2
Hatay	2
Zonguldak	2
Aksaray	2
Şanlıurfa	2
Balıkesir	1
Bolu	1
Diyarbakır	1
Edirne	1
Erzurum	1
Kırıkkale	1
Kütahya	1
Mersin	1
Osmaniye	1
Siirt	1
Sivas	1
Şırnak	1
Yalova	1
Total	229

Top 10 Automotive Investments (2018)

	Company	Investment Location	Type of Investment	Fixed Investment Amount (TRY)	Estimated New Employment
1	Oyak Renault Otomobil Fabrikaları A. Ş.	Bursa	Modernization	3.720.413.277	N/A
2	Hyundai-Assan Otomotiv Sanayi ve Ticaret A.Ş.	Kocaeli	Expansion	1.959.440.000	105
3	Tofaş Türk Otomobil Fabrikası A.Ş.	Bursa	Modernization	1.120.000.000	N/A
4	Ortadoğu Rulman San. ve Tic. A. Ş.	Ankara	Expansion	938.590.000	300
5	Prometeon Turkey Endüstriyel ve Ticari Lastikler A.Ş.	Kocaeli	Expansion	502.652.000	50
6	Valeo Otomotiv Sanayi ve Ticaret A.Ş.	Bursa	Expansion	409.000.000	140
7	Ataylar Makina Sanayi ve Ticaret Ltd.Şti.	İstanbul	Expansion	276.150.000	145
8	B-Plas Bursa Plastik San. ve Tic. A. Ş.	Bursa	Expansion	250.000.000	29
9	Sampa Otomotiv Sanayi ve Ticaret A.Ş.	Samsun	Expansion	190.000.000	200
10	Hema Otomotiv Sistemleri A.Ş.	Tekirdağ	Expansion	181.730.000	21

Source: Ministry of Industry and Technology

Automotive Companies Supported by Turquality Programme
17 companies (as of December 2018)

Erkunt
Kirpart
Standart Profil
Sampa
Petlas
BMC
Assanhanil
Karsan
Airtech
İnci Akü
Mutlu Akü
Teklas
Lassa
Hema
Temsa
Otokar
CMS

Authorized Economic Operators (AEO)

Yiğit Akü
Pirelli
Magnet Marelli
Standart Profil
Tırsan
Yazakı
Bosch
Ford
Mercedes Benz
FIAT
Temsa
Alsin
Karsan
Toyota
Renault
Isuzu
Otokar
BMC
CMS
Honda
Bridgestone
Hyundai
Good Year
Hematrw
Norm Cıvata
ORS
Denso
Autoliv
ZF

Automotive Companies Supported by Turquality Brand Support Programme
10 companies (as of December 2018)

AYD
Bantboru
Ditaş
Fompak
Doğupres
EKU
Tırsan
Platin Akü
Norm Cıvata
Katmerciler



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Automotive industry research | Q&A

Cavo Automotiv Q&A

1) Turkey's automotive supply industry has a history of at least 50 years. It has secured a strong foothold in the global value chain, but nevertheless, changes are on the horizon in the automotive industry. What do you single out as the most significant asset for our supply industry as it transitions from its half-century history to the new era?

The most valuable asset of the Turkish automotive supply industry is obviously its highly trained and qualified human resources.

Although one can easily get sidetracked in today's globalized professional world, it is still possible to mine the correct information if you have the right knowledge and experience to sort through the noise.

Technology can be an asset provided that you have sufficient financial funds on hand and provided that you have the capability to determine which technology is the correct and most suitable one to utilize.

The ability to process acquired knowledge and turn it to your benefit depends on your ability to avail of the technology in line with your objectives and your access to skilled labor.

There exist talented individuals who have professional curiosity, who think, correctly interpret, use and implement the current technology in every sense, and who can do all that while factoring in the rules, practices, requirements, and expectations of the automotive industry.

The point that our automotive supply industry has reached at present makes access to such talent absolutely necessary. This is certainly justified by the generally acknowledged ferocity of global competition.

North Africa, Central and Eastern European Countries (CEECs), Mexico, and China, against whom we ran a high-stake competition in terms of production in the automotive supplier industry, are now turning up the heat on Turkey-based car manufacturers. Local manufacturers are now pitted against competitors from North Africa and CEECs in particular and are facing challenges in attracting new projects and vehicles to Turkey.

The key to emerging victorious out of this tough competition lies primarily in the level of quality that must be achieved in production, particularly in engineering and R&D, and the logistics costs.

Given the fact that we mainly set our eyes on Europe as the primary target export market for the supplier and automotive

industry, the level that has been achieved over several years in the fields of quality and logistics is sufficient and acceptable. In addition, engineering and R&D maintain their key positions.

As there is still a good distance to cover before we develop our engineering and R&D skills to the desired advanced levels, we must leverage the experience and knowledge acquired thus far as a "stepping stone" for future advancement. Likewise, we must set for ourselves a strategic goal to continue to make progress.

There is no better way to stress my point of view that skilled talents are the most valuable asset on which we have to focus should we aspire to take on a better position in the global automotive industry. It is a marketplace where we have to target development and progress as absolute must-haves in order to survive. It is equally a must that we objectively evaluate our experience and knowledge.

2) Considering your own assets at Cavo Otomotiv, which of your competencies would lend you a competitive edge in the automotive industry of the future? Which areas are you strategically considering for investment in your future plans?

At Cavo, we are a corporation which has been growing with continuous investment for 7 years. Therefore, we are "able" to carry out our 10-year strategic plans by investing the required efforts and time for 5 years and taking stock of them every year.

In this framework, with a view to becoming part of the global industry, we have abandoned the generally-accepted practice in our industry of having a "resident engineer". We created our R&D Center to be in the "kitchen" of the engineering, R&D, and procurement departments of our customers. We completed this process in 2016.

Shortly afterwards, we established our engineering offices in North America and Germany. And despite the economic imbalance in our country, we completed the process in approximately 2 years. We acquired a German company with two factories in early 2019. It was once our competitor.

Our short- and medium-term plans for the future include organic growth by gaining new projects and customers in our portfolio at our factories in Turkey and Slovakia.

Again, our medium- and long-term plans include expanding our existing product mix and, equally important, advancing our engineering and R&D talent.

3) The engineering capacity for product development for companies in the automotive industry is set to assert its importance further. We know that you are also investing in this field. In which direction have these investments changed the relations between you and vehicle manufacturers? Would you please elaborate on this point?

They key to your survival in the automotive industry lies in your continued ability to respond to your customers' needs.

At this point, it is important that you come up with solutions drawn from your engineering talent, knowledge, and know-how.

But more importantly, the most striking point is that instead of developing solutions to technical issues that may arise, you should be able to go to your customer with well-researched and verified recommendations on cost, process, weight, and technical performance. This makes a big difference.

From our experiences in this area, we clearly saw that the customer perceives you in a new light as long as you can make this difference. You would then be considered a "partner" beyond the conventional customer-supplier relation model.

This does not just create new business opportunities—It actually gives rise to a sense of "gratification" that arises from your boosted courage, your refreshed belief in your technical competence, and the excitement and motivation that spread to the entire team...

This is our dream that we have never stopped chasing as the Cavo family.

This is the actual gain, which does not fit in any known conventional measures.

EY and Investment Office - automotive industry research

Spokesman: Ali Çalışkan, Kordsa CEO



1. Is it possible to define Kordsa as an engineering and technology company? We know that you have a very strong R&D structure. Could you please shed some light on it? For instance, we know that you have made a very significant investment in an R&D center. Could you also tell us about this center?

R&D and innovation are an inseparable part of our corporate culture. We have been conducting our activities at two R&D centers. In 2007, we founded our first R&D Center in Izmit. This center serves as an innovation kitchen for both the global market and the Turkish market in terms of tire and construction reinforcement technologies. Our second R&D center specializes in composite reinforcement technologies. It is the one at the Composite Technologies Center of Excellence (CTCE), which we realized in collaboration with Sabancı University. This center is a role model for both Turkey and the world, because Kordsa and Sabancı University carry out the fundamental research, applied research, technology development, product development, entrepreneurship, and production processes all under the same roof. Our center is the first textile and pre-preg ("pre-impregnated" composite fibers) manufacturer in Turkey, which provides support of fundamental research to prototype part production. And it is one of the most select test centers in the world.

A team of approximately 100 people are working on developing new technologies at our two R&D Centers. As of the end of March 2019, we patented as many as 182 inventions throughout the world. In addition, we filed applications for 770 more patents and have been granted 178 patents.

At our Izmit R&D center, we perform activities to increase energy efficiency and reduce carbon dioxide emissions by taking into account the environmental factors. The latest cutting-edge technology that we developed there is a formula that we developed in partnership with German tire manufacturer Continental. We named this eco-friendly bonding technology "CoKoon". We are aiming to transform the industry with CoKoon, which represents a change in the 80-year formula and is free from resorcinol and formaldehyde.

We are involved in international projects with the participation of stakeholders from various disciplines at the CTCE R&D Center. These projects include production of composite materials with 3D printer technology under the scope of the Horizon 2020 program sponsored by the European Union. We are also involved in the production for the aviation industry of composite repair materials using nano-material additives. The new fast pre-preg curing system named CM14 is the latest technology we developed at CTCE. This new generation curing technology completely eliminates water spot and white spot formation, which has been one of the biggest challenges of the automotive industry. Now composite materials are approaching the batch production speed of the automotive industry.

2. The change of technology and its speed will have serious outcomes for all branches of industry soon. Studies and progress on materials also have a critical role in this change. How do you comment on this change in general and specific terms for the materials? What are the critical headlines for Kordsa?

As Kordsa, we are involved in strategically important markets in all three of the business branches, and we are continuing our investments to support our constant growth. We are working in construction reinforcement technologies to extend the life of and strengthen concrete structures, while our innovations in the tire reinforcement technologies reduce tire friction resistance. We are a strategic partner of major tire manufacturers owing to our innovations in tire reinforcement. We are continuing our R&D studies according to the changing requirements of the industry. In composite technologies, we enable vehicles to be lighter and more durable, thereby reducing fuel consumption. We are developing new and sustainable technologies for new-generation transportation vehicles.

We acquired fabric development, textile products, and advanced honeycomb technologies companies involved in composite technologies in Q2 2018. With these investments, we took very important steps towards becoming a strong player in the composite market of the USA and the supply chain of the growing aviation industry. We decided to acquire Axiom Materials, an approved company in the supply chain, to eliminate long approval processes for aircraft components and

space vehicles. With this acquisition, we will lead the advanced composite material technologies for both the aerospace industry and the new generation transportation vehicles.

Being the only world-leader and technology exporter in Turkey in its industry, Kordsa is expanding its sphere of influence by merging the knowledge and skill in the areas that we invest today with our innovative perspective.

3. You certainly benefit from the country's innovation ecosystem as a technology company. Could you talk about this ecosystem for us? Which elements of this ecosystem do you benefit from most in your activities?

While focusing on innovation and R&D at Kordsa, we adopted a shared work culture and open innovation. In this sense, I can say that we benefit from both our country's and the global innovation ecosystem. In order to develop new and sustainable technologies as Kordsa, we are collaborating with many domestic and international universities and institutions. We are finding and working with the best experts, companies, organizations in their related subjects, regardless of wherever they are in the world, in order to conduct projects fast and efficiently and with a view to acquiring knowledge.

One of the most prominent reflections of this culture is our CTCE, which brings university and industry together under the

same roof. Here, there are many studies that we have conducted with several project partners as I mentioned earlier. We have partnered with 2 universities and 5 industrial organizations in a project supported by the European Union on the production of composite repair materials with nano material additives for the aviation industry. The outputs of this project will start being used by the leading repair and maintenance company of the Turkish aviation industry after being tested and approved. The DiCoMi project to develop a system of software and materials for the manufacture of composite materials with 3D printer technology is being carried out with the participation of 16 project partners from 11 countries.

The CoKoon bonding technology that we recently introduced at the Tire Technology fair in Germany is also an output of our open innovation culture. We are opening this eco-friendly formula, which we produced with Continental by combining our forces and experience, for use by the entire industry with free of charge licensing now. Nevertheless, in order to enhance this technology further, we are expecting the license holders to open their patents for use by other partners of the pool free of charge. Anyone interested may request a sample. In other words, at Kordsa we are both supporting open innovation and inviting all players of the industry to become involved in open innovation. As a matter of fact, we believe that innovation is a long and tough road to walk alone.





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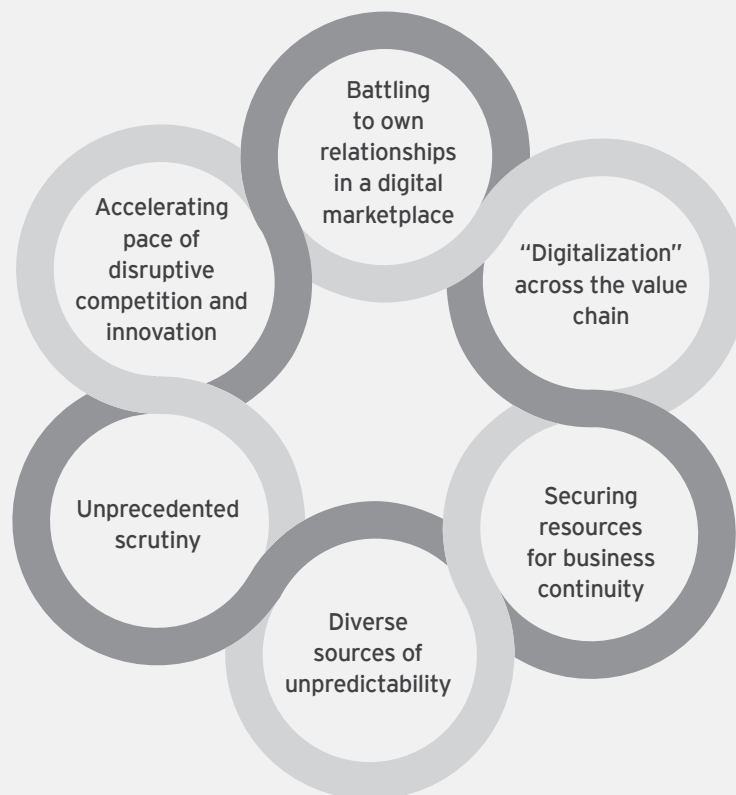
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Digitalization in the automotive sector

Digital, a defining megatrend, is transforming the automotive ecosystem.

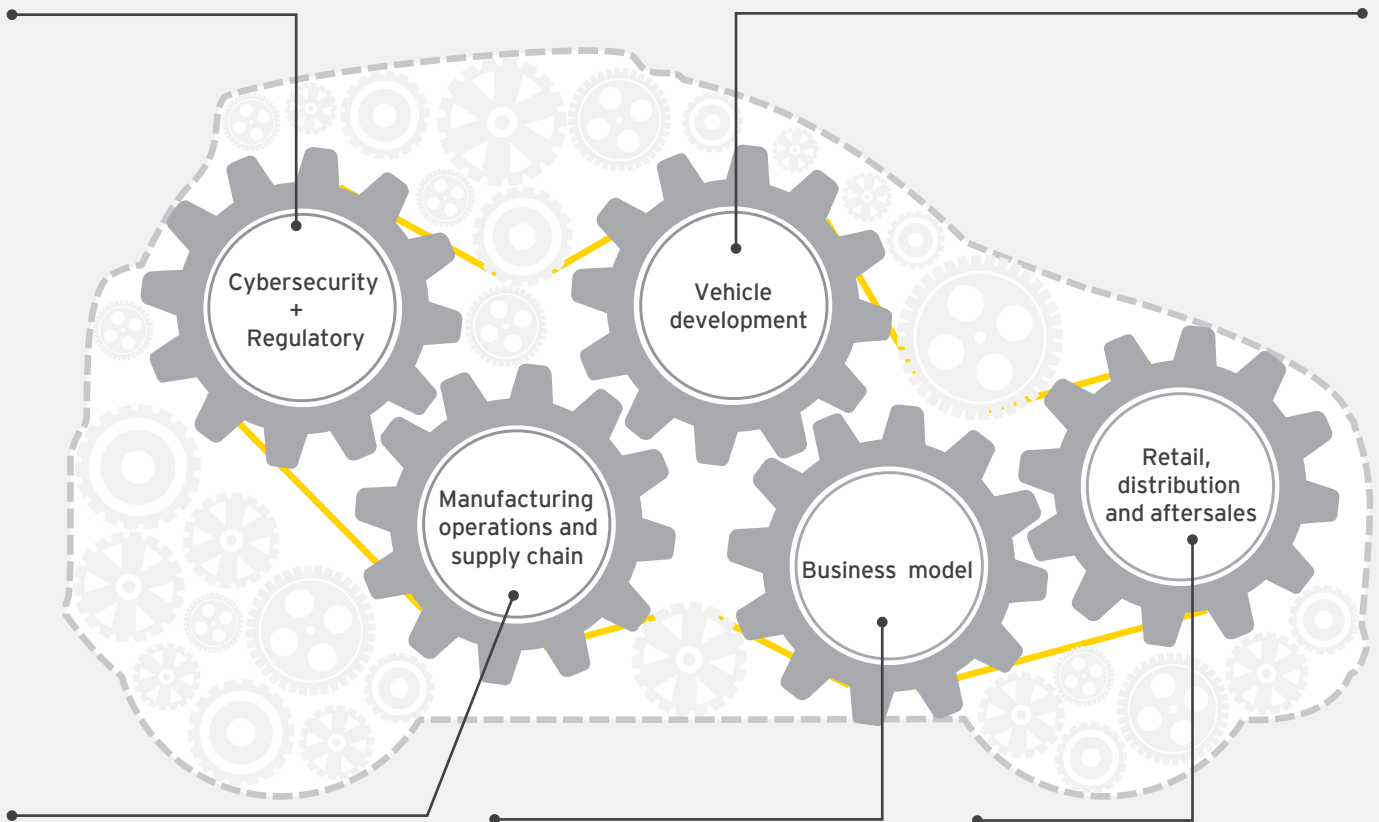
- ▶ For years, automotive players had classic advantages that protected them – trusted brands, manufacturing excellence, protective regulation and massive scale.
- ▶ But the advent of digitalization era – enabled by the combined effect of the four forces of business disruption: information availability and accessibility; decline of transaction costs; decentralization of decisions; and dematerialization – has resulted in rapid transformation of the automotive industry, thus creating new possibilities and challenges.
- ▶ The digital economy is bringing down barriers to entry in the automotive industry and this has paved the way for more entrants.
- ▶ Consequently, digital technologies necessitate companies across the ecosystem to transform core operations.
 - ▶ This newly created digital economy is forcing players in the automotive ecosystem to leverage digital technologies in order to transform their core operations while complying with regulations, ensure data privacy and simultaneously protect itself from cyber-threats.
- ▶ This playbook will give readers a high-level view of how digital technologies are aiding in overcoming strategic challenges across the automotive value chain.

Automotive drivers of change



Digital, as an enabling technology, can help the automotive ecosystem address strategic challenges posed by the drivers of change.

- ▶ Develop digitally enabled new offerings (such as ride-sharing, mobility-as-a-service) for new mobility consumers.
- ▶ Ensure consistent customer experience throughout stationary, mobile and virtual communication channels.
- ▶ Manage data privacy, cybersecurity, and leverage digital customer identity to provide personalized experience and secure loyalty in a collaborative economy.
- ▶ Use advanced analytics for demand sensing, cloud-based collaboration platforms and real-time financial analytics.
- ▶ Use Robotic Process Automation (RPA) for shared services efficiency, cloud for improving internal and multi-enterprise collaboration to improve operating efficiency.
- ▶ Leverage electronic data capture of processes, smart shop floor and intelligent asset management.

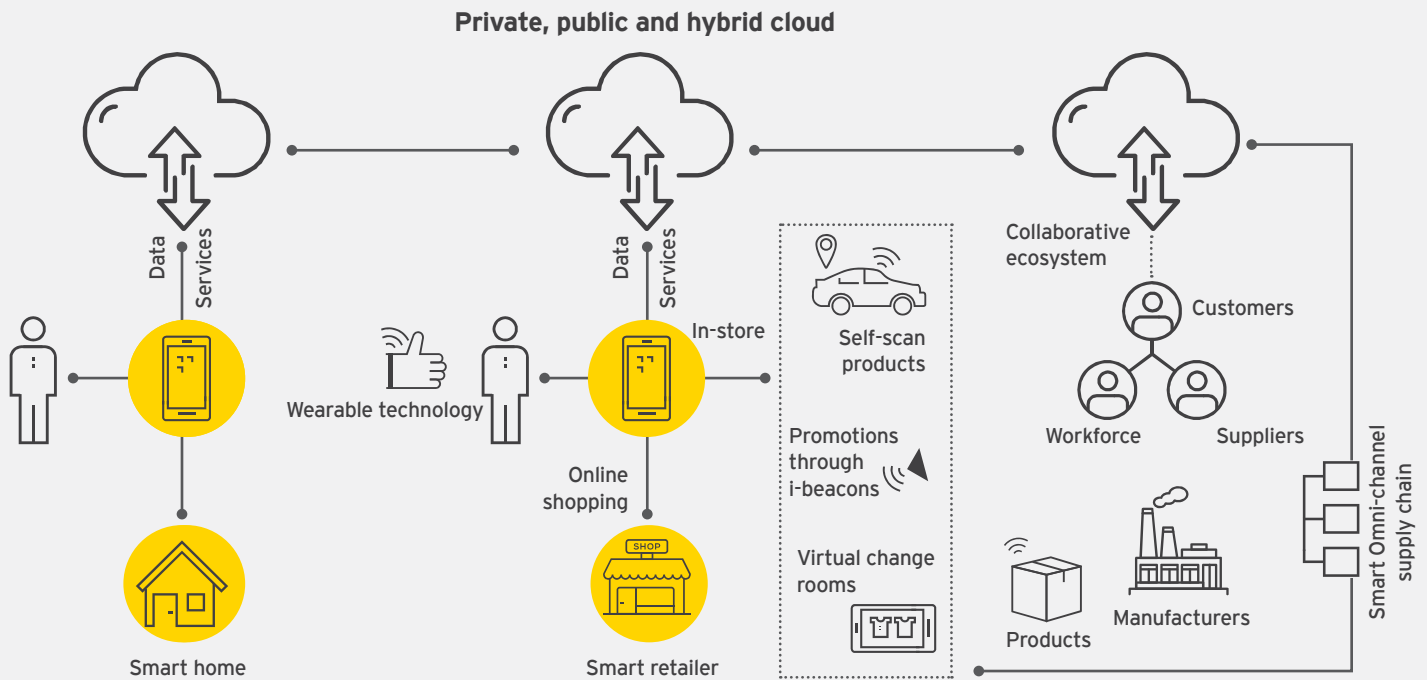


- ▶ Leverage blockchain to develop decentralized mobility and use multiple platforms (mobile apps, chatbots) to establish a direct connect with customers as well as consumers.
- ▶ Leverage cloud platforms for improved collaboration and develop close ties with start-ups to focus on distributed innovation.
- ▶ Utilize models from IT industry such as two-speed IT and micro-services architecture models for agile and fast-paced innovation.
- ▶ Leverage over-the-air (OTA) updates, advanced designing techniques and community collaboration models.
- ▶ Use predictive analytics and digital techniques such as Augmented Reality (AR), Virtual Reality (VR) and simulations.
- ▶ Use innovation labs and real-time analytics, increase visibility over key processes and spot the trend through social listening to prepare for volatility.
- ▶ Use RPA to improve compliance and quality.
- ▶ Deploy smart contracts on the blockchain to ensure an autonomous data governance structure.
- ▶ Take advanced cybersecurity measures. (tokenization of data sharing)
- ▶ Use cloud platforms to ensure internal and multi-enterprise collaboration and visibility.

Digitalization in the Automotive Sector

Digital and its role in the evolving automotive sector

The initial waves have already transformed the world around us into a smart and connected ecosystem in an unprecedented fashion, where customer is the new epicenter.



Source: EY analysis

This exponential growth has generated four forces of business disruption.



US\$ 1
million

Dematerialization

- ▶ An average mobile phone today houses over a million dollars' worth of technologies from the 1980s.



US\$ 550
billion

Decline of transaction costs

- ▶ Blockchain technology could save global businesses US\$550 billion a year.



UBER

Decentralization of decision-making

- ▶ Through its intuitive platform, Uber ensured that taxi drivers and customers retain control over the key terms of the interaction, which includes the ability to determine the nature and quality of services offered.

Four forces of business disruption

Forces breaking down the silos of the pre-digital era



2 **5**
trillion searches / million years

Information availability and accessibility

- ▶ 2 trillion searches are made in google each year.
- ▶ It would take an individual over 5 million years to watch the amount of videos that will cross global IP networks each month in 2019.

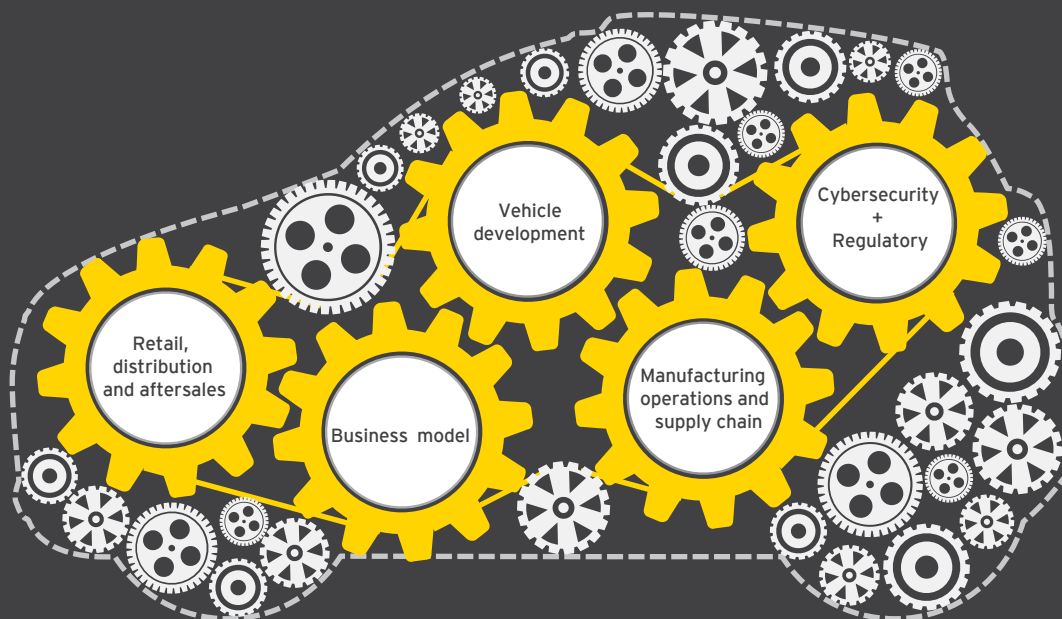
Source: CoinDesk, Big Think, CISCO Visual Networking Index; Credit: Digital Advisory GSA CSO team

What does this mean for the automotive industry?

Digital is a fundamental part of the major drivers of change shaping the global automotive ecosystem over the next decade ...



... we break the automotive ecosystem into five parts to analyze the consequent disruption.



Digitalization in the Automotive Sector

Strategic implications of digital on the automotive sector

Developing and owning an ongoing relationship with both customers as well as consumers and retaining loyalty are the biggest challenges.

Retail, distribution and aftersales

Strategic challenges	Critical enablers	Role of digital
Own the relationship with traditional customers and new mobility consumers	<ul style="list-style-type: none"> Map new segmentation that distinguishes customers (ranging from cities to ride-hailing companies) from consumers and even drivers based on ownership and access preferences. Understand the multi-generational consumer preferences for ownership versus access across geographies. 	<ul style="list-style-type: none"> Digitalize the customer journey, including the sales process, and create packages that fit customers' changing needs. Customer analytics (social media analytics, mystery shopping, survey, etc.) to have insight-led personalized interactions. Develop digitally enabled new offerings (such as ride-sharing, mobility-as-a-service) for new mobility consumers.
Own the relationship with traditional customers and new mobility consumers	<ul style="list-style-type: none"> Develop a well-designed and understood customer or consumer journey to create relevant touch points throughout their life cycle. Craft an omni-channel brand management strategy to give customers or consumers a seamless online and offline experience. 	<ul style="list-style-type: none"> Coordinate big data management (CRM, social media analytics, connected car data, DMS, etc.) to fulfill customer expectations. Ensure consistent customer experience throughout stationary, mobile and virtual communication channels. Facilitate digital customer engagement throughout overall vehicle ownership experience. (even after the vehicle is sold)
Secure loyalty in a collaborative economy	<ul style="list-style-type: none"> Shift focus from experience of driving the vehicle, to experiencing the brand. Develop loyalty management programs. Upgrade distribution networks to improve flexibility and increase relevant touch points both offline as well as online. 	<ul style="list-style-type: none"> Manage data privacy issues and cybersecurity Leverage digital customer identity and preferences (in the shared mobility environment) to give a consistent user experience (such as seat positioning and infotainment) whenever an individual is in a vehicle by the brand.

Source/s: EY analysis

Building new business models with the aid of digital technologies will be the stepping stone to sustainable growth.

Business Model

Strategic challenges	Critical enablers	Role of digital
Offer a distinctive value proposition for customers. (owners of assets) and consumers (users of assets)	<ul style="list-style-type: none"> ▶ Create value propositions that help customers and consumers tailor their mobility packages – offering choices ranging from buying vehicles to designing a package involving access to multiple premium over the top services (music and video streaming). 	<ul style="list-style-type: none"> ▶ Leverage advanced analytics and IoT to segment customers and consumers on the basis of their behavior patterns (social, driving) and also provide other over-the-top services like predictive maintenance, in-vehicle content, royalty- or loyalty-based services. ▶ Leverage multiple platforms (mobile apps, chatbots) to act as direct touchpoints with customers and consumers for sales and customization. ▶ Deploy blockchain to develop decentralized mobility.
Balance the pace of progressive and disruptive business model innovations.	<ul style="list-style-type: none"> ▶ Redefine organization structure to balance the delivery of progressive and disruptive business models. ▶ Leverage technologies to enable multi-enterprise collaboration. ▶ Tie up with start-ups. 	<ul style="list-style-type: none"> ▶ Leverage cloud platforms for improved collaboration and to develop flat hierarchy. ▶ Develop close ties with start-ups to focus on distributed innovation.
Drive innovation.	<ul style="list-style-type: none"> ▶ Support the growth of new revenue streams as well as protect the existing revenue streams ▶ Build a service-oriented company culture: customization and adaptation to individual preferences ▶ Rethink metrics from volume-centric measurement to asset utilization and miles driven. 	<ul style="list-style-type: none"> ▶ Allow asset monetization: “Car To Stay” – use vehicles for selling wifi, at resting places, entertainment places, power grid, etc. ▶ Utilize models from IT industry such as two-speed IT and micro-services architecture models for agile and fast-paced innovations.

Keeping pace with technological changes, balancing progressive and disruptive innovation and volatility are the biggest challenges from a “vehicle development” perspective.

Vehicle development

Strategic challenges	Critical enablers	Role of digital
Enhance speed to market.	<ul style="list-style-type: none"> ▶ Shortening vehicle development cycles. ▶ Using over-the-air updates to keep vehicles updated. ▶ Standardizing processes to drive efficiency while maintaining local flexibility. 	<ul style="list-style-type: none"> ▶ Leveraging software and V2X connectivity. ▶ Usage of advanced designing techniques. (such as virtual prototyping) ▶ Integrating community collaboration models in the product design and development stages.
Balance the pace of progressive and disruptive innovation.	<ul style="list-style-type: none"> ▶ Using modular platforms that enable customization. ▶ Developing vehicles that are web integrated, customizable, autonomous and green. ▶ Keeping up with technological changes: increasing shelf life of hardware. 	<ul style="list-style-type: none"> ▶ Conducting predictive analytics aligned to key business decisions. ▶ Leveraging digital techniques such as AR, VR and simulations. ▶ Allowing digital “tagging” of all customer touch points and content.
Prepare for market and demand volatility.	<ul style="list-style-type: none"> ▶ Building understanding of evolving customer needs and accordingly designing vehicles that allow for reconfiguration. ▶ Being quick in identifying the emerging trends and change faster. 	<ul style="list-style-type: none"> ▶ Using state-of-the-art and real-time analytics capabilities to become a key differentiator to anticipate volatility and accordingly redefine product attributes at the development stage ▶ Spotting the trend through social listening and innovation labs ▶ Obtaining increased visibility and control over key processes and activity drivers.

New business models require close integration of both manufacturing and supply chain operations.

Manufacturing, Supply Chain & Operations

Strategic implications	Critical enablers	Role of digital
Prepare for volatility and variables.	<ul style="list-style-type: none"> ▶ Improve supply chain visibility and resilience. ▶ Facilitate supply chain synchronization to reduce bullwhip effects. ▶ Develop pricing strategies to combat competition. ▶ Ensure effective collaborative planning. 	<ul style="list-style-type: none"> ▶ Implement advanced analytics for demand sensing, correlating market and planning data to predict demand. ▶ Use cloud-based collaboration platforms and RPA to minimize lag time between demand identification and production. ▶ Leverage automated warehouse and picking process ▶ Apply real-time financial analytics to enable advanced pricing strategies.
Improve operating efficiency.	<ul style="list-style-type: none"> ▶ Enable broader and faster communications, allowing remote and flexible working. ▶ Capitalize and manage inventory costs and minimize line downtime. ▶ Respond to competitive pressures with limited resources. ▶ Ensure effective collaborative planning. ▶ Coordinate modularization and reduction in parts. 	<ul style="list-style-type: none"> ▶ Implement predictive analytics to make faster decisions. ▶ Detect and prevent in-line failure using robotics and advanced analytics. ▶ Integrate RPA for shared services efficiency. ▶ Use cloud for improving internal and multi-enterprise collaboration. ▶ Enable a paperless office and digital records management. ▶ Demand sensing to avoid out-of-stock situations by identifying "close-to-out-of-stock" situations.
Manufacturing and supply chain re-invention.	<ul style="list-style-type: none"> ▶ Apply key process analytics to flag anomalies and discrepancies. ▶ Set up smart factories. ▶ Integrate mass customization. ▶ Manage logistics more efficiently. ▶ Optimize overall equipment effectiveness (OEE) in manufacturing. 	<ul style="list-style-type: none"> ▶ Capture electronically the data of processes driven by IoT to improve logistics and operations. ▶ Enable intelligent asset management. ▶ Leverage smart shop floor. ▶ Ensure digital replenishment. ▶ Enable intelligent tracking and last-mile delivery.
Evolving workplace models to leverage and attract talent.	<ul style="list-style-type: none"> ▶ Increase workforce productivity and employee engagement. ▶ Adapt talent management structures holistically, including talent attraction, development and retention. ▶ Align incentives and performance management. 	<ul style="list-style-type: none"> ▶ Use visualization technologies like AR and VR to improve picking process efficiency, prototype testing and training. ▶ Enable gamification of knowledge sharing and KPI management. ▶ Allow collaborative knowledge management suites to optimize the training process.

Responding to heightened scrutiny and accountability, defining ownership of data and managing supply chain risk are becoming strategic imperatives for trust building.

Regulatory and Cybersecurity

Strategic challenges	Critical enablers	Role of digital
<p>Responding to heightened scrutiny and accountability.</p>	<ul style="list-style-type: none"> ▶ Enabling regulatory radar and change management. ▶ Building in emission compliance, cybersecurity, etc. right from the product development stage. ▶ Collaborating with advocacy groups, regulators and government to develop regulatory agenda. ▶ Being accountable and transparent in the event of recalls and failure. 	<ul style="list-style-type: none"> ▶ Leveraging digital for strengthening reporting processes to demonstrate the economic value added. ▶ Enabling data privacy and cybersecurity. ▶ Leveraging digital technology for transparency and to trace provenance effectively.
<p>Defining ownership of data across the value chain.</p>	<ul style="list-style-type: none"> ▶ Creating strong alliances and partnerships, and clear agreements with partners. ▶ Breaking down organizational silos with data sharing and teaming. 	<ul style="list-style-type: none"> ▶ Creating smart contracts on blockchain to ensure autonomous data governance structure ▶ Taking advanced cybersecurity measures. (tokenization of data sharing) ▶ Enabling automotive data monetization – "Data as a product" – for example, data-sharing partnerships with third-party insurance companies to device customized insurance packages. ▶ Leveraging cloud platforms to ensure internal and multi-enterprise collaboration.
<p>Managing supply chain risk.</p>	<ul style="list-style-type: none"> ▶ Being flexible to adapt quickly in response to recalls and quality issues without significantly increasing operational costs. ▶ Protecting the supply chain network of networks from data and cybersecurity breaches. 	<ul style="list-style-type: none"> ▶ Leveraging blockchain to improve transparency and provenance* across the system. ▶ Using cloud-based collaboration platforms. <p>* Provenance: The place of origin or earliest known history of something.</p>

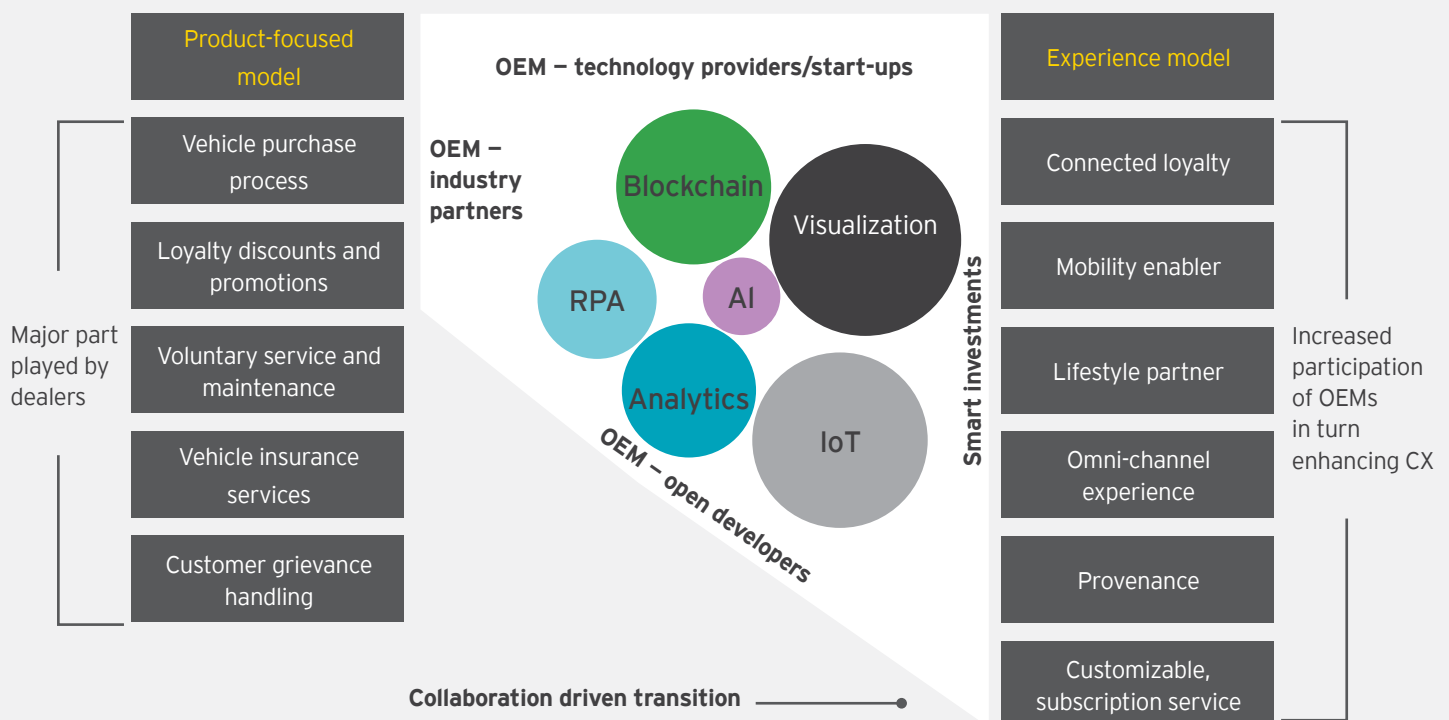
Digitalization in the Automotive Sector

Appendix

Strategic Implications – Retail, distribution and aftersales

The industry needs to transition from a product-focused model to an experience model, enabled by collaboration.

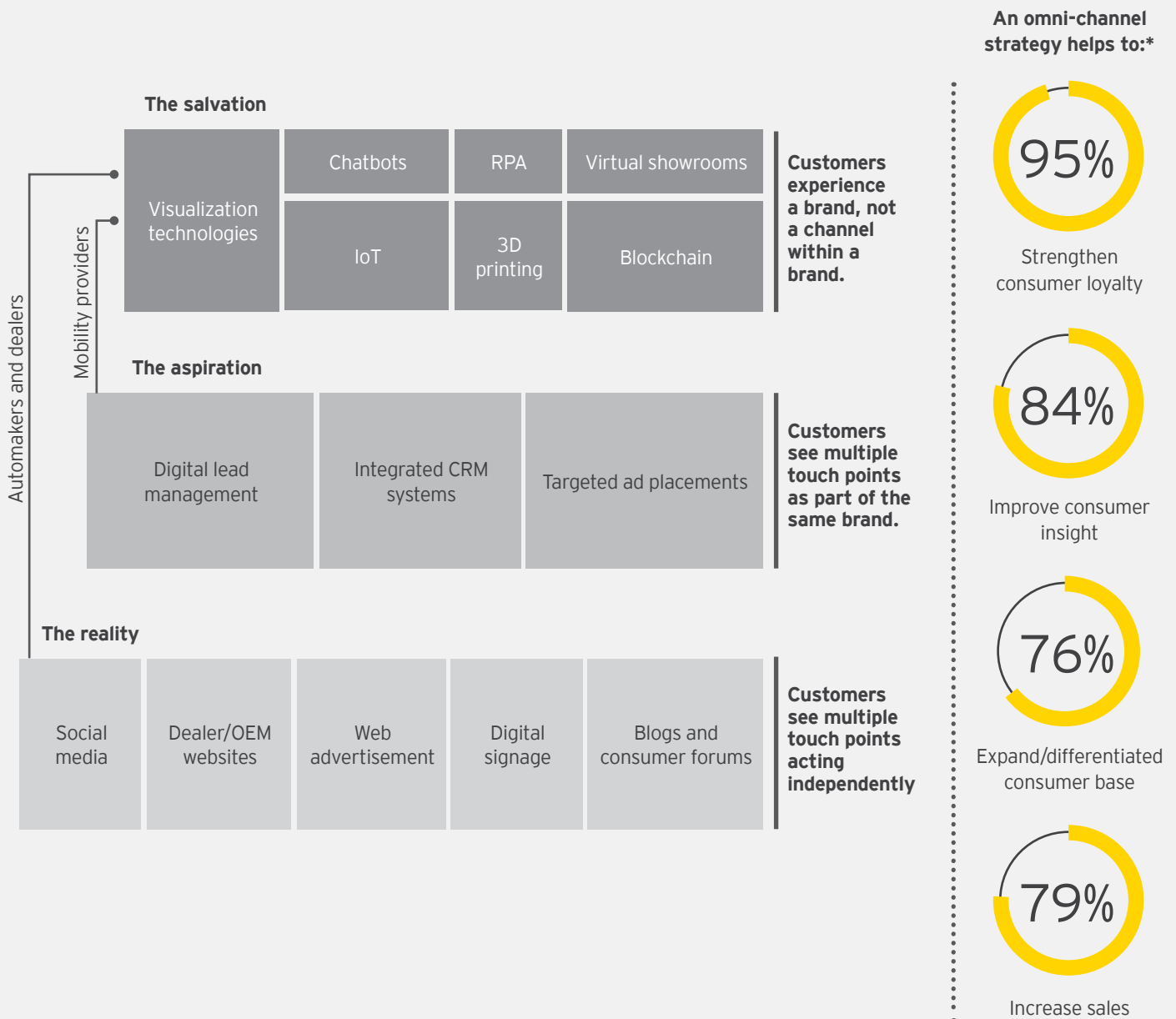
- ▶ Today, drivers and occupants are, at best, peripherally served by product-oriented, traditional business models of the auto industry.
- ▶ Consequently, automakers risk losing relationship with consumers whose needs are met by the variations of shared mobility, ranging from peer-to-peer car-sharing, ride-hailing and ride-sharing, to integrated mobility providers.
- ▶ The industry needs to lay emphasis on delivering an integrated car-centric experience to the beat of new technologies, leveraging existing product design development and delivery assets, and re-imagining the car to deliver exceptional experiences and to remain at the core of personal mobility.



Source/s: EY analysis

The automotive retail of the future will be a blend of “bricks” and “clicks”.

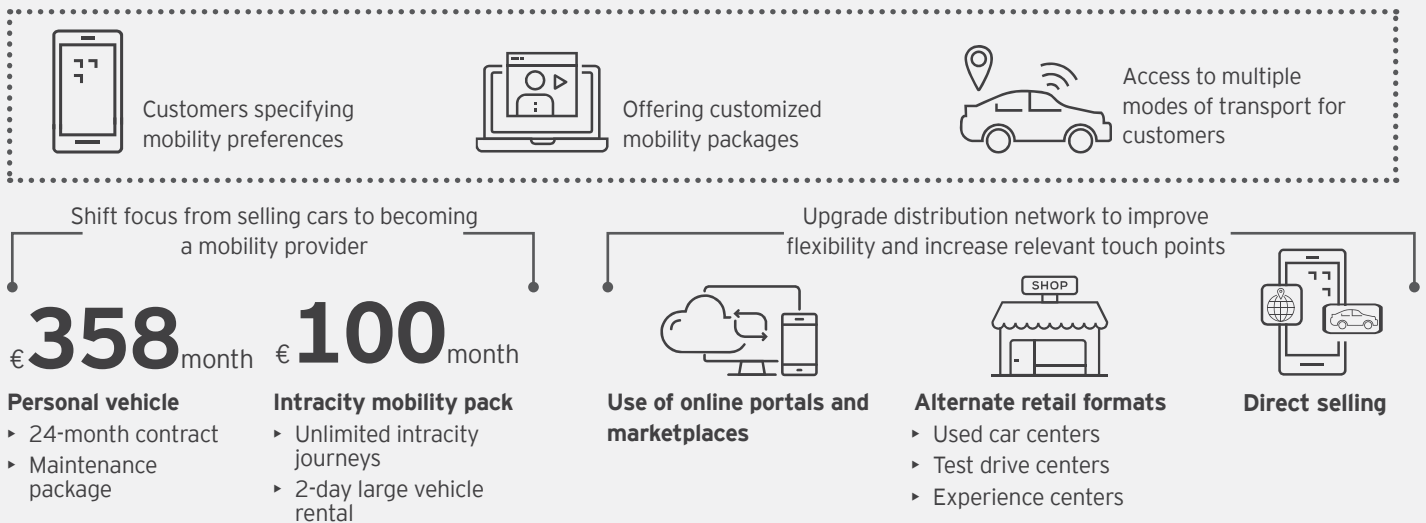
- ▶ Customers (at present) see multiple touch points acting independently and retailers’ channel knowledge and operations exist in technical and functional silos.
- ▶ Evolving customer expectations and the advent of new mobility solutions have transformed the manner in which customers interact with OEMs. The trend toward on-demand mobility has placed customers’ loyalty at risk.
- ▶ Therefore, it is critical to provide customers with a personalized and consistent brand experience that blends digital and physical channels throughout their life cycle.



*Source: Reengineering the supply chain for the omni-channel of tomorrow, EY, 2015.

The automotive industry will need to rethink its value proposition and distribution network to meet changing mobility preferences.

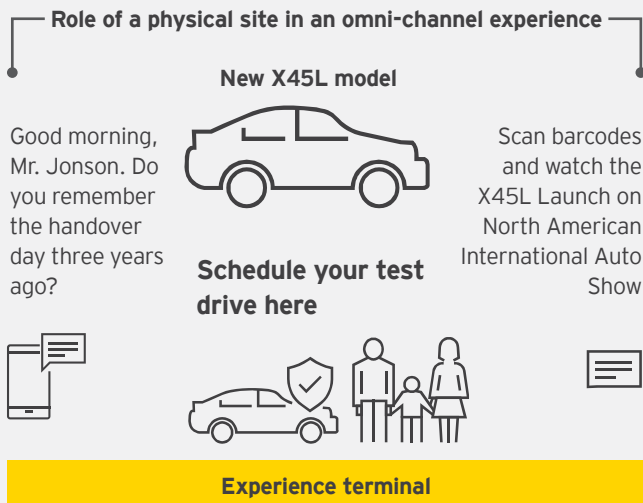
- ▶ Traditionally, decision-making for vehicle purchases has been driven by brand experience and cost of ownership. However, increasingly, consumers' loyalty will no longer be tied down with capital investments or contracts to a specific brand or service provider.
- ▶ The automotive industry will need to rethink its value propositions to meet changing mobility preferences, especially as the world population migrates to megacities. The new customer life cycle requires totally different touch points, channels and content, with an accent on new technologies and new customer perspectives.



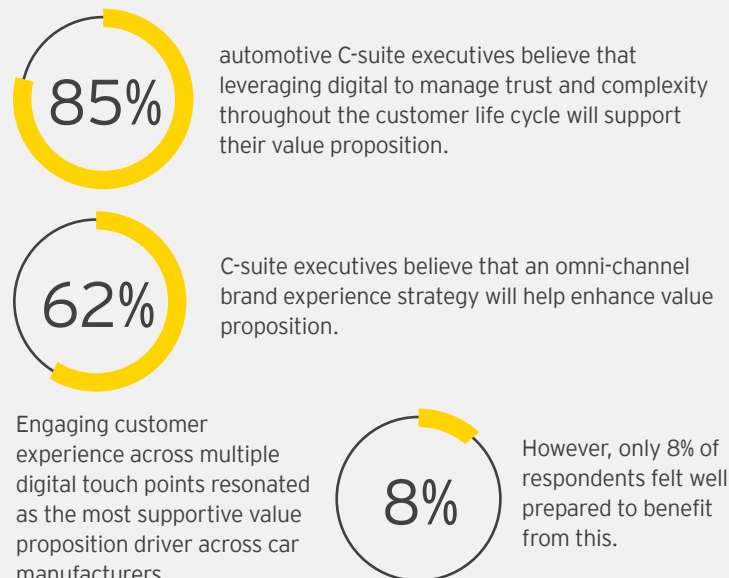
Source/s: EY analysis

An omni-channel strategy offers customers the ultimate freedom and flexibility of using and shifting between channels.

- ▶ Omni-channel brand management is a powerful tool for consistent brand and customer experience throughout all possible channels.
- ▶ An omni-channel brand management strategy includes active management of all communication channels, customization to customer preferences, and ability of customers to define their own channel mix and path.

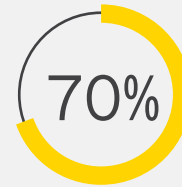


Source/s: EY analysis, EY's Changing Lanes 2016 survey



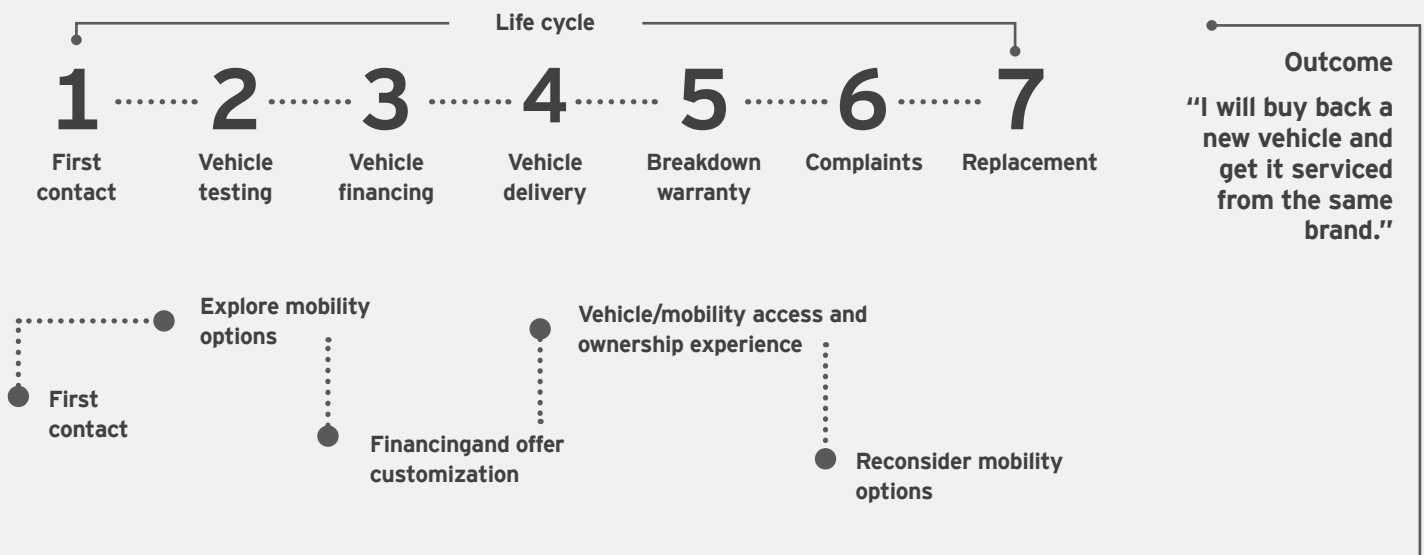
The industry needs to optimize customer experience and trust across the life cycle to build customer loyalty.

- ▶ Managing customer experience across the life cycle is critical to building a trusted relationship.
- ▶ Consumer behavior has transformed radically, and OEMs and dealers must undergo a similar transformation.
- ▶ Ownership of cars is no longer a priority as millennials' affinity to technology and active lifestyle will shape the new economy.



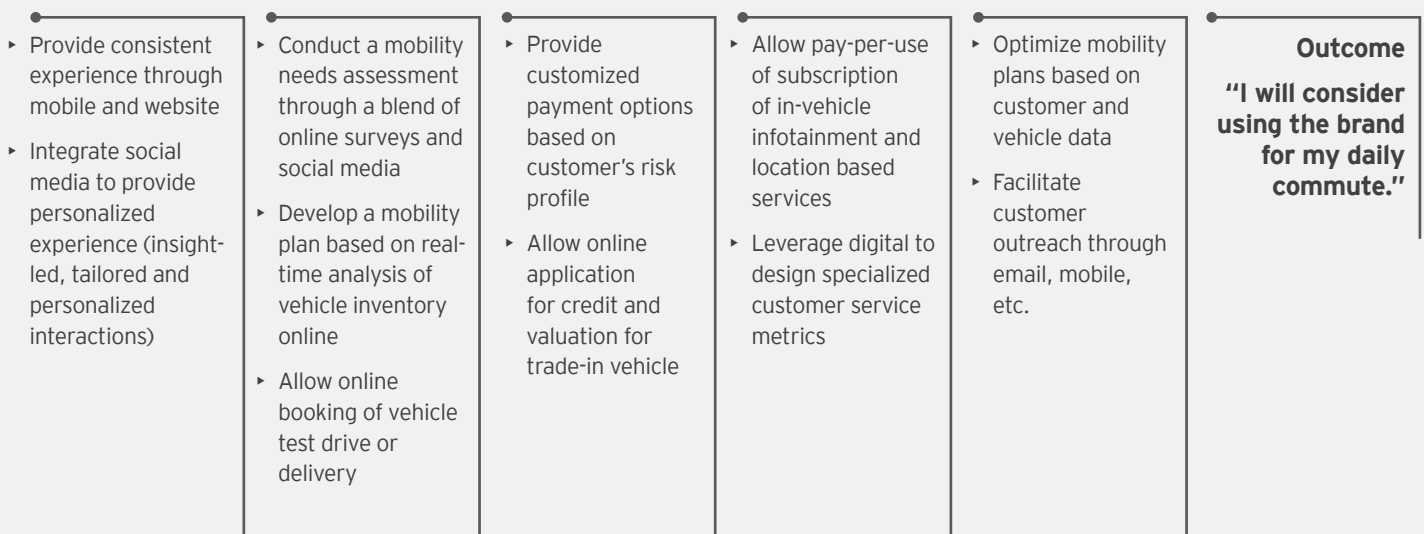
Organizations believe that an increasing emphasis on customer experience is driving business growth strategies.

Traditional "product centric" customer journey



Consumer journey in a new mobility ecosystem

Digital opportunities

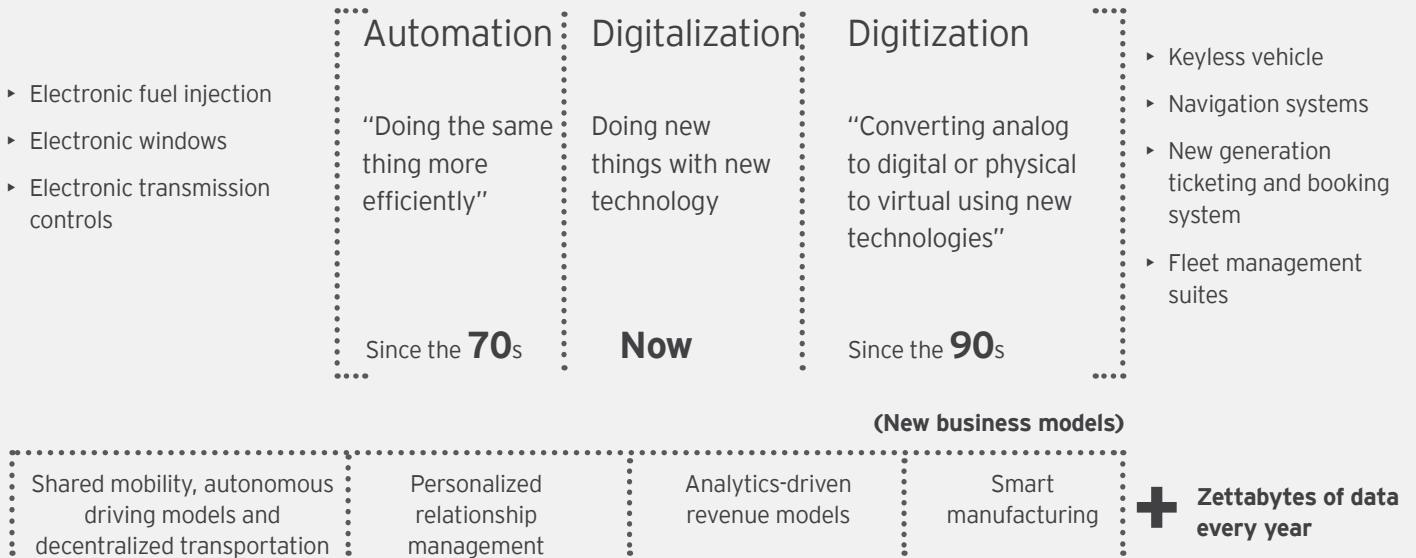


Source/s: EY analysis; The perfect landing: an engaging customer experience, EY's TL report.

Digitalization in the Automotive Sector

Strategic Implications – Business Model

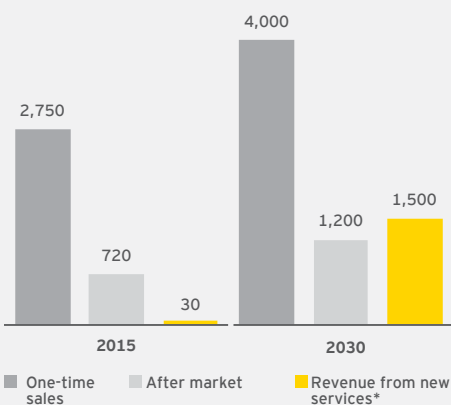
In each era, digital had different roles ...
Now the role of digital is to drive new business models.



Credit: Digital advisory GSA CSO Team

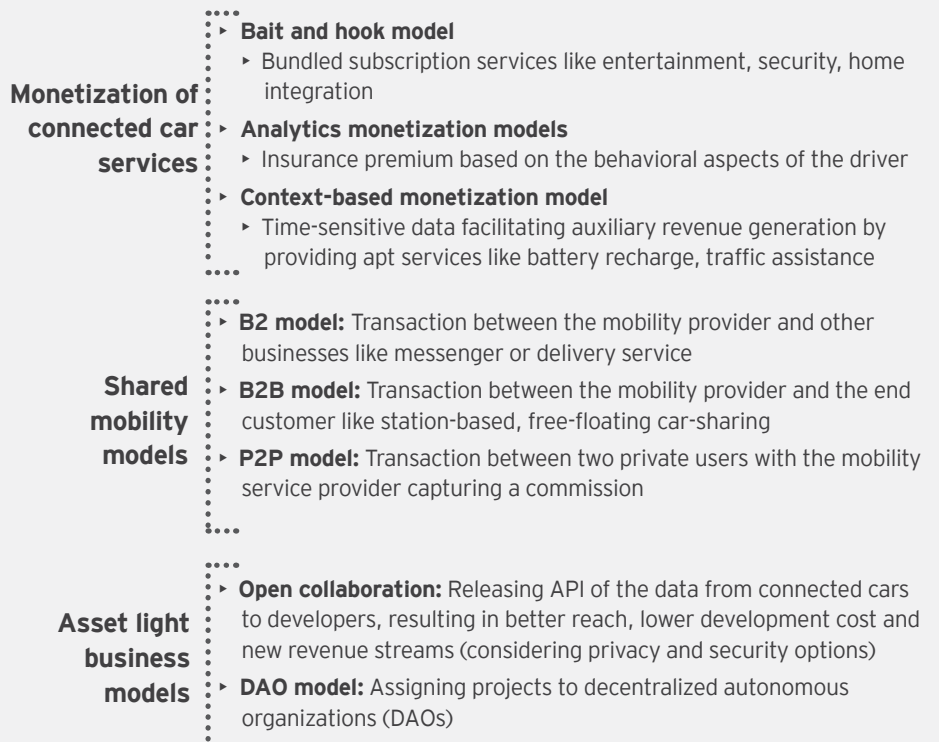
The data generated across the auto industry ecosystem in this era could open up new possibilities and revenue pools for the industry players.

Disruption scenario in automotive revenue pool, US\$ billion



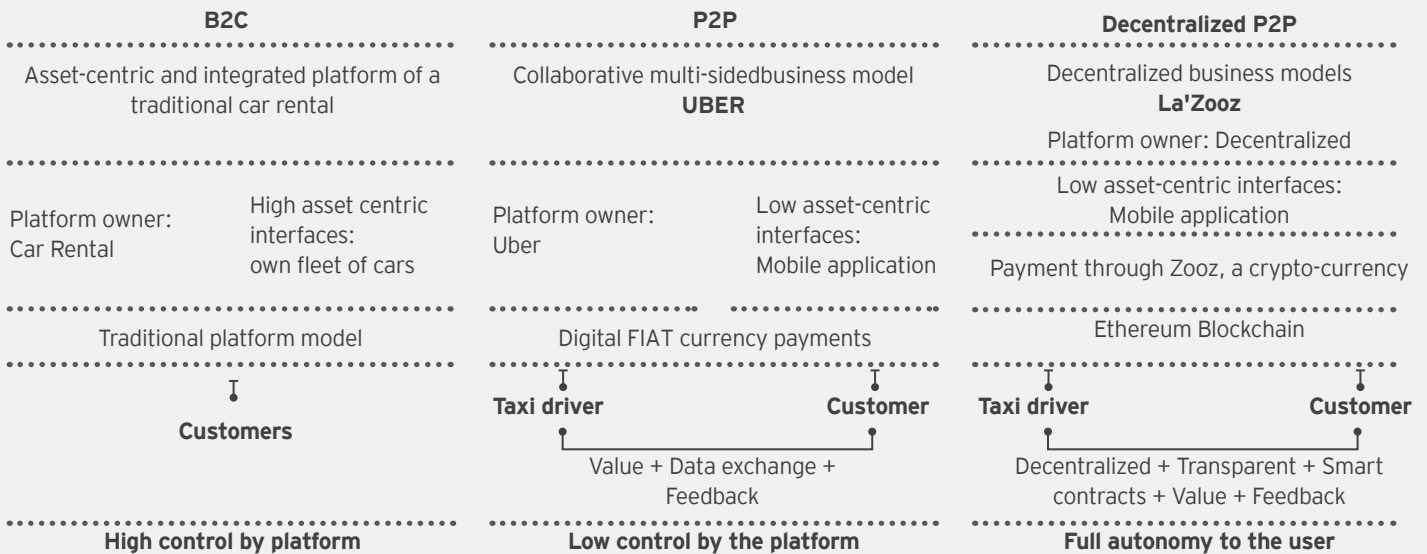
Source: McKinsey, 2016

*Shared mobility and data connectivity services



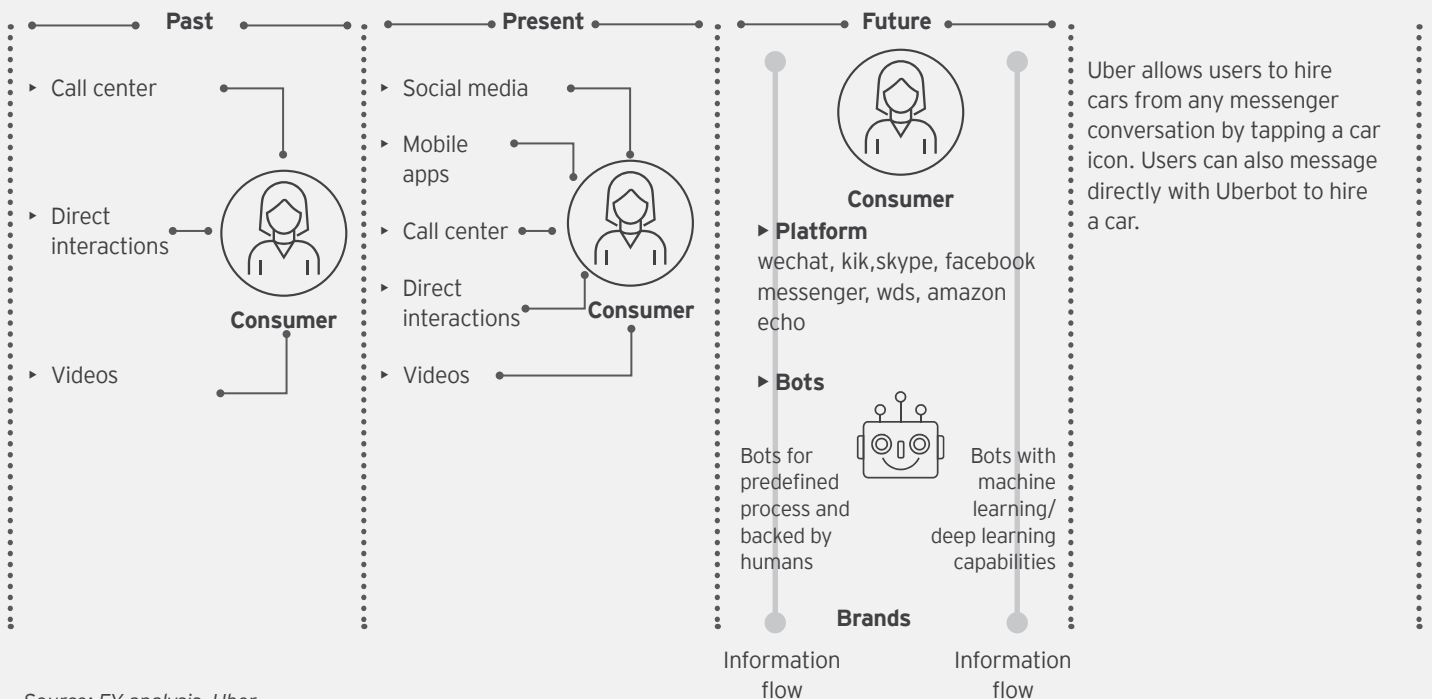
Blockchain is opening up new ways for developing decentralized shared mobility.

Advanced distributed ledger technologies are transforming multi-sided business models successfully orchestrated by Uber by bringing in autonomous trust, tokenization and smart contracts. These three core elements bring transparency in the whole transaction, thus handing over full autonomy to the user.



Source: EY analysis, Uber, Lazooz

Context-based monetization utilizing multiple platforms through bots are enabling organizations to fulfill consumer demand at the right micro-moment.



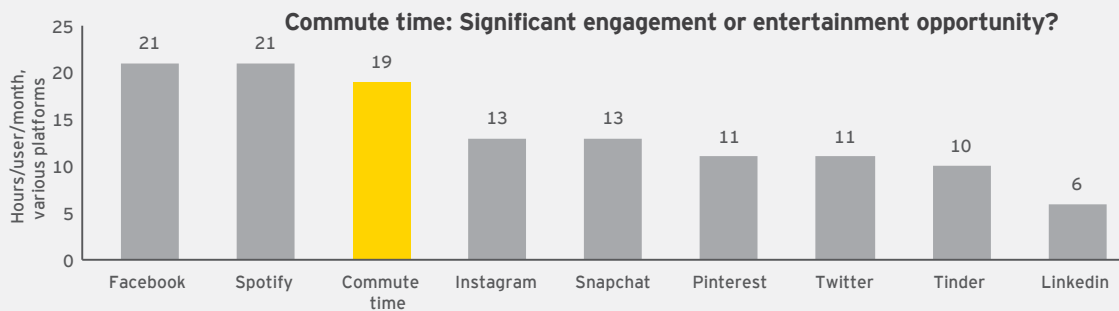
Source: EY analysis, Uber

The growth of autonomous driving technology are forcing OEMs to re-imagine the most important seat in the car to generate bundled subscription revenues through services like entertainment.

Rolls Royce 10hp (1904): Designed for Rider

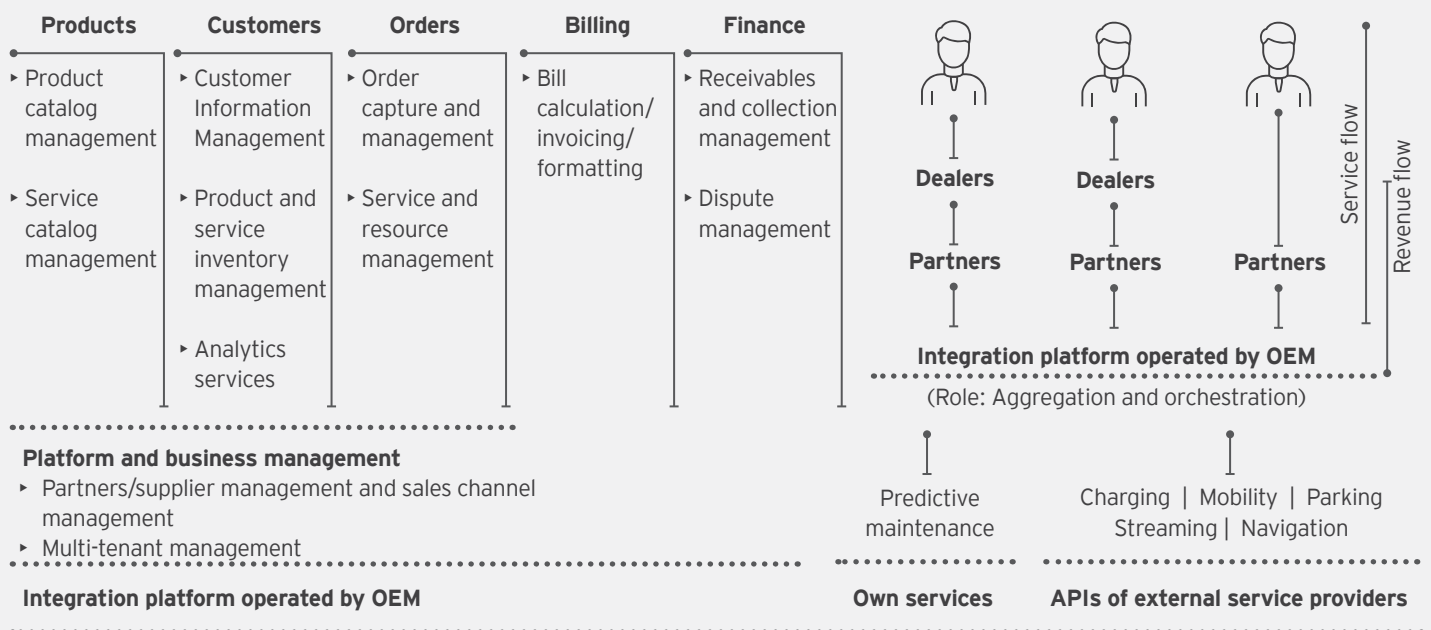


Mercedes-Benz F-015, "Luxury in Motion" concept (2015)



Source: Cowen & Co. Research

But monetization of new business models require creation of an ecosystem to drive multi-enterprise collaboration.



Multiple business models would require OEMs to operate a collaborative environment, wherein each OEM should act both as an aggregator of external services as well as an orchestrator.

Source: EY analysis

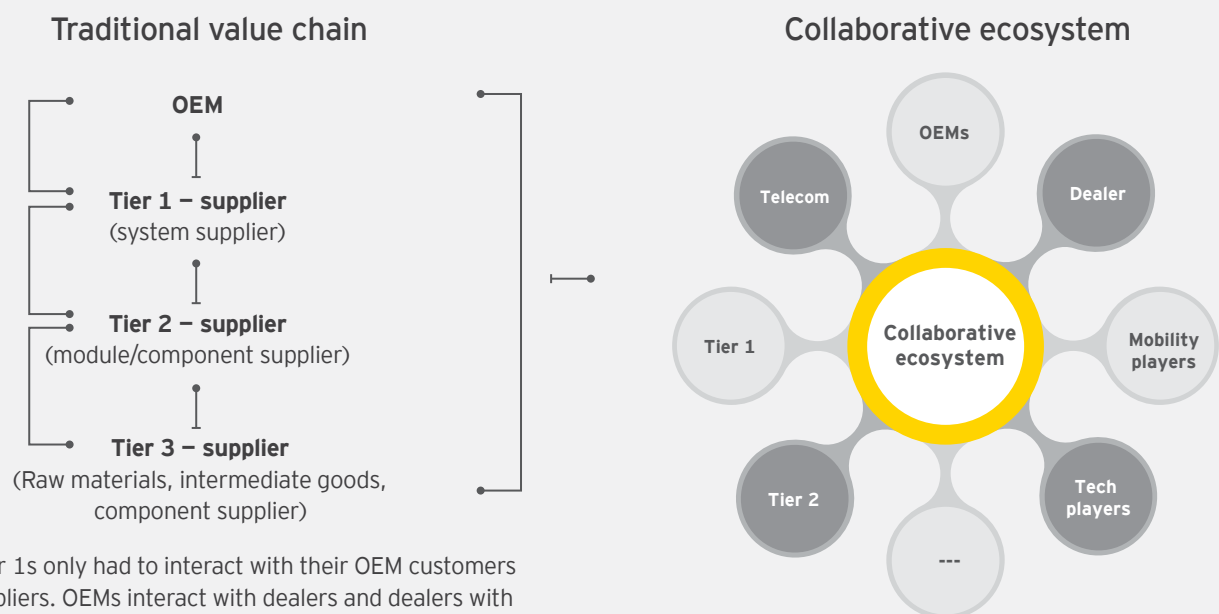
Today's automotive innovation is pioneered by start-ups; ignoring them could be a loss of innovative and creative ideas.

- ▶ Traditional OEMs continue to accelerate the pace of their engagement with ride-sharing companies and other tech start-ups.
- ▶ The acceleration of activity seen in H1 2016 is immediately obvious with the world's biggest oil nation Saudi Arabia, alongside OEMs have already announced investment worth US\$9 billion in ride-sharing apps.

Ride-sharing service	Investor	Amount (US\$ billion)
Uber	Saudi Arabia	3.3
Didi	TBD*	3.5
Didi	Apple	1.0
Lyft	General Motors	0.5
Gett	Volkswagen	0.3
Via	Venture Capital	0.1
Scoop	BMW	0.0051
Uber	Toyota	Undisclosed

Source: Bloomberg; *Didi's US\$3.5 billion not yet disclosed

Collaboration in the ecosystem is the new normal and is replacing traditional automotive value chain dynamics.



In the past, tier 1s only had to interact with their OEM customers and tier-2 suppliers. OEMs interact with dealers and dealers with customers.

In the collaborative ecosystem, there is intersection of different stakeholders with consumer at the center.

Although the brunt of digital disruption will be felt by OEMs, these forces will drive a bullwhip effect throughout the value chain .

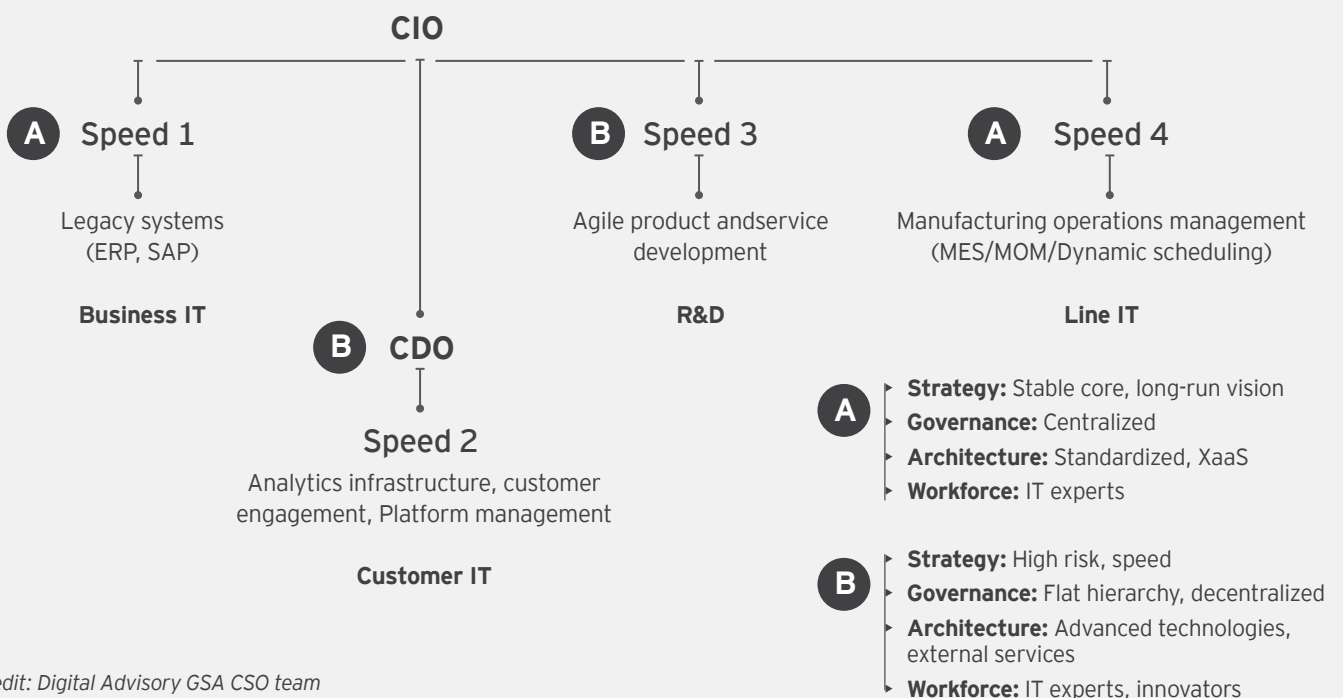
New business models are required when suppliers come in direct contact with the consumer.

- ▶ Selling services rather than products
- ▶ Selling directly to the consumer
- ▶ Utilizing data to generate business value

Adopting the new model enables suppliers to generate incremental revenue.

- ▶ Companies convert what has been a traditional product into a service by tying in a recurring pricing model for specific features. For example, automotive tier-I suppliers could replicate Rolls-Royce's Power by the Hour model wherein the company sells uptime rather than engines.
- ▶ For example, selling services directly to a used car consumer. Supplier directly contacts the used car owner and provides OTA updates for advanced cruise control system, navigation system, security features, etc.
- ▶ Companies generate revenue from data gathered from sensors, e.g., providing analytics enabled services.
 - ▶ Bosch launching its own IoT cloud platform and Bosch connected powertrain
 - ▶ Michelin Earthmover Management System (MEMS) Evolution3, an advanced system for sensing and transmitting tire information
 - ▶ Example from other industry: GE released the Predix software platform in 2015.

And to protect existing business operations and simultaneously implement fast paced disruptive business models demands IT to work at multiple speeds.



Credit: Digital Advisory GSA CSO team

Digitalization in the Automotive Sector

Strategic Implications – Vehicle development

Digital is fundamental to the future of urban mobility as it would reshape the vehicle characteristics and value proposition.

- ▶ Digital technologies are a critical enabler to develop vehicles that are web-integrated, customizable, autonomous and green, and also for designing the business models around these vehicles.
- ▶ Digitization, mobile connectivity and social media are making “vehicle access without ownership” more attractive for consumers.

Why this matters:

The road map to the urban mobility vision is based on the growing collaborative economy and the proliferation and success of shared mobility business models. As urbanization depletes natural resources and digitization disrupts distribution channels, technology and peer-to-peer sharing will take center stage in designing a city’s intelligent transport infrastructure.

Vehicle characteristics

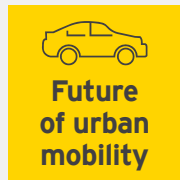
- Web-integrated**
 - ▶ V2V and V2I (collectively V2X) communication
- Customizable**
 - ▶ Hardware and software reconfiguration
- Autonomous**
 - ▶ Control shifts from driver to vehicle
- Green**
 - ▶ Fuel-efficient/alternate power train

Digital infrastructure

- Real-time travel information**
 - ▶ Optimized and personalized journey planning
- Connected transport infrastructure**
 - ▶ Traffic and virtual parking management
- One-stop payment system**
 - ▶ Smart cards, e-wallets, online account management
- Omni-channel strategy**
 - ▶ Seamless customer experience through relevant distribution networks

Cross-sector stakeholders

- ▶ Automotive manufacturers
- ▶ Infrastructure providers
- ▶ Transport/travel providers
- ▶ Research institutions/academia
- ▶ Mobility sharing providers
- ▶ Connectivity providers



Digital can help the automotive industry reduce its product development cycle in order to meet the rapidly growing customer expectations and available choices.

- ▶ Consumer electronics and technology players have taught consumers to expect a rapid pace of innovation. This expectation has made it increasingly difficult for automakers and suppliers to maintain the current three- to four-year product development cycle.
- ▶ These challenges are complicated by the need to make the transition from mechanical engineering processes to digital ones.

Product development challenges for the automotive industry

Long time to market

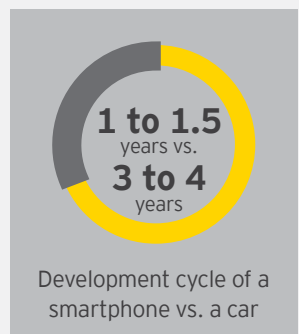
- ▶ Poor speed to market, especially since customers want latest connectivity technology inside the car

High cost

- ▶ Too many prototypes being developed
- ▶ Designs often being inflexible and developed with a view of current trends

Quality issues

- ▶ Huge recall costs as a result of design or development lapses
- ▶ Customer feedback often getting lost when designs are translated from functional to technical specifications



Results

- ▶ Usage of digital simulations that model full-vehicle functionality, reducing the need for the lengthy construction of physical prototypes
- ▶ Community collaboration models in the product design and development stages
- ▶ Borrowing techniques such as agile development from the software world and applying them to mechanical and electrical designs
- ▶ Leverage innovations in additive manufacturing and other computer-aided manufacturing methods to reduce time to create and test prototypes

Source/s: EY analysis

Digital is a key enabler to develop vehicles based on real-time assessment of demand.

► Digital transformation enables the achievement of an intelligent and adaptive enterprise.

► For “vehicle development,” digital could be leveraged for product conceptualization and planning (through in-house digital labs and consumer insights via digital), rapid prototyping, use of cloud platforms to collaborate with suppliers, etc.

► Order to delivery



How can value chains be disrupted to boost revenue, improve responsiveness to demand signals and reduce cost to serve while improving the experience for customers, partners and employees?

Automatic ordering of parts, labor and equipment via a digital marketplace

► Design to produce



How can operations across various elements of the value chain be optimized for maximum productivity, uptime, throughput, etc., and effective decision-making with minimal human intervention?

► Demand to design



Based on inputs from external and internal data, how to design new products?

Internal data:

- Vehicle data
- Location
- Behavioral
- Social
- Customer service
- Third party

Data generated by assets and field force is captured and analysed to drive insights for asset management, value added insights and effective real-time decision making

Source: EY analysis

The industry needs to build in modular platforms, customizable interiors and OTA updates right from the vehicle development stage to improve flexibility and speed to market.

► Automakers should look to shorten product life cycles in order to respond to individualized and fast-changing consumer demands with innovative products.

Modular platforms

Adoption of modular platforms flexible enough to design vehicles (from hatchbacks to sedans to SUVs) as per changing preferences

27.8 million

Estimated number of vehicles to be produced on top-10 platforms, up from 19.2m in 2014

Customizable interiors

Dynamic interiors as per customer preferences, driving preferences (retractable center console and steering)

us\$ **4.5** billion

Forecast global market size for HMI systems by 2017

OTA updates

Build-in capabilities to introduce changes in hardware through OTA updates

us\$ **35** billion

Forecast cost savings to automakers by 2022 as a result of OTA updates

Source/s: EY analysis, IHS, MarketsandMarkets

The automotive industry is increasingly focusing on OTA updates to bring down the recall costs and keep vehicles updated in terms of latest features.

Drivers

Rising vehicle recalls

Rising connectivity

Need for autonomous driving

Threats

- ▶ **Secure environment:** Hacks will continue to pose a significant safety risk; OEMs will need to secure hardware, software and cloud hacks.
- ▶ **Connectivity issues:** OTA patches and updates require uninterrupted connectivity; any connectivity failure can disrupt the update, resulting into vehicle malfunction.

Technology

- ▶ **Software over-the-air (SOTA) updates:** These are updates to improve or upgrade the existing application, maps, infotainment, etc. Ideally done over wifi or mobile network, however, OEMs are exploring more radical option – sending an update to driver's smartphone and then having it transmitted to the car via Bluetooth – allowing even older vehicle to receive updates.
 - ▶ **Firmware over-the-air (FOTA) updates:** These include updates to improve or upgrade the operating firmware of the vehicle ideally with respect to Electronic Control Unit (ECU) or Telematics Control Unit (TCU). In future, the OEMs will be to update or replace only the code, rather than the entire file. Until now, Tesla is the only company to have roll out FOTA update – autopilot driver-assist system in 2015.
- Benefits**
- ▶ **OTA updates to save time:** Offering new updates on the move and delivering new features and applications wirelessly improves performance and fast fixes.
 - ▶ **Reduced vehicle recalls and cost savings:** Will help reduce recalls by offering ECU updates over the air and significant savings on maintenance and warranty costs. Not all recalls can be fixed via an OTA update, however, one-third of recalls in 2015 could be addressed over the air, with manufacturers saving as much as US\$6 billion.
 - ▶ **OTA updates could pave the way for V2X communication:** OTA updates are the key to a truly connected car to pave the way for more advanced automotive architecture, including V2X communication.

Market indicators



In the short term, traditional automakers are likely to leverage SOTA updates as they are still at a nascent stage in terms of FOTA updates.

▶ **MAP SOTA**

Projected to grow from about 1.2 million vehicles in 2015 to nearly 32 million vehicles by 2022

▶ **APPS SOTA**

Projected to grow from about 3.0 million vehicles in 2015 to 53.8 million vehicles by 2022

▶ **Infotainment SOTA**

Projected to increase from approximately 200,000 vehicles in 2015 to about 96.4 million vehicles enabled vehicles by 2022

▶ **ECU and TCU FOTA**

About 25.7 million ECU update support vehicles by 2022
 About 160 million vehicles with TCU OTA capabilities by 2022

Core focus area for the next four to five years, especially for the traditional OEMs – a significant impact on sales retention, customer satisfaction, brand equity and franchise dealer networks

Existing focus area for disruptors (such as Tesla) and future focus area for traditional OEMs – largely to counter recall-based fixes

- ▶ This is primarily done via telematics systems.
- ▶ Examples: BMW, VW and Tesla recently announced OTA procedures for updating navigation maps while Hyundai and Ford are expected to deploy systems in future.

- ▶ This is the easiest segment to implement – small in total memory with limited associated safety issues.
- ▶ This can be done via OTA platforms.
- ▶ All major OEMs are expected to introduce app OTA updates by 2019.

- ▶ It is more complex due to program size.
- ▶ Such updates are expected to occur over wifi, rather than through LTE4G service, due to mobile network limitations.
- ▶ It has expected to become a growth segment and will grow quickly over the next six years.

- ▶ ECU is a rare segment and only Tesla has announced updating core auto ECUs.
 - ▶ It is expected to occur over LTE4G and wifi both.
- ▶ TCU is currently being implemented via telematics systems.
 - ▶ It is expected to happen over all wireless connections, including smartphones' Bluetooth.

Source: IHS, ABI, news articles, EY analysis

New digital design processes and tools have revolutionized product development, with technologies such as AR, VR and digital simulation leading to lower costs and time to market and addressing rising complexities.

Drivers

- ▶ Intensifying competition and rising customer demands
- ▶ Increasing costs associated with production changeovers and prototypes
- ▶ Rising complexities through introduction of hybrid, plug-in and electric cars

Reduction in costs

Faster time to market

Rising model complexity:

Technology (illustrative)

- ▶ Cloud-based integrated PLM solutions such as Arena's solution or Autodesk coupled with 3D printing capabilities for rapid prototyping
- ▶ Digital channels such as simulation centers, AR and VR labs, to infuse customer expectations directly into the early stages of product design
- ▶ Advanced analytics for demand sensing, tagging and further integrating sourcing with prototyping and production

Benefits

- ▶ Reduced development cycle and costs, for example, crash tests through digital prototypes and simulation, enable reduced number of physical crash-test prototypes per new model as well as the cost incurred per prototype
- ▶ Reduced product iteration cycle times – allows OEMs to address iterations such as aerodynamics, fuel economy and styling prior to the tooling phase, thereby bringing the development time down by about 30%
- ▶ Product experiences – through technologies such as AR and VR, OEMs are able to simulate or overlay reality with digital information to familiarize with product features

Market indicators

Digital prototyping: could reduce development time for new models

~36 months ▶ ~24 months

Design freeze to Job 1

.....
Reduced number of crash-test prototypes

30-50 cars ▶ 10-15 cars

Case example of JLR

Spare parts

40% reduction in costs

90% faster repairs

Source: IHS, ABI, Gartner and EY analysis

The automotive industry is leveraging digital to develop and modify products virtually before physical production of prototypes.

JLR: Digital simulation, aerodynamic engineering process

- ▶ JLR produced Jaguar XE saloon model without using any prototypes during the aerodynamic engineering process.
- ▶ The company aims to eliminate all physical prototypes from the early development process by 2020.

Mercedes: Digital simulator for test driving

- ▶ This enabled Mercedes to evaluate the handling characteristics of its vehicle digitally at an early stage.

Availability of real-time test drive and suspension data offered significant flexibility.

JLR: Vehicle design through analytics

- ▶ JLR carried out extensive virtual prototyping and big data comparison during the development of Evoque.
- ▶ This enabled design improvement and saved time.

Valeo: Manufacturing process improvement through PLM

- ▶ The company leveraged Dassault Systèmes' DELMIA to extend its PLM deployment in order to optimize its manufacturing processes.

Harman: OTA capabilities

- ▶ Harman acquired Redbend to enhance capabilities for OTA updates.



Digital simulation



VR and AR



Cloud PLM

VW: Spatial augmented reality

- ▶ VW projected virtual data on to real vehicle design models, thus allowing the analyses of components.
- ▶ This saved time and cost by accepting or rejecting design without physical prototype.

BMW: Augmented reality projections

- ▶ This enabled BMW technicians with step-by-step instructions on how to fix an engine and what tools to use.
- ▶ Doing so saved time and brought precision while working on more obscure, complicated or high-value vehicles.

Ford: VR to develop vehicle design

- ▶ Through Oculus Rift headset technology, the company visualized cars' designs and experience before the actual production.
- ▶ It also helps customers validate the quality of the vehicle.

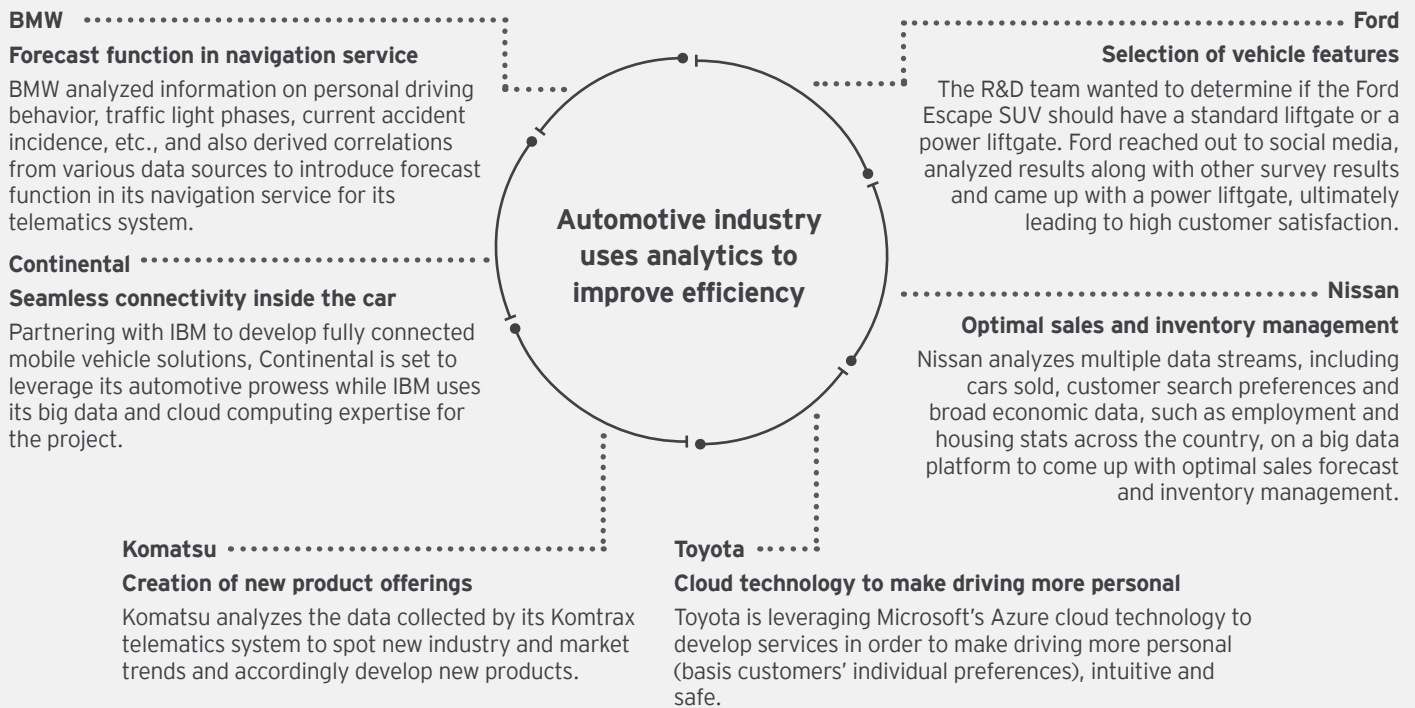
Robert Bosch: Internet of things

- ▶ Bosch aims to connect everyday wares and devices over the internet, fuelling the rise of "smart" homes and car.

Source: IHS, ABI, news articles, EY analysis

With digital leading to an exponential surge in the volume of data generated, analytics could transform how business decisions are made in the automotive industry.

- ▶ Digitization has led to data explosion; analytics could transform how business decisions are made across the automotive industry.
- ▶ The automotive industry is leveraging analytics to drive greater efficiency across vehicle development as well as other parts of the automotive ecosystem.
- ▶ The industry needs to have a defined analytics or big data strategy, align the organization structure, invest in IT infrastructure and hire data scientists to drive the uptake of analytics.

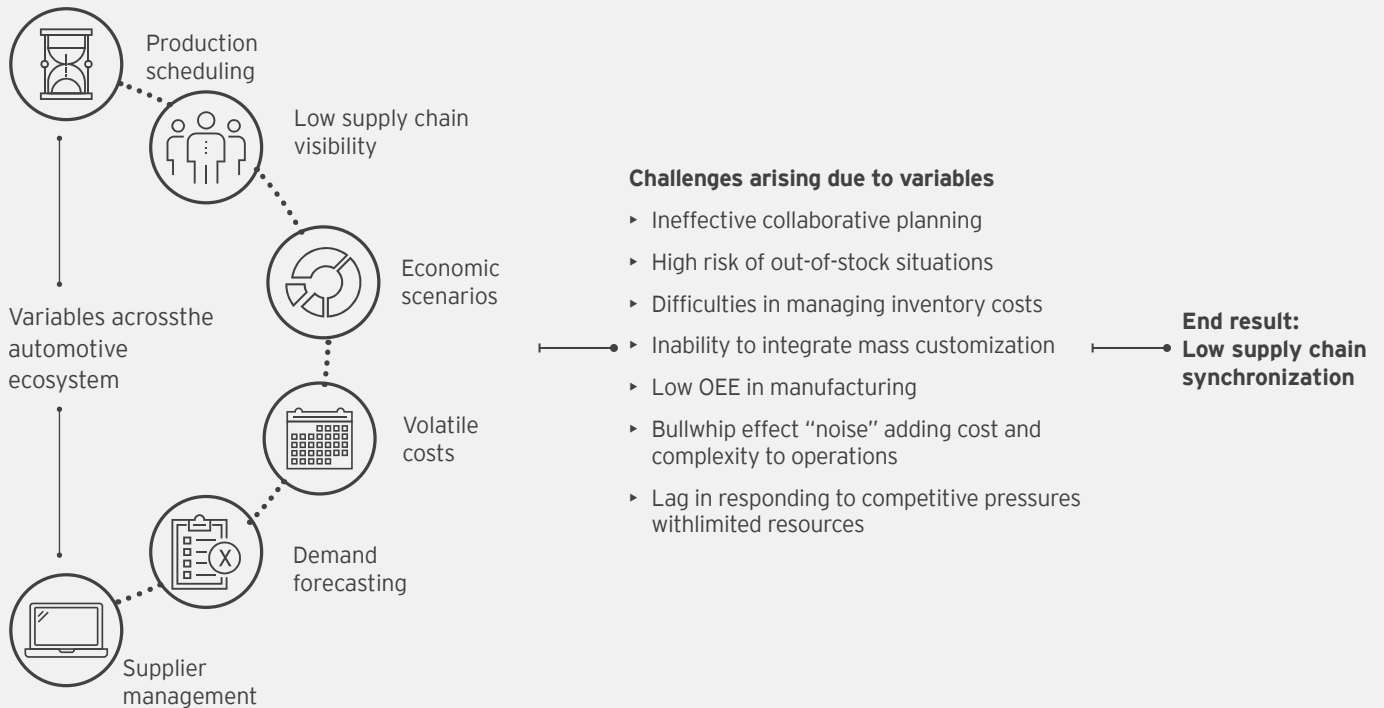


Source/s: EY analysis

Digitalization in the Automotive Sector

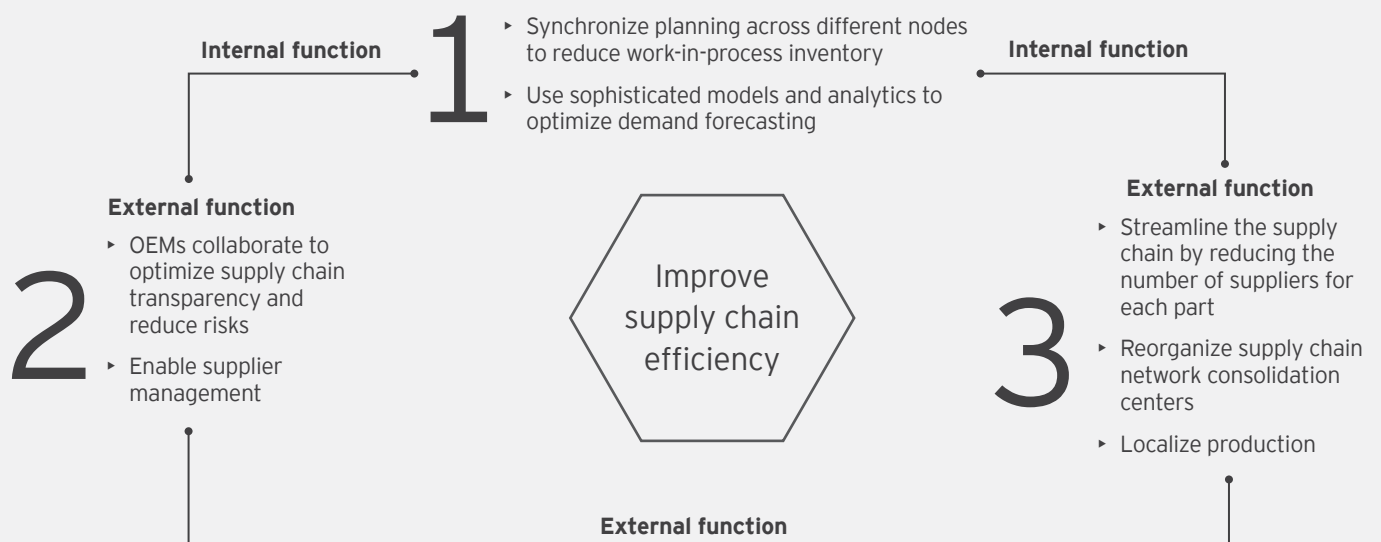
Strategic Implications – Manufacturing, Supply Chain & Operations

Variables faced by the automotive industry have resulted in low supply chain synchronization ...



Source: EY analysis

... thus requiring a high degree of integration of both internal and external processes.



Digital technologies will thus be integral for a high degree of integration of the core processes.

Advanced analytics	<ul style="list-style-type: none"> Multi enterprise and predictive analytics would aid in an improved demand sensing, thus resulting in the reduction of bullwhip effects and an efficient production scheduling.
3D printing	<ul style="list-style-type: none"> Customized and complex products can be manufactured to meet changing customer preferences.
Blockchain	<ul style="list-style-type: none"> Blockchain improves provenance in supply chain, reducing counterfeiting issues. Blockchain will empower organizations to successfully sync “supply chain management, supply chain finance and audit” boosting efficiency and agility of the value chain.
Robotic automation	<ul style="list-style-type: none"> Automation technologies would aid in reducing manufacturing cost and also improve throughput speeds. Software bots would auto-check shipment documents ensuring up-to-date information. AI technologies are evolving, thereby enhancing productivity, consistency and accuracy, resulting in better compliance across the system.
AR/VR	<ul style="list-style-type: none"> AR and VR technologies would enable enhanced visual picking of products as well as reduce errors in picking.
IoT cloud	<ul style="list-style-type: none"> IoT aids in developing a fully connected and monitored supply chain to improve efficiency and agility, along with improving interoperability between entities.

Supply chain synchronization



Integrated supply chain operating model



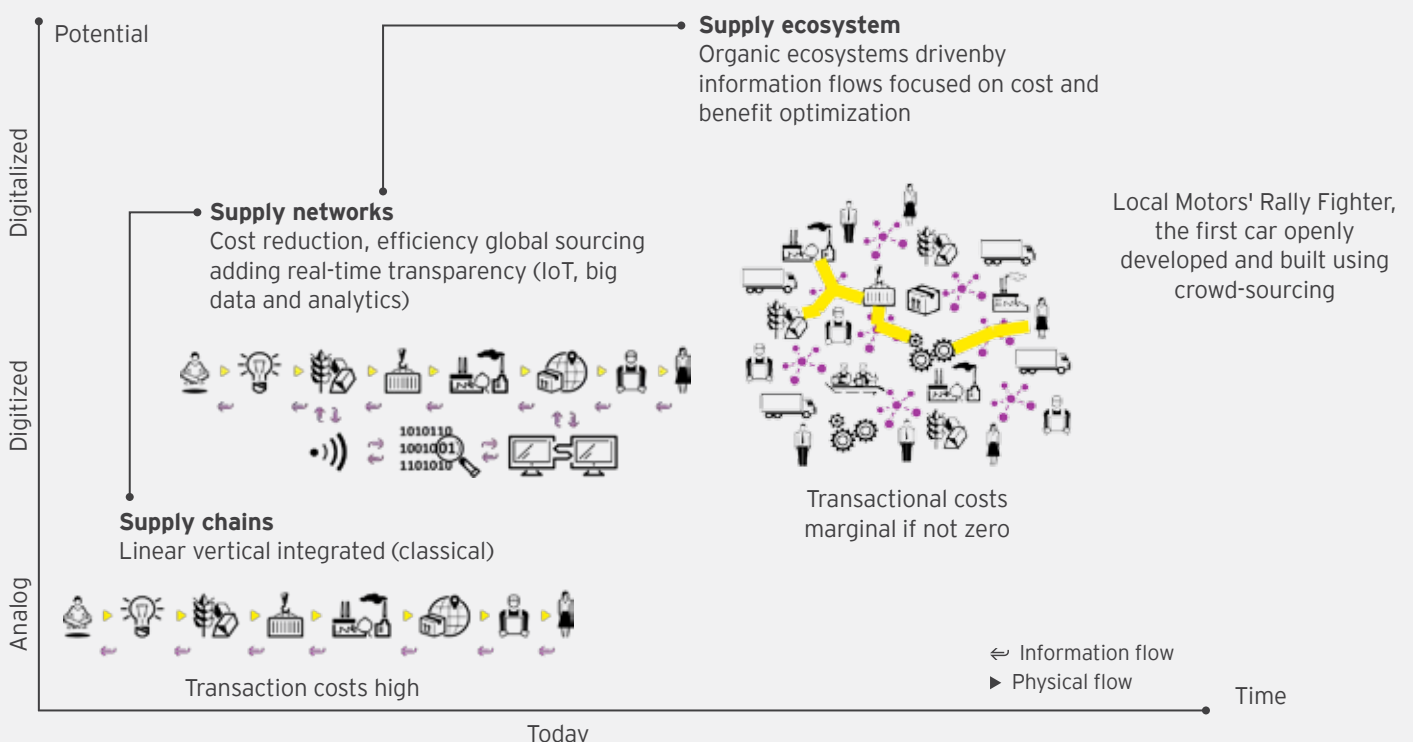
Supply chain network and flow optimization



Supply chain resilience

Source: EY analysis

One such classic example is how digital transformed the linear supply chain of the automotive industry to a distributed ecosystem.



Credit: Digital advisory GSA CSO Team

Automotive OEMs are also currently streamlining their manufacturing operations ...

End-to-end digitization of production processes – Industry 4.0

Mercedes-Benz (MB) plant in Tuscaloosa, US, assembles next SUV generations (including hybrid).

Digitization to enable flexible production

- ▶ Tuscaloosa is connected to all MB Cars locations, allowing location-independent access to data and process management.
- ▶ All installations and robots are controlled centrally and updated.
- ▶ Big data applications are to be used for intelligent analysis and improvement of production processes.

Mass customization

Ford's production line for its F-150 pickup trucks:

Up to **1** million

variations without adding costs for retooling and re-equipping lines.¹

Scania's mass customization of its trucks:

only **1.2**

trucks have same configuration – allows many variations in how a truck is configured.²

Modularization and reduction in parts

- ▶ Daimler adopts modular strategy to satisfy regional customer needs and varying emissions and size regulations across MB in Europe; Freightliner and Western Star in North America; Fuso in Southeast Asia; and BharatBenz in India.
- ▶ Easier customization with Scania's modular system: Scania uses shared components in trucks, buses and coaches, as well as industrial and marine engines.

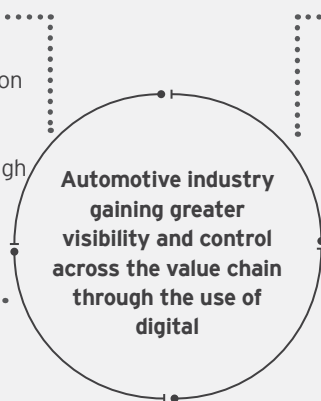
Source: 1- www.bizjournals.com; 2- www.engineering.com

... while also leveraging digital and analytics in logistics and supply chain.

- ▶ Digital and analytics are allowing automakers have greater visibility and control over the complete supply chain, thus reducing risk. Analytics will aid in transforming information into action through agile decision making across the automotive industry value chain
- ▶ Digital would be a critical enabler towards having better component traceability, optimal inventory management, reduced warranty/recall costs, etc.

FreightVerify
Transportation visibility using telematics
 FreightVerify helps automakers gain real-time transportation visibility using truck telematics data. The company also leverages a "sharing-economy" like model in the trucking industry and also uses the cloud to speed operations through increased and secure connectivity.

Surgere
Improved tracking of containers
 Surgere leverages software, bi-directional RFID to achieve transportation visibility, global location and sensor-based monitoring. The company provides a view of supply chain that helps automotive industry increase efficiency, gain control and greater visibility over packaging, and in turn reduce costs.



Ford's Smart Inventory Management System
 Ford uses Smart Inventory Management System (SIMS). The company analyses multiple data streams, including cars sold, customer search preferences, economic data, etc. to manage vehicle complexity and delivering right cars to dealerships.

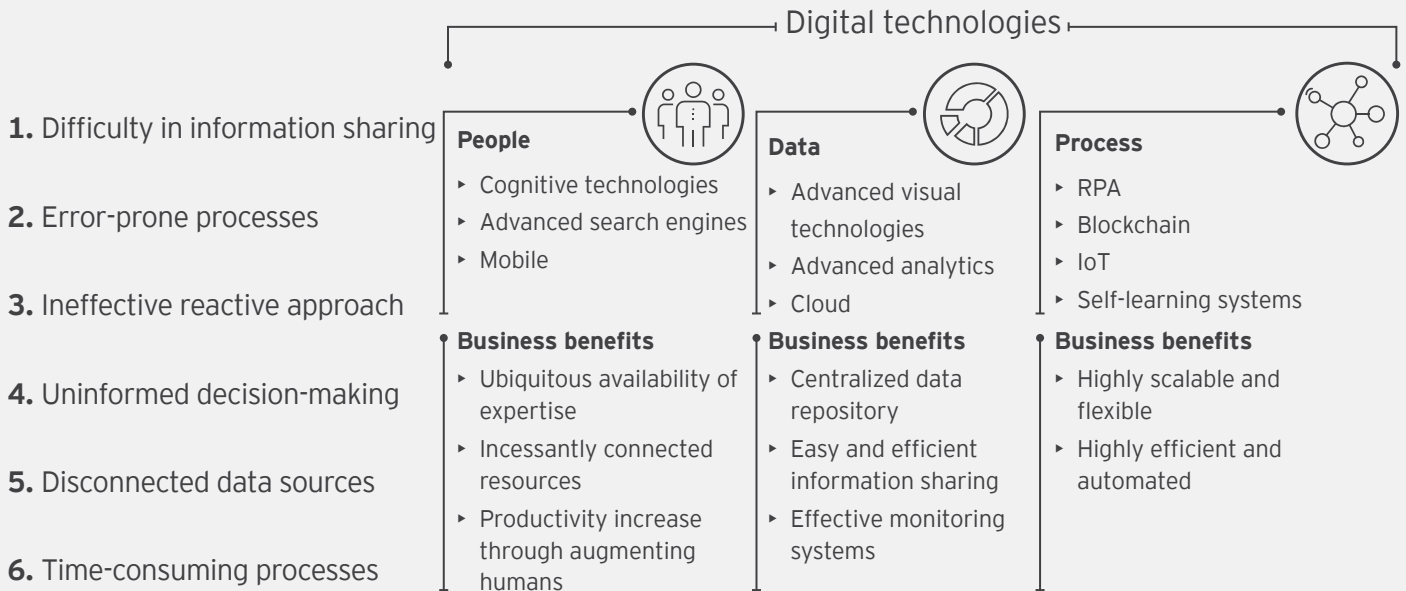
GM Reduction in vehicle recall costs
 The components used at GM's assembly lines are linked to the identification number of the vehicle in which it is installed. If a defect is found, the automaker and its suppliers trace the defective part or assembly problem to the VINs of all other affected cars, thereby reducing the warranty costs.

Source/s: EY analysis

However, supply chain transformation should be backed by digitally optimized supporting processes ...

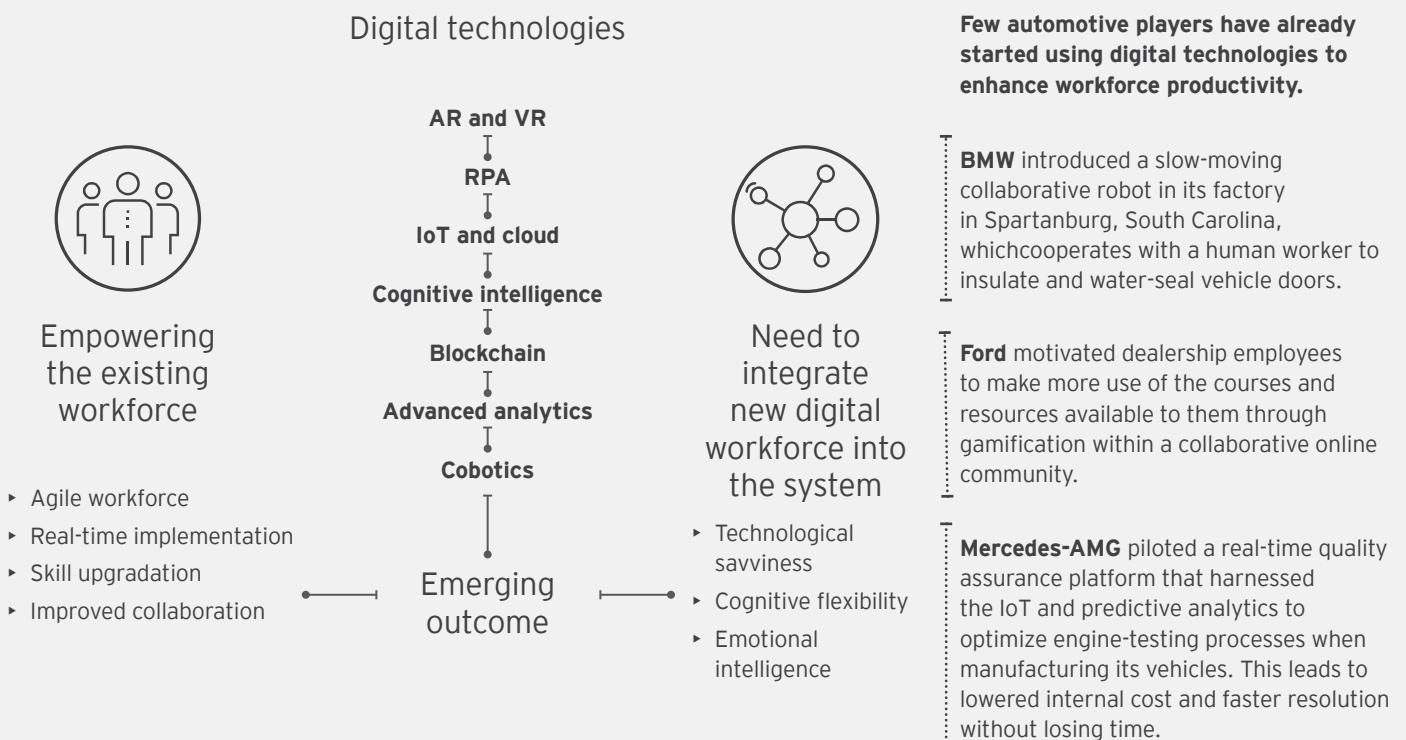
Key business challenges

Digital technologies that can improve operational efficiency in the automotive industry



Source: EY analysis

... and a workforce strategy to make work in this industry attractive for the digital generation.

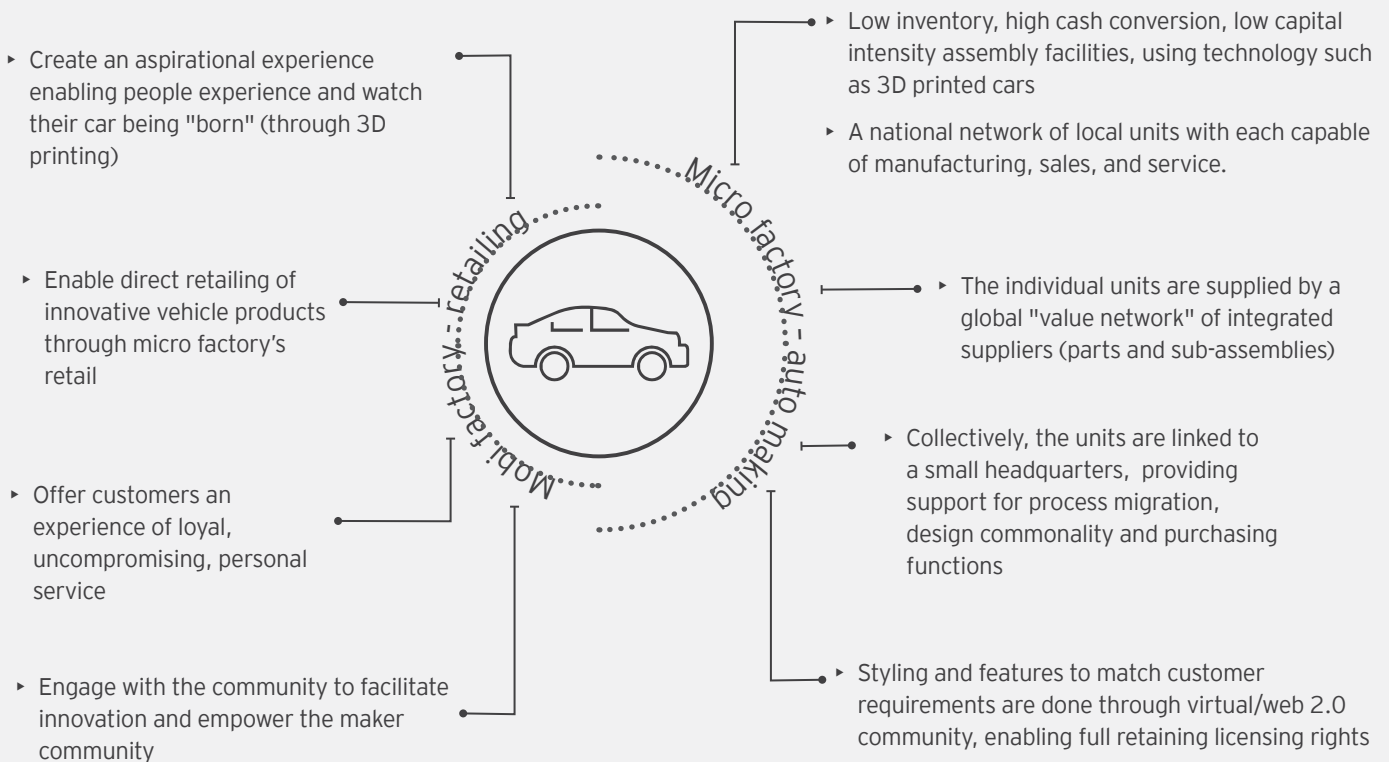


Source: EY analysis, Ford, BMW and Faraday future

Case study: Local Motors

Local Motors is circumventing the incumbent players and building an ecosystem of passionate co-creators to design new products and new processes to deliver innovative product.

- ▶ Local Motors has built a community of co-creators by recruiting industrial designers, automotive engineers, and potential customers who are passionate about cars.
- ▶ The company is a great example of a customer ecosystem—a business network that is aligned to help customers meet their goals: in this case, design and produce great cars (3D printing used for manufacturing).
- ▶ Local Motors is also innovating in customer experience—what it means to own a car that customers built themselves. Local Motors is also redefining how cars are manufactured, sold, and serviced by substituting local micro factories for traditional dealerships.

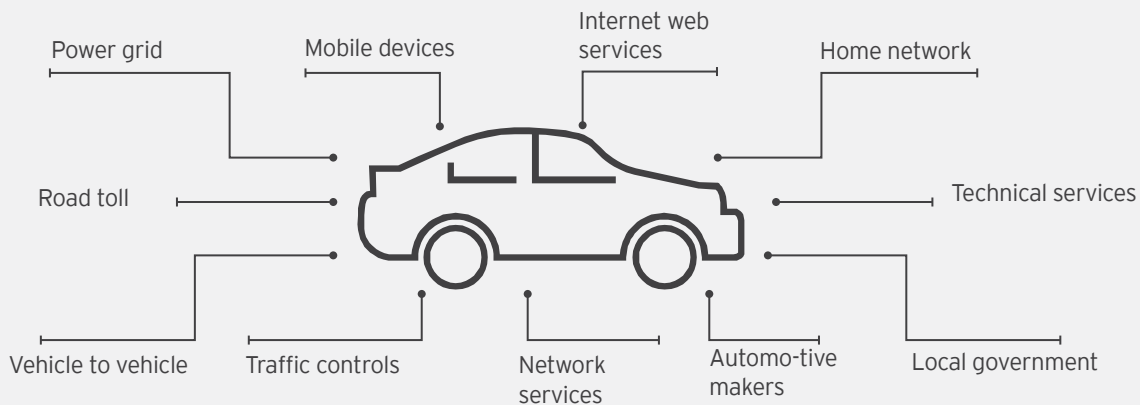


Digitalization in the Automotive Sector

Strategic Implications – Regulatory and Cybersecurity

Relevance of cybersecurity has increased with connected car initiatives that link vehicles with surrounding networks.

- ▶ Telematics units are attractive entry points for cyber attackers as they communicate both with the outside environment and the car's internal network.
- ▶ Vulnerability in any one link of the automotive supply chain can impact many others.

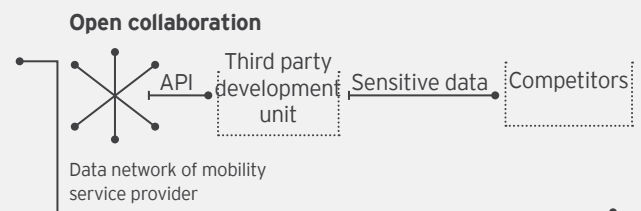


Sources: Information-technology Promotion Agency Japan, EY analysis

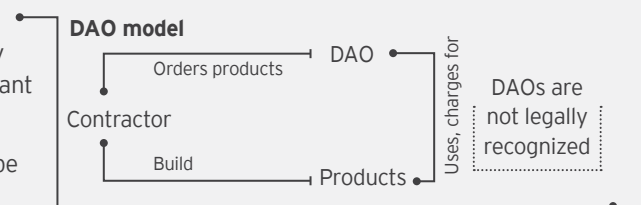
Impact of cybersecurity on the automobile industry: Asset-light business models and operations

Connected car ecosystem is a “network of networks,” a full-blown internet of people and things, with the following challenges:

▶ **Risk of open collaboration programs:** Mobility service provider must understand the risks involved in open collaboration programs and should operate appropriate mitigation policies. Advanced analytics engines can derive sensitive information from the data shared by the mobility service provider with a third party.



▶ **Legal challenges with DAO model:** Operations of DAOs dictated and governed by open computer programs are visible to all, making it an easy target for intruders. Also, responsibility and legal liability of each participant is also not clearly defined in its framework.



Boundaries of mobility service providers are disappearing; the risk landscape also becomes unbounded with extended business operations



Sources: News releases

Cyber attacks on connected cars and latest security software systems

Security threat

Fiat Chrysler recalled 1.4 million vehicles due to cybersecurity threat.

Cybersecurity researchers identified six significant flaws.

OEM's response

OEM has insulated connected vehicle systems from the network and also provided software upgrades to improve internal safety features.

OEM addressed this security threat by distributing OTA upgrades to its users.

Latest car security software systems in the market:

► Symantec

Symantec introduces an anomaly detection software for automobiles and IoT systems. The software is capable of identifying issues in the early stages using machine learning technology and helps to initiate remediation to lessen impact. This solution is platform-independent and can fit in any make and model with minimum installation procedure.

► Savari

provides an entire set of vehicle safety communication technologies that enables the vehicles to communicate with other vehicles, roadside infrastructure, smart phones and pedestrians.

► Karamba Security

Karamba Security introduces Carwall Software to secure connected cars from cyber attacks. Carwall does not allow any malicious code to run on the car's electronic control units (ECUs) prevents even in-memory attacks.

Cases of creating agility and resiliency in automobile sector

Tesla

Remediates cybersecurity vulnerabilities remotely via OTA updates

GM

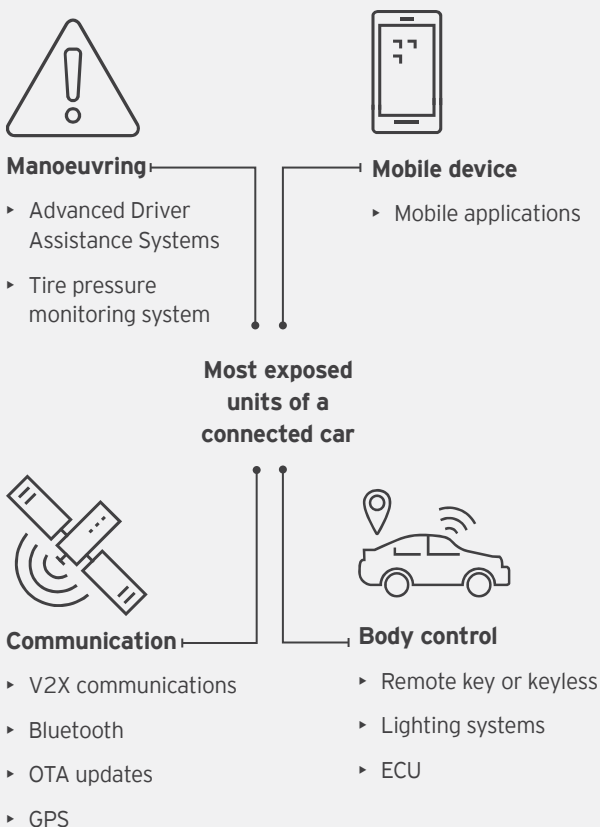
Publicly announces the appointment of a chief product security officer

Daimler

Endorses bug bounty programs for risk identification and mitigation

Sources: Various industrial sources

Hackable units of a connected car and security concerns



Attacks on connected cars' security and manoeuvring systems

Attack on telematics system:

Attackers can intrude into a car's computer system and take control of its movement and data.

Case details:

A team from the Defense Advanced Research Projects Agency (DARPA) wirelessly hacked into the computer system of Chevrolet Impala. The team could take over several functions, including the brakes of this vehicle in a controlled situation.

GM is developing a fix for its OnStar telematics system in light of the cyber attack.

Attack on body control unit:

Attackers can take control of cars security systems.

Case details:

ADAC, a German motoring association, could lock and unlock car doors by mimicking mobile communications and sending signals to a SIM card installed in the affected vehicles.

BMW sent software patches to the 2.2 million cars equipped with ConnectedDrive to prevent similar breakages in future.

Simultaneously keeping constant vigilance toward data privacy and customer sentiments is critical to maintaining trust and loyalty of customers.

Alliance of Automobile Manufacturers and Association of Global Automakers have started to draft data privacy standards across the industry.

Alliance of Automobile Manufacturers draft privacy fundamentals

Fundamentals	Description
Transparency	Participating members commit to providing owners and registered users with a ready access to clear, meaningful notices about the member's collection, use, and sharing of covered information.
Choice	Participating members commit to offering owners and registered users with certain choices regarding the collection, use, and sharing of covered information.
Respect for context	Participating members commit to using and sharing covered information in ways that are consistent with the context in which the information was collected, taking account of the likely impact on the owners and registered users.
Data minimization, de-identification and retention	Participating members commit to collecting covered information only as needed for legitimate business purposes. Participating members commit to retaining covered information no longer than they determine necessary for legitimate business purposes.
Data security	Participating members commit to implementing reasonable measures to protect covered information against loss and unauthorized access or use.
Integrity and access	Participating members commit to implementing reasonable measures to maintain the accuracy of covered information and commit to giving owners and registered users reasonable means to review and correct personal subscription information.
Accountability	Participating members commit to taking reasonable steps to ensure that they and other entities that receive covered information adhere to the principles.

Source: Alliance of Automotive Manufacturers

Blockchain to improve transparency and provenance across the system

Is this really the car that Sebastian Vettel drove? Who else has owned it?

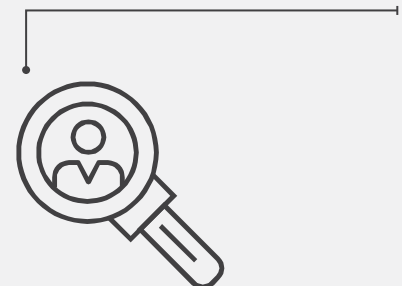
Is this bottle of motor oil counterfeit? Or is it endorsed by Audi?

Are there any hazardous materials in this car?



Now
.....
Lack of visibility of the product origin – Is it counterfeit or stolen?

Revealing the provenance of a product to everyone involved, from originator to end user



Blockchain era
.....
Breaking supply chain data out of silos

Source: EY analysis

Automakers should make sure that they have the flexibility to act upon any unexpected business setbacks.

Companies, to sustain their product quality in case of unexpected setbacks, such as recalls, need an agile strategy to ensure business continuum and to contain risk.



Product malfunctioning causing the vendor to be called off

Tesla

Tesla's semiautonomous car, which used Mobileye's chips for autopilot vision, failed to detect a laterally moved truck trailer, resulting in a fatal accident.

Mobileye

Tesla claims that an autopilot sensor should be able to recognize "any interruption of the ground plane in the path of the vehicle". However, Mobileye stated that the current generation AEB systems are not designed to actuate upon laterally crossing vehicles.

Organizations should develop and deploy control mechanisms that draws a clear accountability and ownership supported by technology and analytics which are critical to sustaining a resilient supply chain.



2018 YE and 2019 Q1 Evaluation

Global Automotive Industry vs Turkey

Investment incentives in automotive industry in 2018

Automotive industry research

Digitalization in automotive sector

Global EV market analysis

Global EV market analysis March 2019

Key questions regarding future of the EV market ...

Will EVs always continue to be niche products? If no, when will the sales hit an inflection point?

Which EV technology (BEVs, hybrids, FCEVs) and geographies would dominate the global EV sales?

- ▶ After a few unsuccessful attempts, we believe that the EV market, this time around, is likely to witness success in terms of achieving mass penetration ... driven by tightening emission norms, steep reduction in battery costs, charging infrastructure development & availability of compelling models
- ▶ The gradual uptake of EVs in the medium term will hit an inflection point around 2023 / 24, beyond which mass penetration is likely to start taking place
- ▶ Hybrids (particularly mild hybrids) are likely to drive EV sales during transition period
- ▶ However, beyond 2025, BEVs are likely to be the only option to meet the emission norms ... growing car sharing and AVs to also fuel the BEV demand
- ▶ China, Europe, US* and Japan to be the key geographies driving EV sales

US\$ **100**
/KWh

Battery cost expected by 2022 / 23, tipping point for EVs



218%

Forecast CAGR for 48V mild hybrid sales during 2017-27

*Subject to the outcome on the review of US fuel efficiency standards

OEMs are showing a renewed interest in the EV market and have set steep targets for EV penetration. Despite the automaker interest, most customers continue to avoid EVs.

... Does this require a rethink regarding the type of customers and the business model used?

Implications for automakers

New business models

- ▶ Focus on car / battery leasing models
- ▶ Focus on new customer types such as ride-hailing and car-sharing companies
- ▶ Collaborate with other automakers, battery producers and charging infrastructure providers

Subsidiaries dedicated for EVs

- ▶ Set up electric-only subsidiaries, at least in the transition period, to insulate EV efforts from the gasoline-car collapse
- ▶ Direct sales or alternate dealer network for EVs

Educating customers

- ▶ Increase advertising budgets for EVs, focus on educating customers
- ▶ Focus on attributes such as instant torque (which is fun and also cuts the stress of driving) and convenient home charging

EVs are inevitable, focus now to get a head-start

- ▶ Ignoring EVs could prove to be detrimental, the inflection point for EV sales is less than a decade away
- ▶ Build out portfolio of electric car models – one compact electric car model will not be sufficient going forward

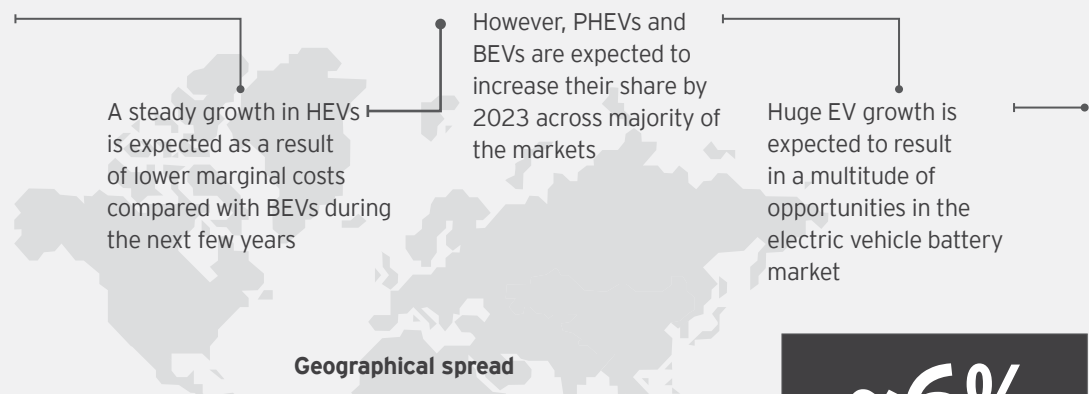
Automakers have a tight rope walk in front of them i.e. the need to strike the right balance between selling enough EVs to meet ever tightening regulations, while also preventing the incremental cost of adding battery packs from cannibalizing corporate profits. Further, automakers cannot afford to lose focus on ICE models, which are more profitable, (at least) right now.

Global EV market analysis March 2019

Market Outlook

EVs are expected to witness rapid growth with BEVs and PHEVs gradually gaining share from HEVs.

Global EV sales are expected to double by 2023, although ICEs are expected to hold a majority share



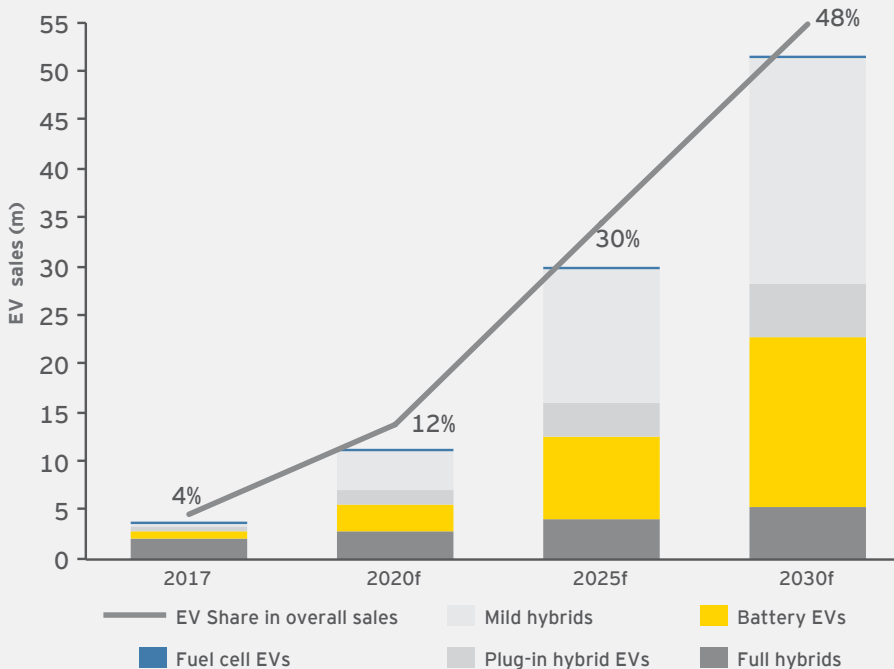
- Geographical spread**
- 1** 16 countries holding around 95% of the total EV stock during 2014
 - 2** During 2015, Japan and the US accounted for 72% of the global sales volume (BEV, PHEV and HEV)
 - 3** China is expected to become the biggest alternate fuel market with a focus on BEVs

~6%
EV (including HEVs) penetration in new vehicle sales by 2024

Sources: EY analysis

The tightening emission norms coupled with reduction in battery costs is likely to drive EV sales, growing car sharing to also fuel EV demand.

Global EV sales volumes and growth



Industry trends to further augment EV growth

- ▶ Growing demand for SUVs is making emission reduction (using conventional ICEs) even more challenging
- ▶ EVs likely to be the powertrain of choice for AVs and car sharing vehicles

Key statistics

US\$ 75-100/Kwh

Battery cost tipping point for EVs' to achieve mass penetration

~40%

Share of EVs in Norway in 2017, primarily on the back of high incentives

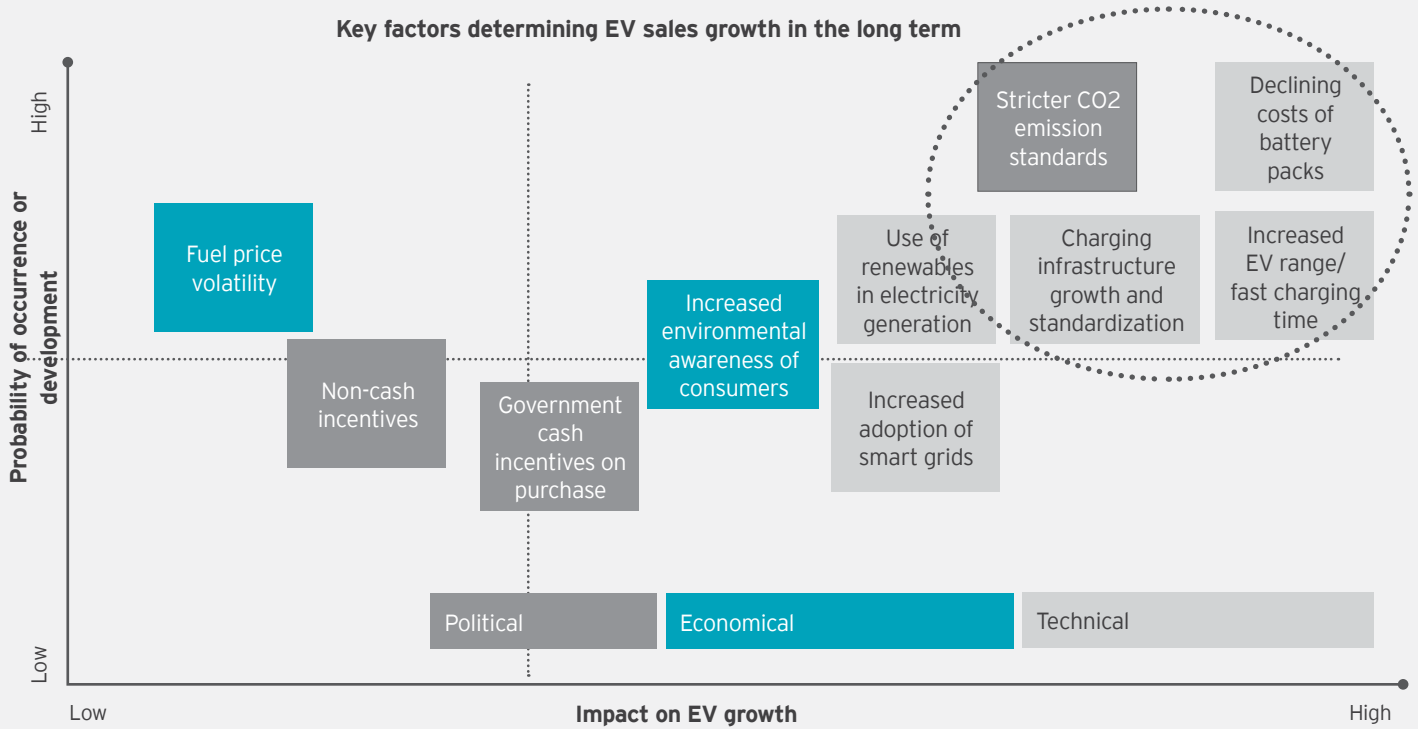
7.3b barrels

Daily fuel saving in 2040 due to EV

Note: Both BEVs and hybrids included

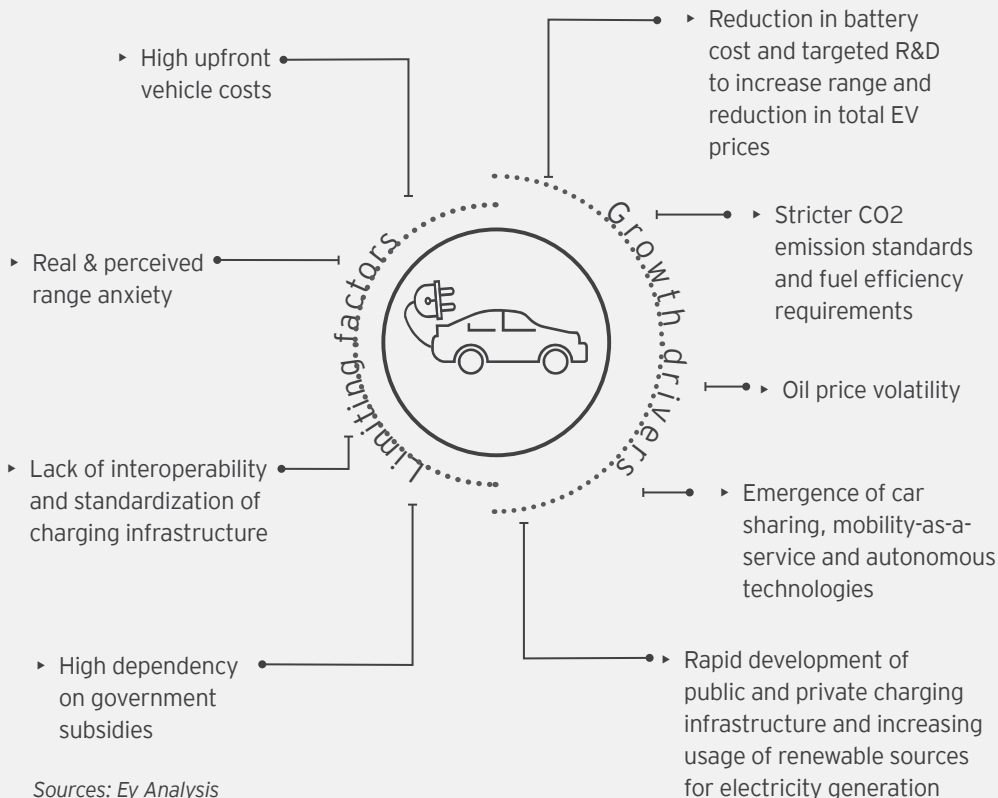
Sources: Analyst reports, LMC Automotive, EY analysis

Emission standards, declining battery costs and charging infrastructure remain the determining factors for EV adoption rate.



Sources: Ey Analysis

Various technological and socio-political developments are expected to impact mass adoption of EVs.



Sources: Ey Analysis

Illustrators

US\$ 150/kwh

Expected cost of battery packs by 2025 making EV prices comparable to ICES

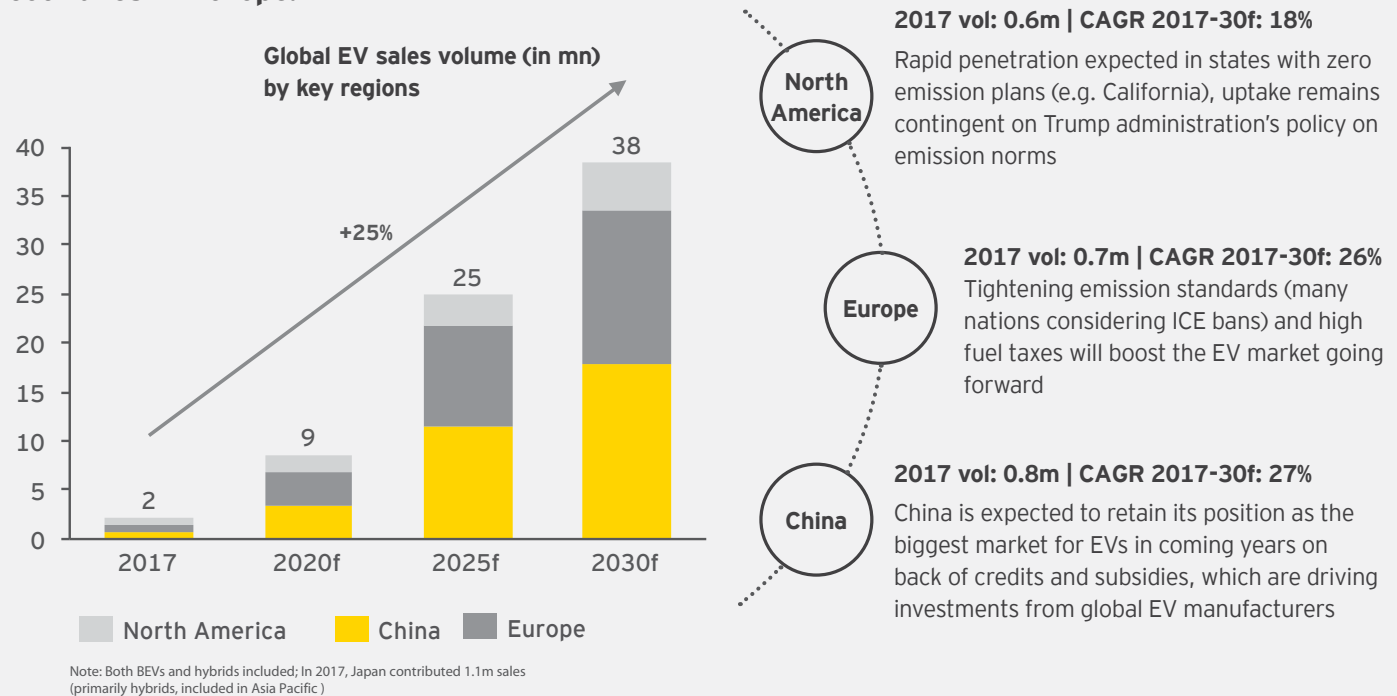
50-60%

Reduction in incremental cost of EVs as compared to ICES by 2025

~90%

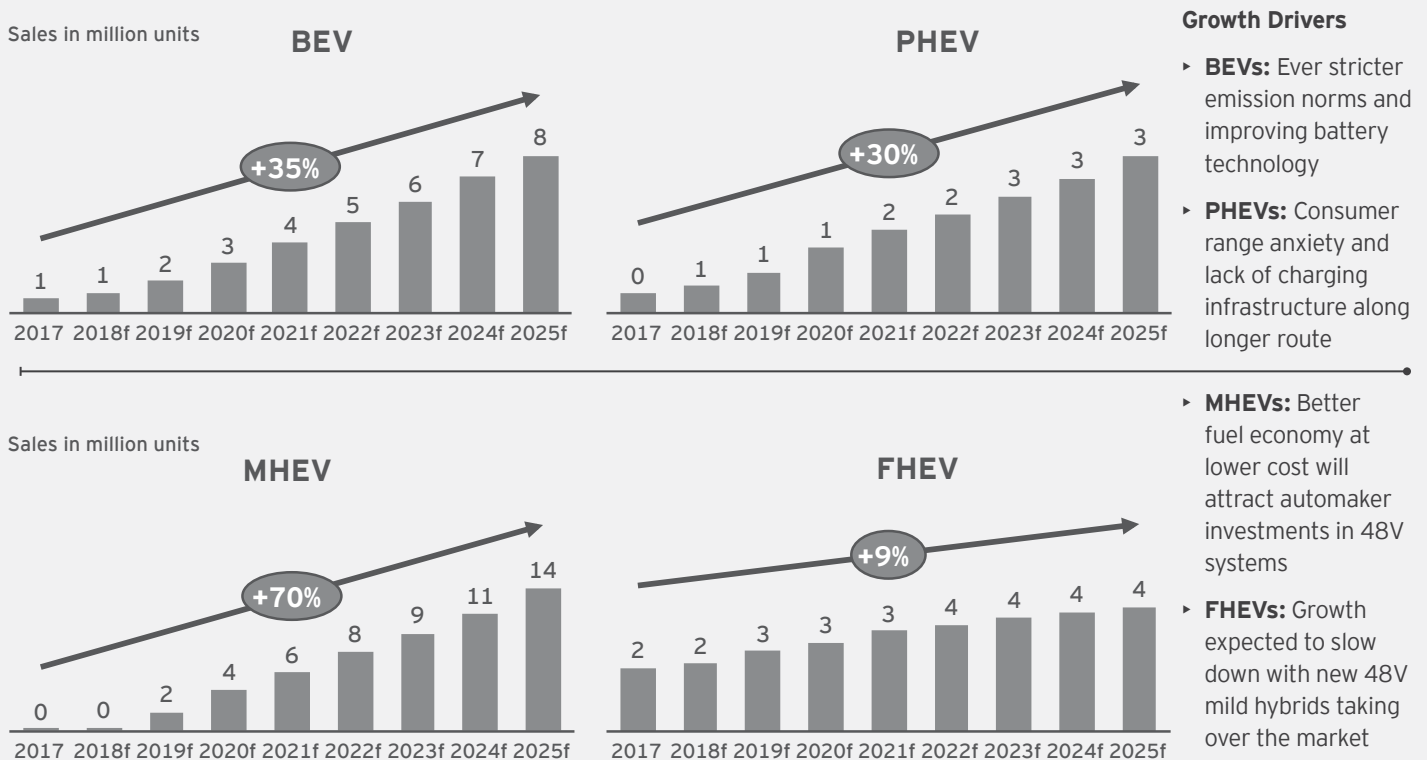
Reduction in CO2 emissions from EVs using renewable sources of electricity for charging

The demand for electric vehicles is likely to be driven by China, in particular, as well as select countries in Europe.



Sources: Analyst reports, LMC Automotive, EY analysis

The inflection point for BEVs is likely to be around 2023/24, hybrids (particularly 48V mild hybrids) set to become very popular during the transition period.

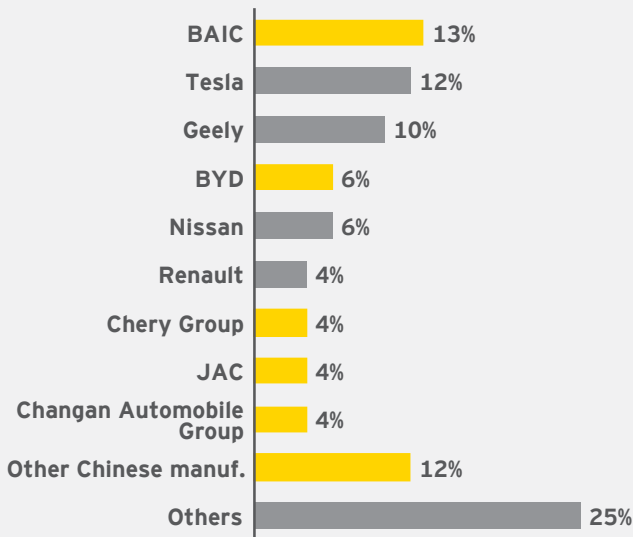


Sources: LMC Automotive, EY analysis

BEVs PHEVs Hybrids

Chinese manufacturers have grabbed majority share of the BEV market on the back of strong volume sales in China. (more than half of global sales in 2017)

BEV market share by brand in 2017



Chinese manufacturers accounted for ~48% of the global BEV sales in 2017

Sources: LMC Automotive, EY analysis

Market share outlook for BEVs

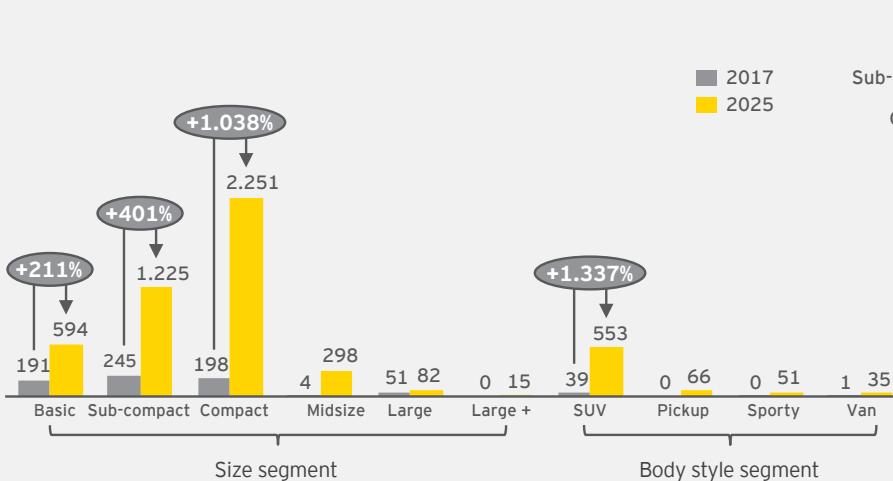
Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
BAIC	13%	-8%
Tesla	12%	-7%
Geely	12%	-4%
BYD	6%	-4%
Nissan	6%	-2%
Renault	4%	-2%

Going forward, established OEMs are expected to gain share of the BEV market on the back of new model launches having higher range

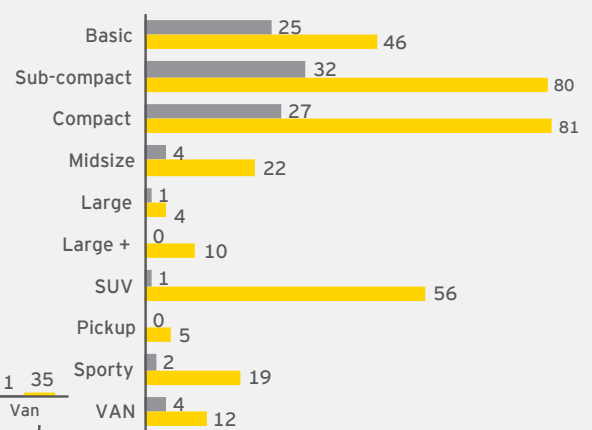
Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
Volkswagen	2%	11%
SAIC	3%	4%
Hyundai	3%	2%
Toyota	0%	5%
Mercedes-benz	1%	2%

BEVs are expected to witness adoption across bigger segments as range anxiety of buyers reduces.

Segment wise BEV sales (in '000 units)



Global BEV models outlook by segment



Growth in compacts and SUVs is expected to outpace the growth in basic and sub-compact BEVs

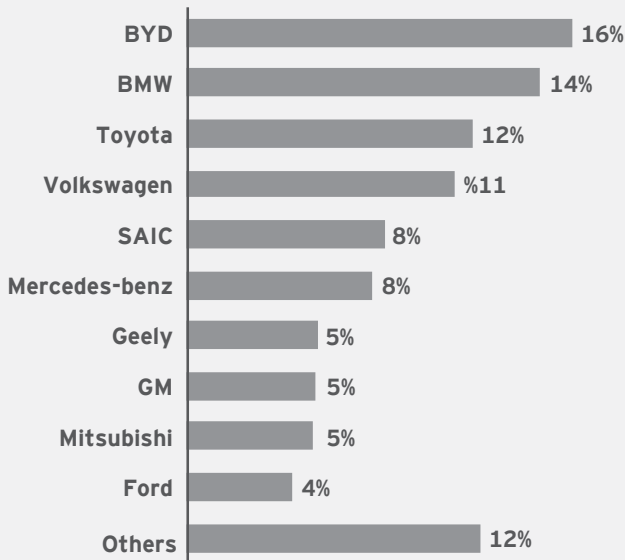
- Improvement in vehicle range and availability of charging stations on highways will increase consumer confidence in BEVs for long distance trips
- SUVs and large segment vehicles are usually the preferred choice for long distance travels as they provide better comfort and more boot space

Sources: LMC Automotive, EY analysis

BEVs PHEVs Hybrids

PHEVs are expected to be the new growth area to sustain the EV market, as they have less dependence on infrastructure.

PHEV Market share by brand in 2017



Market share outlook for PHEVs

Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
BYD	16%	-10%
BMW	14%	-7%
Toyota	12%	-8%
SAIC	8%	-4%
Mercedes-benz	8%	-4%
Mitsubishi	5%	-3%

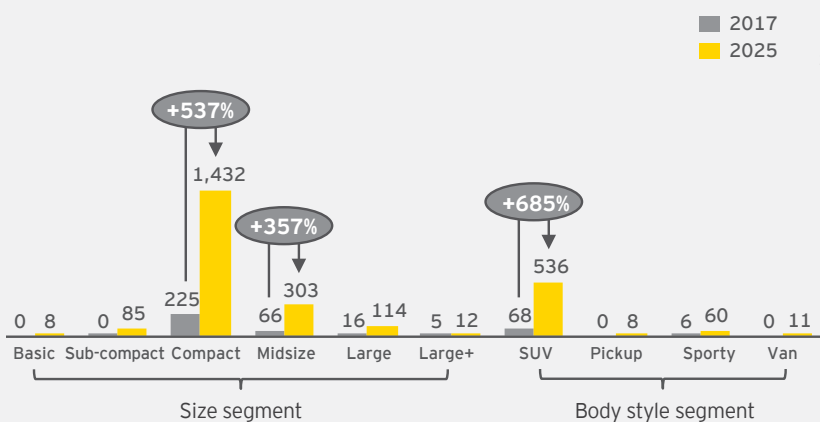
New players are expected to enter the PHEV market to grab share in this high growth segment

Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
VW	11%	8%
Geely	5%	0%
GM	5%	1%
Hyundai	3%	2%
Fiat	1%	3%
Honda	0%	3%
Nissan	0%	3%
Psa	0%	3%
Tata	0%	2%

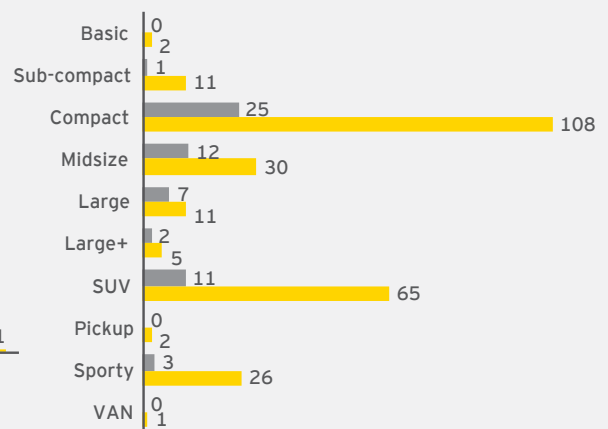
Kaynak: LMC Automotive, EY analysis

Contrary to the BEVs, plug-in hybrid systems are being used in bigger segment vehicles mainly to justify the high cost.

Segment wise PHEV sales (in '000 units)



Global PHEV models outlook by segment



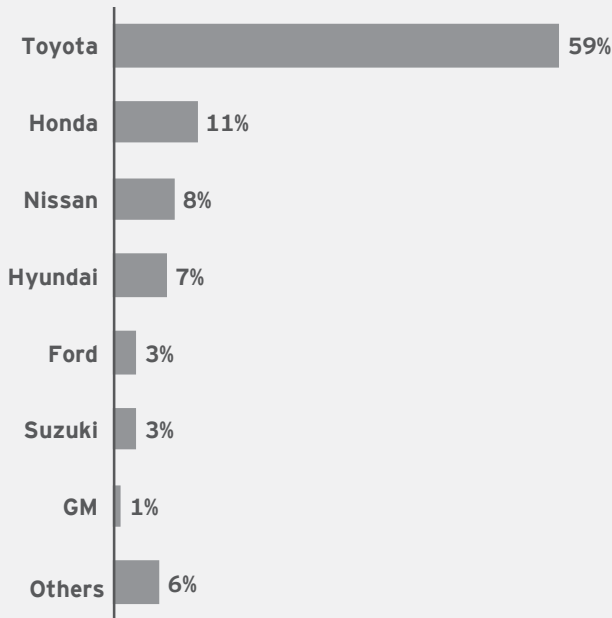
- ▶ PHEVs can provide the necessary switch from gasoline vehicles until a robust charging infrastructure is available for pure electric vehicles
- ▶ Automakers will also rely on PHEV sales for meeting the ever-strict emission targets and upcoming credit based subsidy programmes in EU and China

Kaynak: LMC Automotive, EY analysis

BEVs PHEVs **Hybrids**

The hybrid vehicle market currently dominated by Toyota's full hybrids is likely to see new entrants as the 48V mild hybrid systems gain popularity.

Hybrid vehicles* market share by brand in 2017



*Includes mild hybrids and full hybrid vehicles

Sources: LMC Automotive, EY analysis

Market share outlook for hybrids

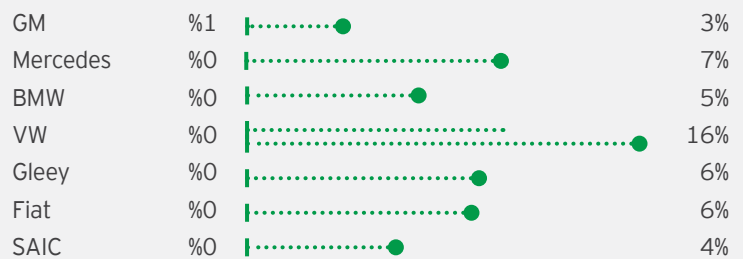
Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
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Recent developments

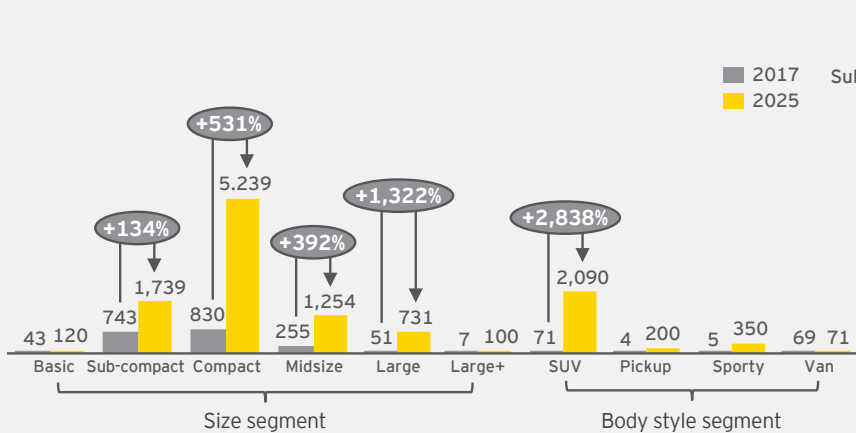
- ▶ VW introduces 48V system to the Golf
- ▶ Kia Motors will introduce 48V diesel mild-hybrid powertrain in second half of 2018

Sales Group/brand	Market share (2017)	Change in market share (2017 vs 2025)
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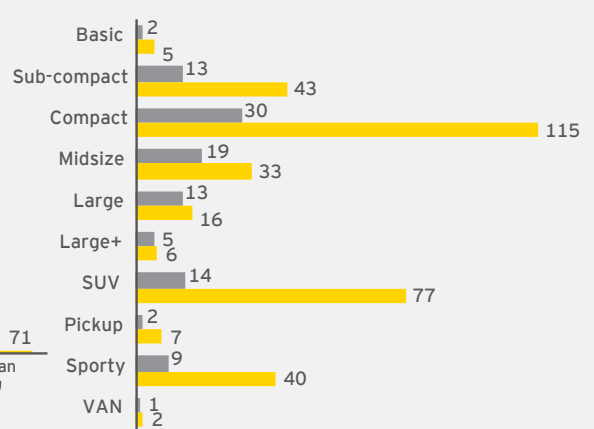


Lower development cost compared to BEVs and PHEVs, and independence from charging infrastructure requirements will continue to drive adoption of hybrids across all segments.

Segment wise hybrids sales (in '000 units)



Global hybrid models outlook by segment



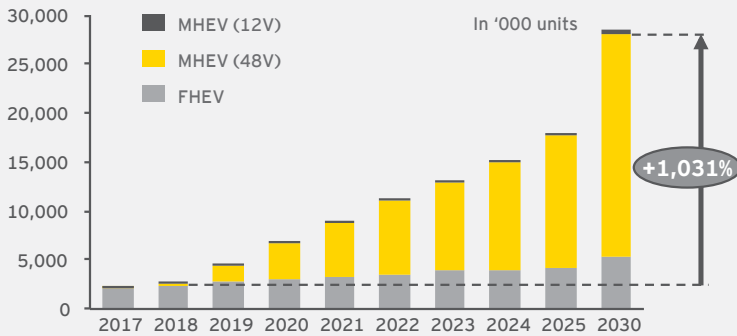
- ▶ Hybrid systems (specially the 48V mild hybrids) is likely to be the powertrain of choice for vehicle segments such as large and midsize sedans, SUVs, pickups and sports cars until the pure battery versions becomes feasible
- ▶ The new 48V mild hybrid systems are expected to revolutionize the hybrid vehicle market as they provide up to 70% benefit of full hybrids at 30% of the total cost

Sources: LMC Automotive, EY analysis

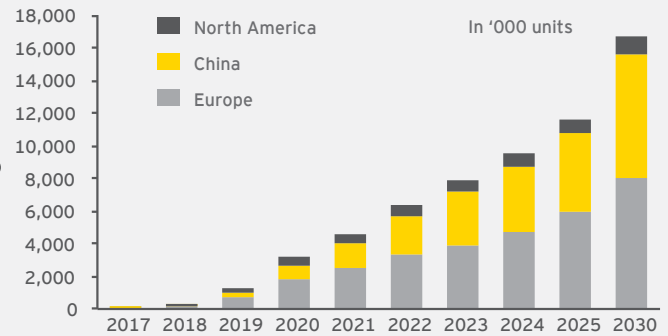
BEVs PHEVs **Hybrids**

The 48V hybrid systems are getting popular primarily to meet the fuel economy targets and CO2 regulations in the EU and China.

Global hybrid vehicle sales outlook



48V mild hybrid sales outlook



Why are the 48V mild hybrid systems getting popular?

- ▶ The 48V design complements the existing electrical architecture, making it a relatively cheap, easy and lightweight way to get fuel economy benefits at lower cost. The system can help automakers in meeting the ever-stricter emission regulations at a reduced cost
- ▶ Need for more on-board power in cars with addition of new infotainment options and other driver-assist safety features can be effectively met

Sources: LMC Automotive, EY analysis

Tightening emission norms are the key drivers of automakers' alternate powertrain strategy.

Historical emission levels and future targets (in gCO₂/km) for key markets

	2012	2014	2015	2020	2021	2024	2025	2030
EU	140g/km		130g/km		95g/km		-15% by 2025 versus 2021 -20% by 2030 baseline	
USA	180g/km		160g/km				103g/km	Not finalized
Japan	110g/km		130g/km		106g/km			Not finalized
China	180g/km		130g/km		117g/km			Not finalized

Implications for automakers

- ▶ Achieve an optimal fleet powertrain mix with a focus on increasing contribution of low/no emission vehicles such as PHEVs and BEVs
- ▶ Explore partnerships and JV opportunities to share the development costs of advanced alternate powertrains
- ▶ Devise a customized marketing and distribution strategy to increase customer awareness and acceptance

Sources: EY analysis, News articles, Navigant Research, Canalis

Increasing BEV sales penetrations will help OEMs to achieve the overall CO2 fleet averages

The regulatory support provided by governments to EVs in many countries is likely to fuel EV growth.

Area	Action	China	France	Germany	India	Netherlands	Norway	UK	USA
EV purchase incentives	Rebates at registration/sale	Widespread policy**	Widespread policy**	Widespread policy**	Widespread policy**	No policy	No policy	Widespread policy**	Targeted policy*
	Sales tax exemptions (excl. VAT)	Widespread policy**	Widespread policy**	No policy	Widespread policy**	Widespread policy**	Widespread policy**	Widespread policy**	Targeted policy*
	VAT exemptions	No policy	No policy	No policy	Widespread policy**	No policy	Widespread policy**	No policy	No policy
	Tax credits	No policy	No policy	Widespread policy**	No policy	No policy	No policy	No policy	Widespread policy**
EV use and circulation incentives	Circulation tax exemptions	Widespread policy**	No policy	Widespread policy**	No policy	Widespread policy**	No policy	Widespread policy**	Targeted policy*
	Waivers on fees (tolls, parking)	Targeted policy*	Targeted policy*	Widespread policy**	No policy	No policy	Widespread policy**	Targeted policy*	Targeted policy*
	Electricity supply reductions/ exemptions	Targeted policy*	No policy	No policy	No policy	No policy	Targeted policy*	Targeted policy*	Targeted policy*
	Tax credits (company cars)	No policy	Widespread policy**	Widespread policy**	No policy	Widespread policy**	No policy	Widespread policy**	No policy
EV use and circulation incentives	Access to bus lanes	No policy	Targeted policy*	Targeted policy*	No policy	No policy	Widespread policy**	Targeted policy*	No policy
	Access to HOV lanes	No policy	No policy	No policy	No policy	No policy	No policy	No policy	Targeted policy*
	Access to restricted traffic zones*	Targeted policy*	Targeted policy*	Targeted policy*	No policy	Targeted policy*	No policy	No policy	No policy
Tailpipe emission standards	Fuel economy standards	Widespread policy**	Widespread policy**	Widespread policy**	General fuel economy standard	Widespread policy**	Widespread policy**	Widespread policy**	Widespread policy**
	Road vehicles tailpipe pollutant emissions standards	China 5	Euro 6	Euro 6	Bharat 4	Euro 6	Euro 6	Euro 6	Tier 2

No policy
 Targeted policy*
 Widespread policy**
 Nationwide policy***
 General fuel economy standard
 Pollutant emission standard (2015)

*such as environmental/ law emission zones **policy affecting less than 50% inhabitants ***policy affecting more than 50% inhabitants

Sources: IEA Publication, news articles, EY analysis

Global EV market analysis March 2019

OEM go-to-market Strategy

Automakers are looking to drive EV sales through a differentiated customer experience, robust product portfolio and charging infrastructure development.

Customer engagement

Differentiated customer experience for potential / existing EV buyers:

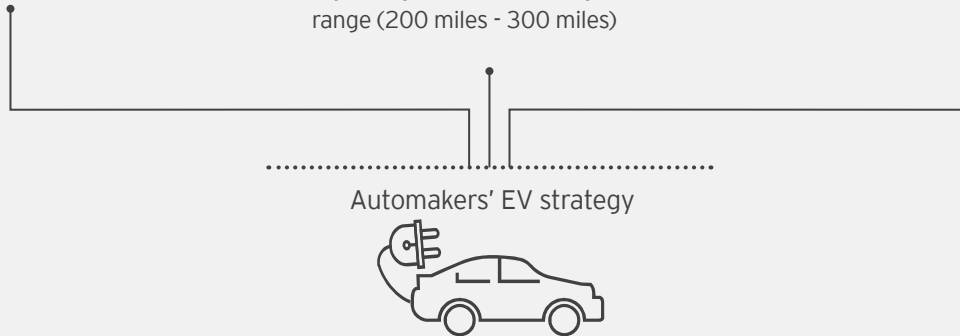
- ▶ Launching EV specific brands
- ▶ EV specific distribution network / stores, sales personnel
- ▶ Access to complementary EV charging facilities
- ▶ EV specific apps
- ▶ Specialized finance / lease options, referral programs, etc.

Product portfolio development

- ▶ Aggressive new launches in pipeline
- ▶ A few automakers developing EVs on existing platforms, while others develop new ones
- ▶ Collaborations with tech players
- ▶ Investments in R&D for EV performance improvement
- ▶ Plans to launch EVs in SUV / crossover segment
- ▶ Lightweight vehicles for a greater range (200 miles - 300 miles)

Charging infrastructure

- ▶ Charging infrastructure development through collaborations with other automakers and P&U companies
- ▶ Developing batteries in-house as well as acquiring energy related startups
- ▶ Working on new technologies such as wireless charging
- ▶ Tie-ups with malls, hotels, city authorities, etc. to set-up charging infrastructure



Sources: Company websites, news, EY analysis

OEMs need to consider the regulatory changes happening around the world as they plan to shift from ICEs to EVs.

1 Ban on ICEs

- ▶ **The UK** government has proposed full phasing out of ICE powertrain production by 2040
- ▶ **France** has proposed phase out of ICE powertrain production by 2040
- ▶ **California** announced ban on the sale of new cars and trucks powered by fossil fuels in 2040

2 Necessary quotas for EVs

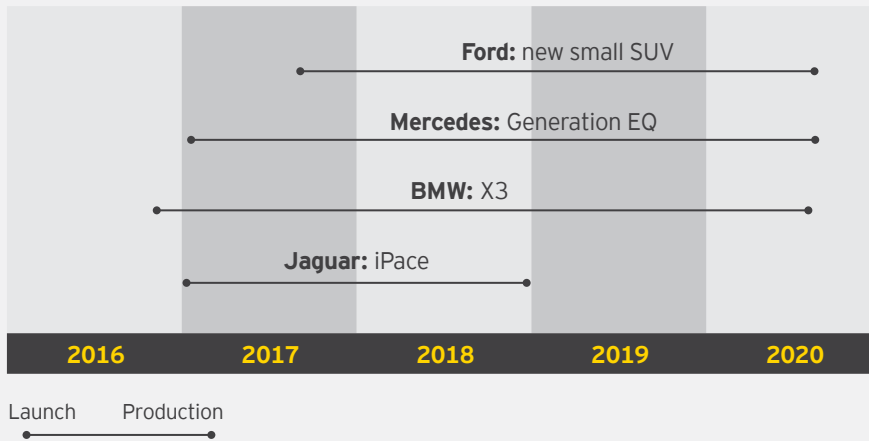
- ▶ **China** is implementing specific quotas of zero- and low-emission vehicles for automakers starting 2019
- ▶ **Many US states including California** have zero-emission vehicle (ZEV) credits

3 Tightening fuel efficiency standards

- ▶ **South Korea** to tighten fuel efficiency standards by 2020; 30% reduction compared to 2015
- ▶ **European commission** has proposed further emission cuts of 15%-30% beyond 2021.

OEMs are planning to launch all electric SUVs in coming years to meet the rising preference of customers for SUVs.

OEMs have revealed all-electric SUVs concepts which are planned to go into production next 3 years

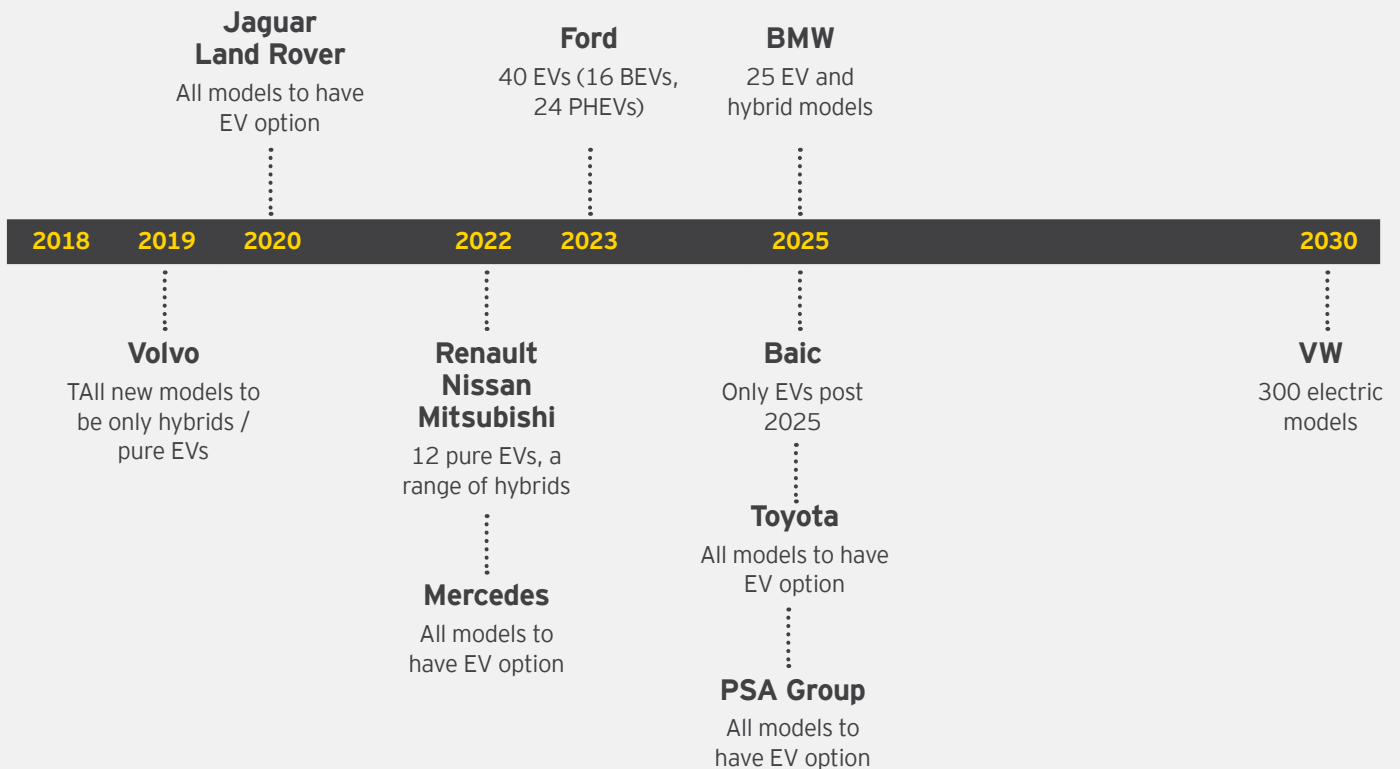


Sources: Company websites, news, EY analysis

Why are OEMs focusing on SUV launches?

- ▶ Growing customer preference for larger SUVs
- ▶ Accelerating decline of diesel vehicle sale which is the preferred powertrain for SUVs
- ▶ Difficult to meet emission regulations of future with conventional powertrain SUVs as they cause higher emissions
- ▶ SUVs are more profitable to OEMs as compared to sedans and hatchbacks

OEMs are adding EV launch targets to their plans to diversify the product portfolios.

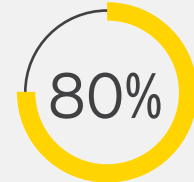


Sources: News articles

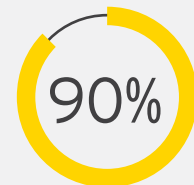
Automakers are adopting new models to sell EVs, particularly with an aim to reduce the high upfront cost and also address concerns around residual value.

Automakers are exploring access based models to drive EV adoption.

	Ownership based models			Access based models		
Model	Cash purchase	Guaranteed resale*	Financing	EV Leasing	Battery leasing	Subscription
Ownership	Customer	Customer	Customer / Captive finance co. / third party financier	Captive finance co. / third party financier	Vehicle: customer; Battery: Automaker	Automaker / Dealerships
Upfront cost	High	High	Medium/Low	None	Medium	None
Monthly payment	NA	NA	Low	Low	Low	Medium/High
Examples of automakers	VW, Nissan, Toyota, Tesla	Tesla	Volvo, BMW, Hyundai	Volvo, BMW, Nissan, Tesla	Renault	BMW, Polestar



Share of BEVs that are bought on lease in the US, 55% for plug-in hybrids; compared to around 30% for overall new car sales



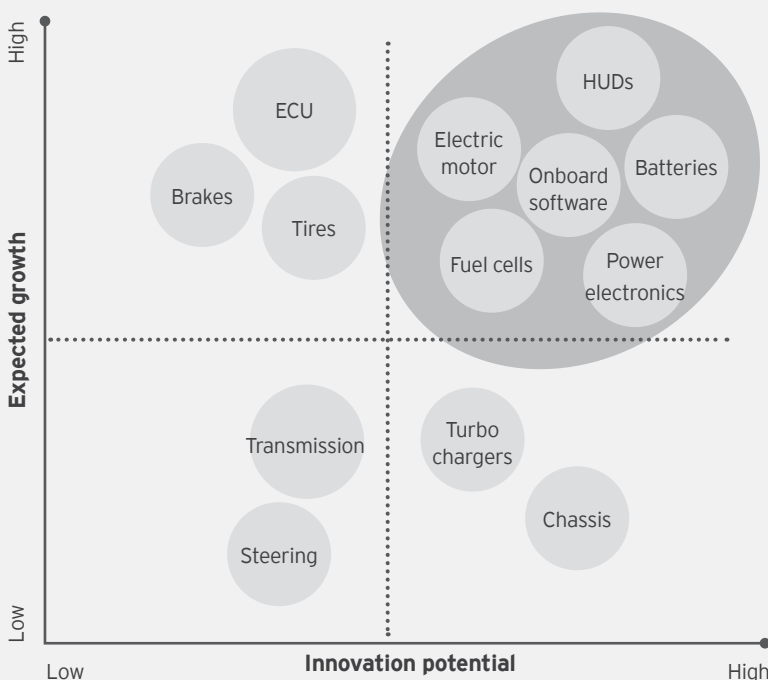
Renault EV customers who lease their car batteries, Renault owns these batteries across their lifecycle

*Tesla offered this option for some time (now discontinued) to reassure buyers of residual value of its EVs; buyers got an option to resell EV after 36 months for a residual value higher than competing luxury car models

Source: Bloomberg, Renault website, News articles, EY analysis

Automakers are following varied manufacturing approaches to develop EVs

Future focus area for OEMs and suppliers



Source: EY analysis

Manufacturing approaches being followed by automakers

- ▶ Underpin EVs on the same ICEV* platforms to save cost and achieve flexibility
 - ▶ Examples of existing models electrification - Volvo XC90, GM Bolt, Toyota - Camry, BMW 3-series
- ▶ Develop a new dedicated platform such as NEP (New electric platform) and NEVD (New electric vehicle concept design)
 - ▶ For example NEVD platform - Tesla, Nissan Leaf, Toyota Prius, Bolt, etc.
 - ▶ Faraday Future's - VPA (Variable platform architecture) to support vehicles with different sizes, powertrains and battery configurations
- ▶ Invest in requisite ecosystem to retool or support the expanding green vehicle market
 - ▶ For example, Ford's Michigan Truck Plant was retooled with the help of ATVM loans (Advanced Technology Vehicles Manufacturing Loan Program) to build electric vehicles.
- ▶ Focusing on in-house battery manufacturing
 - ▶ Tesla to manufacture batteries at its Giga factory; expecting to slash battery costs by 30%
 - ▶ Nissan to develop next generation EV batteries at its plant in UK, Sunderland
 - ▶ Ford to develop in-house cell for its EVs

*Internal Combustion Engine Vehicle

OEMs are collaborating with players both within and outside the automotive industry to focus on EV manufacturing.

Alliances, mergers and acquisition focused on EV manufacturing

OEMs are forming partnerships to co-develop batteries and EVs

- ▶ Honda Motor and General Motors (GM) considering jointly building a fuel cell plant
- ▶ General Motors and LG Group will jointly design and engineer future electric vehicles
- ▶ Daimler, Ford and Nissan to jointly develop common fuel cell system
- ▶ Toyota, Mazda and Denso to jointly develop technology for electric cars

Ford - in-house battery research

- ▶ Ford conducting research in battery chemistries; also, expanding its R&D for EVs battery in Europe and Asia

GM - focus on manufacturing energy batteries

- ▶ GM has invested in energy storage company, Sakti3, renewable energy company, Coskata and companies involved in developing unique materials, Sirrus Chemistry, the Nanosteel Company

Daimler - acquiring energy related startups

- ▶ Daimler invested in two energy related startups (Deutsche ACCUmotive and Li-Tech Battery)

Toyota - battery research on the use of magnesium

- ▶ Toyota is researching the use of magnesium, in place of lithium, as the base chemical for batteries that could appear in the next 20 years

Key considerations for stakeholders

EV-centric growth markets

- ▶ A high share of pure EVs is expected to benefit EV battery manufacturers, and OEMs and suppliers specializing in BEVs.
- ▶ These markets are more likely to witness a decline in the share of ICE-related components.

Hybrid-dominant growth markets

- ▶ A larger share of HEVs in the overall EV mix presents opportunities for stakeholders to diversify in EV-related components and maintain a focus on ICEs and hybrid powertrains' specific components.

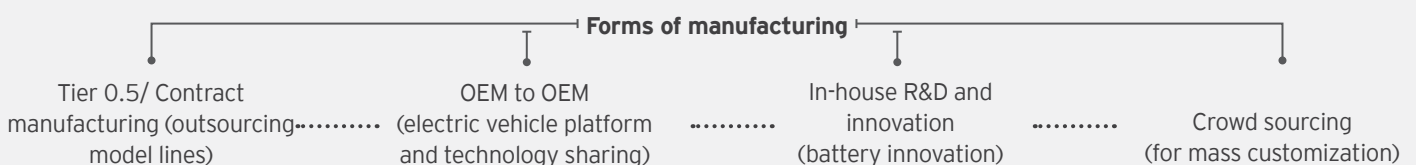
Source: EY analysis, News articles

Adaptive platform strategy, flexible production lines and enabling infrastructure will define the right manufacturing depth for an OEM.

Deployment of EVs requires overcoming three primary challenges "developing enabling infrastructure, delivering programs and driving customer adoptions..."



...however, choosing right form of manufacturing will be equally important to achieve cost benefits and production flexibility



Sources: Company websites, news, EY analysis

Global EV market analysis March 2019

Implications for automotive suppliers

Transition from ICE to EVs to have a significant impact on suppliers in terms of content loss, opportunities and technology shifts.

Opportunities for suppliers

- Outsourcing of components earlier built in-house**
 OEMs are likely to increase outsourcing of components to compensate for high R&D expenditure on EVs, providing suppliers with new revenue opportunities
- New product opportunities resulting from transition**
 New suppliers of electrical/electronic systems will come into picture where content will grow significantly
- Higher prices of components**
 Suppliers can demand high prices for new products resulting from technology shift until the time of mass penetration
- Invest in innovation potential**
 Suppliers need to invest in components that present a higher innovation potential and a higher growth in the future for better business sustainability

Source: EY analysis

Challenges facing the suppliers

- High exposure to OEMs**
 Shift to EVs is likely to impact the profitability of OEMs until the technology matures; supplier earnings will also be impacted as the OEMs will look to reduce expenses
- Powertrain content loss**
 Exclusive suppliers of engine, exhaust, fuel injection and most transmission content will run out of business as these components are obsolete on a battery EV
- Share loss due to new entrants**
 Battery suppliers like LG, Samsung and Panasonic can take up share of tier-1 suppliers of displays, infotainment, interior electronics etc.
- Need for a diverse portfolio**
 Suppliers' need of building a diverse portfolio of powertrains will increase to navigate the shift towards alternate fuel technologies

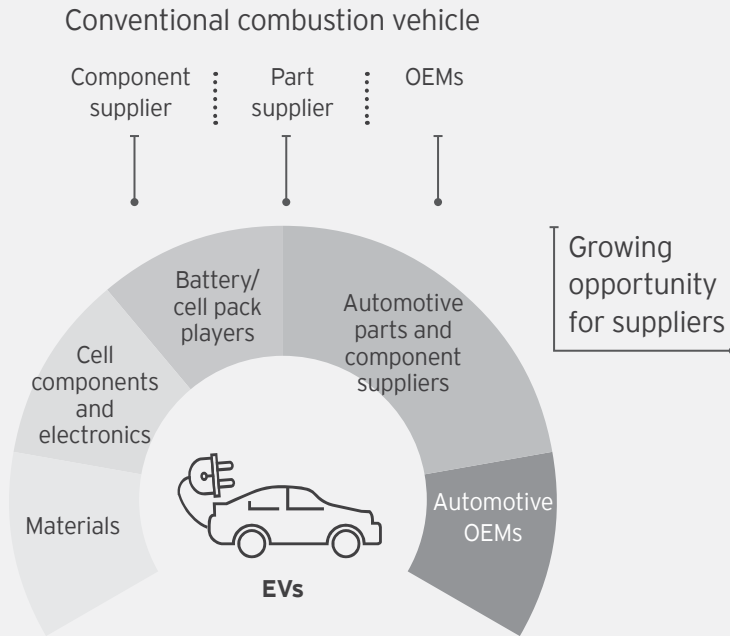
Transition from ICE to EVs to have a significant impact on suppliers in terms of content loss, opportunities and technology shifts. (2/2)

Components impacted due to EV shift

Components to face loss of content	Components to benefit from increased content	Components providing new opportunities due to technology shift
Transmission	Batteries	Thermal/HVAC
Engine components	Electric motors	Electrical
Exhaust	Battery thermal management	Connections
	Power electronics	Steering
	Interior electronics	Axle
	Autonomous sensors	Brakes
	Lightweight materials	

Source: Analyst reports

Mass adoption of alternate fuel vehicles will alter the supply chain, offering new opportunities for component suppliers and disrupters.

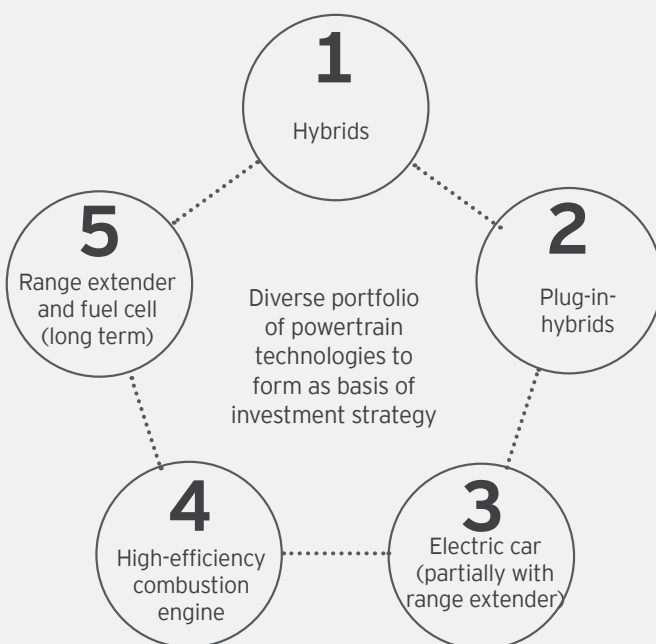


Although EVs and conventional vehicles share component parts, there are a large number of new systems used for EVs that are not compatible with a conventional ICE vehicle

- ▶ Mass deployment of EVs will require supply chains to be retooled, thereby opening up opportunities for battery makers, cell component makers, and their suppliers.
- ▶ Along with the automotive value chain, EVs will create a significant opportunity for infrastructure providers.
- ▶ The development of the smart grid will go hand-in-hand with mass EV deployment, along with exploration of vehicle-to-grid (V2G) technology.

Sources: International Economic Development Council, EY analysis

Building a diverse portfolio of powertrain technologies is expected to be the key success factor for automotive stakeholders in the future.



Component suppliers across the value chain need to make strategic investments across different powertrain technologies as the industry begins its shift from ICEs to EVs and FCEVs

- ▶ Different powertrain technologies are expected to coexist for a foreseeable future requiring component suppliers to build competencies across these various domains.
- ▶ ICEs are expected to remain dominant until 2020; electric powertrains adoption will depend on the regulatory environment, technology and infrastructure development.
- ▶ Electric powertrains fuelled by batteries or fuel cells are expected to play a significant role in urban transit over the longer term.

Source: EY analysis





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