## Preamble

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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
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 consumers 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

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.

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 Industry Association (OSD)

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.

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.
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.

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: ACEA

2. Production performance

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

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.

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.
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.

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.

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.
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.

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.
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

### Comparative analysis of production

<table>
<thead>
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<th>Commercial vehicle production</th>
<th>Passenger car production</th>
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<tr>
<td><strong>Turkey</strong></td>
<td>1,696</td>
<td>553</td>
<td>1,143</td>
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<tr>
<td><strong>Czechia</strong></td>
<td>1,550</td>
<td>524</td>
<td>1,026</td>
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<tr>
<td><strong>Poland</strong></td>
<td>1,420</td>
<td>175</td>
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<tr>
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<th>Thousand Units</th>
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<tr>
<td><strong>2017</strong></td>
<td>Turkey: 1,696</td>
<td>Czechia: 1,550</td>
<td>Poland: 1,420</td>
</tr>
<tr>
<td><strong>2018</strong></td>
<td>Turkey: 1,550</td>
<td>Czechia: 1,420</td>
<td>Poland: 1,345</td>
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<td><strong>2019</strong></td>
<td>Turkey: 1,550</td>
<td>Czechia: 1,420</td>
<td>Poland: 1,345</td>
</tr>
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</table>

Source: OICA
Summary First Quarter Evaluation of 2019

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.

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.

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.
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 2018; 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.

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.
2018 YE and 2019 Q1 Evaluation

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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%.

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.

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.
Central and Eastern Europa has become a solid part of the global producers' production network. Although the production has been decreasing in Western Europa, 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.

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.
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

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<td>Ford Otomotiv Sanayi A.Ş.</td>
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<td>Oyak-Renault Otomobil Fabrikaları A.Ş.</td>
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<td>Hyundai Assan Otomotiv San. ve Tic. A.Ş</td>
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Renault worldwide production network

Source: Marklines

Toyota worldwide production network top 10

Source: Marklines
Ford worldwide production network top 10 countries

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<td>Thailand</td>
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Source: Marklines

FCA worldwide production network top 10 countries

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<td>Poland</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Serbia</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Argentina</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

![Total revenue of Turkish automotive industry graph](image)

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.

![Total personnel cost of Turkish automotive industry graph](image)

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.

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
Supplier industry has been able increase its total revenue from 3.78 billion to 10.09 billion Euro. On the other hand the personel cost industry does carry increased from 555 milyon in 2009 to 1,23 Euro in 2017.

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

**Source:** Turkish statistical institution
29.32 Turnover vs personnel cost of per person employed

Source: Turkish statistical institution

Number of firms and total employment in automotive industry

Source: Turkish statistical institution
Productivity performance of global OEMs in Turkey

Source: The Automotive Manufacturers Association
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 Projects that are Granted Investment Incentive Certificates in 2018

Based on origin of capital:

<table>
<thead>
<tr>
<th>Type of capital</th>
<th># of investment projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>184</td>
</tr>
<tr>
<td>Foreign</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>229</td>
</tr>
</tbody>
</table>

Investment types:

<table>
<thead>
<tr>
<th>Investment type</th>
<th># of investment projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion</td>
<td>163</td>
</tr>
<tr>
<td>Brand new</td>
<td>47</td>
</tr>
<tr>
<td>Modenization</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>229</td>
</tr>
</tbody>
</table>

Investment amount based on origin of capital:

<table>
<thead>
<tr>
<th>Type of capital</th>
<th>Total investment (TRY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign investment</td>
<td>9,624,244,271</td>
</tr>
<tr>
<td>Local investment</td>
<td>3,032,665,856</td>
</tr>
<tr>
<td>Total</td>
<td>12,656,910,127</td>
</tr>
</tbody>
</table>

Total investment amount based on investment type:

<table>
<thead>
<tr>
<th>Investment type</th>
<th>Total investment (TRY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expansion</td>
<td>6,669,152,180</td>
</tr>
<tr>
<td>Modenization</td>
<td>5,202,641,292</td>
</tr>
<tr>
<td>Brand new</td>
<td>785,116,655</td>
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<tr>
<td>Total</td>
<td>12,656,910,127</td>
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</tbody>
</table>

Employment based on origin of capital:

<table>
<thead>
<tr>
<th>Type of capital</th>
<th>Employment (person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign investment</td>
<td>1,819</td>
</tr>
<tr>
<td>Local investment</td>
<td>4,155</td>
</tr>
<tr>
<td>Total</td>
<td>5,974</td>
</tr>
</tbody>
</table>

Top 10 Automotive Investments (2018)

<table>
<thead>
<tr>
<th>Company</th>
<th>Investment Location</th>
<th>Type of Investment</th>
<th>Fixed Investment Amount (TRY)</th>
<th>Estimated New Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Oyak Renault Otomobil Fabrikaları A. Ş.</td>
<td>Bursa</td>
<td>Modernization</td>
<td>3,720,413,277</td>
<td>N/A</td>
</tr>
<tr>
<td>2. Hyundai-Assad Otomotiv Sanayi ve Ticaret A.Ş.</td>
<td>Kocaeli</td>
<td>Expansion</td>
<td>1,959,440,000</td>
<td>105</td>
</tr>
<tr>
<td>3. Tofaş Türk Otomobil Fabrikası A.Ş.</td>
<td>Bursa</td>
<td>Modernization</td>
<td>1,120,000,000</td>
<td>N/A</td>
</tr>
<tr>
<td>4. Ortadoğu Rulman San. ve Tic. A. Ş.</td>
<td>Ankara</td>
<td>Expansion</td>
<td>938,590,000</td>
<td>300</td>
</tr>
<tr>
<td>5. Prometeon Turkey Endüstriyel ve Ticari Lastikler A.Ş.</td>
<td>Kocaeli</td>
<td>Expansion</td>
<td>502,652,000</td>
<td>50</td>
</tr>
<tr>
<td>6. Valeo Otomotiv Sanayi ve Ticaret A.Ş.</td>
<td>Bursa</td>
<td>Expansion</td>
<td>409,000,000</td>
<td>140</td>
</tr>
<tr>
<td>7. Ataylar Makina Sanayi ve Ticaret Ltd.Şti.</td>
<td>İstanbul</td>
<td>Expansion</td>
<td>276,150,000</td>
<td>145</td>
</tr>
<tr>
<td>8. B-Plas Bursa Plastik San. ve Tic. A. Ş.</td>
<td>Bursa</td>
<td>Expansion</td>
<td>250,000,000</td>
<td>29</td>
</tr>
<tr>
<td>9. Sampa Otomotiv Sanayi ve Ticaret A.Ş.</td>
<td>Samsun</td>
<td>Expansion</td>
<td>190,000,000</td>
<td>200</td>
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<tr>
<td>10. Hema Otomotiv Sistemleri A.Ş.</td>
<td>Tekirdağ</td>
<td>Expansion</td>
<td>181,730,000</td>
<td>21</td>
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</tbody>
</table>

Source: Ministry of Industry and Technology
### Automotive Companies Supported by Turquality Programme
17 companies (as of December 2018)

<table>
<thead>
<tr>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erkunt</td>
</tr>
<tr>
<td>Kirpart</td>
</tr>
<tr>
<td>Standart Profil</td>
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<tr>
<td>Sampa</td>
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<tr>
<td>Petlas</td>
</tr>
<tr>
<td>BMC</td>
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<tr>
<td>Assanhanil</td>
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<tr>
<td>Karsan</td>
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<tr>
<td>Airtech</td>
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<tr>
<td>İnci Akü</td>
</tr>
<tr>
<td>Mutlu Akü</td>
</tr>
<tr>
<td>Teklas</td>
</tr>
<tr>
<td>Lassa</td>
</tr>
<tr>
<td>Hema</td>
</tr>
<tr>
<td>Temsa</td>
</tr>
<tr>
<td>Otokar</td>
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<tr>
<td>CMS</td>
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</table>

### Authorized Economic Operators (AEO)

<table>
<thead>
<tr>
<th>Company</th>
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</thead>
<tbody>
<tr>
<td>Yiğit Akü</td>
</tr>
<tr>
<td>Pirelli</td>
</tr>
<tr>
<td>Magnet Marelli</td>
</tr>
<tr>
<td>Standart Profil</td>
</tr>
<tr>
<td>Tırsan</td>
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<tr>
<td>Yazakı</td>
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<tr>
<td>Bosch</td>
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<tr>
<td>Ford</td>
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<td>Mercedes Benz</td>
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<td>FIAT</td>
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<td>Temsa</td>
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<td>Alsin</td>
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<td>Karsan</td>
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<tr>
<td>Toyota</td>
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<tr>
<td>Renault</td>
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<td>Isuzu</td>
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<tr>
<td>Otokar</td>
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<tr>
<td>BMC</td>
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<td>CMS</td>
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<tr>
<td>Honda</td>
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<tr>
<td>Bridgestone</td>
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<td>Hyundai</td>
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<td>Good Year</td>
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<td>ORS</td>
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<tr>
<td>Denso</td>
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<td>Autoliv</td>
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<tr>
<td>ZF</td>
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### Automotive Companies Supported by Turquality Brand Support Programme
10 companies (as of December 2018)

<table>
<thead>
<tr>
<th>Company</th>
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<tbody>
<tr>
<td>AYD</td>
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<tr>
<td>Bantboru</td>
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<tr>
<td>Ditaş</td>
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<td>Fompak</td>
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<tr>
<td>Doğupres</td>
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<tr>
<td>EKU</td>
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<tr>
<td>Tırsan</td>
</tr>
<tr>
<td>Platin Akü</td>
</tr>
<tr>
<td>Norm Civata</td>
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<tr>
<td>Katmerciler</td>
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</tbody>
</table>
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
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.
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.
2018 YE and 2019 Q1 Evaluation

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Digitalization in automotive sector

Global EV market analysis
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

- Battling to own relationships in a digital marketplace
- Accelerating pace of disruptive competition and innovation
- “Digitalization” across the value chain
- Unprecedented scrutiny
- Diverse sources of unpredictability
- Securing resources for business continuity
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.
- Use 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.

This exponential growth has generated four forces of business disruption.

**Dematerialization**
- An average mobile phone today houses over a million dollars’ worth of technologies from the 1980s.

**Decline of transaction costs**
- Blockchain technology could save global businesses US$550 billion a year.

**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.

**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.

**Four forces of business disruption**

**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

<table>
<thead>
<tr>
<th>Strategic challenges</th>
<th>Critical enablers</th>
<th>Role of digital</th>
</tr>
</thead>
</table>
| Own the relationship with traditional customers and new mobility consumers | • 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. | • 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 | • 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. | • 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           | • 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. | • 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

<table>
<thead>
<tr>
<th>Strategic challenges</th>
<th>Critical enablers</th>
<th>Role of digital</th>
</tr>
</thead>
</table>
| Offer a distinctive value proposition for customers. (owners of assets) and consumers (users of assets) | • 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). | • 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.            | • 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.                                                                 | • Leverage cloud platforms for improved collaboration and to develop flat hierarchy.  
• Develop close ties with start-ups to focus on distributed innovation. |
| Drive innovation.                                                                    | • 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. | • 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

<table>
<thead>
<tr>
<th>Strategic challenges</th>
<th>Critical enablers</th>
<th>Role of digital</th>
</tr>
</thead>
</table>
| Enhance speed to market.                                                            | • Shortening vehicle development cycles.  
• Using over-the-air updates to keep vehicles updated.  
• Standardizing processes to drive efficiency while maintaining local flexibility. | • 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.                          | • 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. | • 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.                                           | • Building understanding of evolving customer needs and accordingly designing vehicles that allow for reconfiguration.  
• Being quick in identifying the emerging trends and change faster. | • 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

<table>
<thead>
<tr>
<th>Strategic implications</th>
<th>Critical enablers</th>
<th>Role of digital</th>
</tr>
</thead>
</table>
| **Prepare for volatility and variables.** | ✷ Improve supply chain visibility and resilience.  
✷ Facilitate supply chain synchronization to reduce bullwhip effects.  
✷ Develop pricing strategies to combat competition.  
✷ Ensure effective collaborative planning. | ✷ 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.** | ✷ 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. | ✷ 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.** | ✷ 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. | ✷ 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.  
ushing intelligent tracking and last-mile delivery. |
| **Evolving workplace models to leverage and attract talent.** | ✷ Increase workforce productivity and employee engagement.  
✷ Adapt talent management structures holistically, including talent attraction, development and retention.  
✷ Align incentives and performance management. | ✷ 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

<table>
<thead>
<tr>
<th>Strategic challenges</th>
<th>Critical enablers</th>
<th>Role of digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responding to heightened scrutiny and accountability.</td>
<td>• Enabling regulatory radar and change management.</td>
<td>• Leveraging digital for strengthening reporting processes to demonstrate the economic value added.</td>
</tr>
<tr>
<td></td>
<td>• Building in emission compliance, cybersecurity, etc. right from the product development stage.</td>
<td>• Enabling data privacy and cybersecurity.</td>
</tr>
<tr>
<td></td>
<td>• Collaborating with advocacy groups, regulators and government to develop regulatory agenda.</td>
<td>• Leveraging digital technology for transparency and to trace provenance effectively.</td>
</tr>
<tr>
<td></td>
<td>• Being accountable and transparent in the event of recalls and failure.</td>
<td></td>
</tr>
<tr>
<td>Defining ownership of data across the value chain.</td>
<td>• Creating strong alliances and partnerships, and clear agreements with partners.</td>
<td>• Creating smart contracts on blockchain to ensure autonomous data governance structure</td>
</tr>
<tr>
<td></td>
<td>• Breaking down organizational silos with data sharing and teaming.</td>
<td>• Taking advanced cybersecurity measures. (tokenization of data sharing)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Enabling automotive data monetization — &quot;Data as a product&quot; for example, data-sharing partnerships with third-party insurance companies to device customized insurance packages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leveraging cloud platforms to ensure internal and multi-enterprise collaboration.</td>
</tr>
<tr>
<td>Managing supply chain risk.</td>
<td>• Being flexible to adapt quickly in response to recalls and quality issues without significantly increasing operational costs.</td>
<td>• Leveraging blockchain to improve transparency and provenance* across the system.</td>
</tr>
<tr>
<td></td>
<td>• Protecting the supply chain network of networks from data and cybersecurity breaches.</td>
<td>• Using cloud-based collaboration platforms.</td>
</tr>
</tbody>
</table>

* Provenance: The place of origin or earliest known history of something.
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.

An omni-channel strategy helps to:

- **Customers experience a brand, not a channel within a brand.**
  - **95%**
  - Strengthen consumer loyalty

- **Customers see multiple touch points as part of the same brand.**
  - **84%**
  - Improve consumer insight

- **Customers see multiple touch points acting independently**
  - **76%**
  - Expand/differentiated consumer base

- **79%**
  - Increase sales

*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.

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

  - 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.

  - Customers specifying mobility preferences
  - Offering customized mobility packages
  - Access to multiple modes of transport for customers

  - 85% of automotive C-suite executives believe that leveraging digital to manage trust and complexity throughout the customer life cycle will support their value proposition.

  - 62% of C-suite executives believe that an omni-channel brand experience strategy will help enhance value proposition.

  - However, only 8% of respondents felt well prepared to benefit from this.

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

- Shift focus from selling cars to becoming a mobility provider

  - €358/month Personal vehicle
    - 24-month contract
    - Maintenance package
  - €100/month Intracity mobility pack
    - Unlimited intracity journeys
    - 2-day large vehicle rental

- Use of online portals and marketplaces

- Alternate retail formats
  - Used car centers
  - Test drive centers
  - Experience centers

- Direct selling

- Upgrade distribution network to improve flexibility and increase relevant touch points

- Role of a physical site in an omni-channel experience

  - Good morning, Mr. Jonson. Do you remember the handover day three years ago?

  - New X45L model
  - Schedule your test drive here

  - Experience terminal

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.

70% of organizations believe that an increasing emphasis on customer experience is driving business growth strategies.

Traditional “product centric” customer journey:

1. First contact
2. Vehicle testing
3. Vehicle financing
4. Vehicle delivery
5. Breakdown warranty
6. Complaints
7. Replacement

Outcome: “I will buy back a new vehicle and get it serviced from the same brand.”

Consumer journey in a new mobility ecosystem:

Digital opportunities:

- Provide consistent experience through mobile and website
- Integrate social media to provide personalized experience (insight-led, tailored and personalized interactions)
- Conduct a mobility needs assessment through a blend of online surveys and social media
- Develop a mobility plan based on real-time analysis of vehicle inventory online
- Allow online booking of vehicle test drive or delivery
- Provide customized payment options based on customer’s risk profile
- Allow online application for credit and valuation for trade-in vehicle
- Optimize mobility plans based on customer and vehicle data
- Facilitate customer outreach through email, mobile, etc.

Outcome: “I will consider using the brand for my daily commute.”

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.

- Electronic fuel injection
- Electronic windows
- Electronic transmission controls

Automation
“Doing the same thing more efficiently”
Since the 70s

Digitalization
“Converting analog to digital or physical to virtual using new technologies”
Now

Digitization
- Keyless vehicle
- Navigation systems
- New generation ticketing and booking system
- Fleet management suites

(New business models)

Shared mobility, autonomous driving models and decentralized transportation
Personalized relationship management
Analytics-driven revenue models
Smart manufacturing

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

<table>
<thead>
<tr>
<th>Disruption scenario in automotive revenue pool, US$ billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,750 720 30 1,200 1,500</td>
</tr>
<tr>
<td>2015 2030</td>
</tr>
</tbody>
</table>

Monetization of connected car services

- Bait and hook model: Bundled subscription services like entertainment, security, home integration
- Analytics monetization models: Insurance premium based on the behavioral aspects of the driver
- Context-based monetization model: Time-sensitive data facilitating auxiliary revenue generation by providing apt services like battery recharge, traffic assistance

Shared mobility models

- B2 model: Transaction between the mobility provider and other businesses like messenger or delivery service
- B2B model: Transaction between the mobility provider and the end customer like station-based, free-floating car-sharing
- P2P model: Transaction between two private users with the mobility service provider capturing a commission

Asset light business models

- Open collaboration: Releasing API of the data from connected cars to developers, resulting in better reach, lower development cost and new revenue streams (considering privacy and security options)
- DAO model: Assigning projects to decentralized autonomous organizations (DAOs)

Zettabytes of data every year

*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.

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

Uber allows users to hire cars from any messenger conversation by tapping a car icon. Users can also message directly with Uberbot to hire a car.

Source: EY analysis, Uber, Lazooz
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.

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.

<table>
<thead>
<tr>
<th>Ride-sharing service</th>
<th>Investor</th>
<th>Amount (US$ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uber</td>
<td>Saudi Arabia</td>
<td>3.3</td>
</tr>
<tr>
<td>Didi</td>
<td>TBD*</td>
<td>3.5</td>
</tr>
<tr>
<td>Didi</td>
<td>Apple</td>
<td>1.0</td>
</tr>
<tr>
<td>Lyft</td>
<td>General Motors</td>
<td>0.5</td>
</tr>
<tr>
<td>Gett</td>
<td>Volkswagen</td>
<td>0.3</td>
</tr>
<tr>
<td>Via</td>
<td>Venture Capital</td>
<td>0.1</td>
</tr>
<tr>
<td>Scoop</td>
<td>BMW</td>
<td>0.0051</td>
</tr>
<tr>
<td>Uber</td>
<td>Toyota</td>
<td>Undisclosed</td>
</tr>
</tbody>
</table>

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 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.

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

- 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

Results

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.

- 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?

- 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

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

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

$27.8$ million
Estimated number of vehicles to be produced on top-10 platforms, up from $19.2$m in 2014

$4.5$ billion
Forecast global market size for HMI systems by 2017

$35$ 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.

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

- 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.

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

- 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

**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

**Cloud-based integrated PLM solutions such as Arena’s solution or Autodesk coupled with 3D printing capabilities for rapid prototyping**

**Market indicators**
- Digital prototyping: could reduce development time for new models
  - By 36 months
  - Design freeze to Job 1
  - Reduced number of crash-test prototypes
  - 30-50 cars vs. 10-15 cars

**Spare parts**
- 40% reduction in costs
- 90% faster repairs

**Sources:** 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 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.

**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.

**Sources:** 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.

**BMW**
Forecast function in navigation service
BMW analyzed information on personal driving behavior, traffic light phases, current accident incidence, etc., and also derived correlations from various data sources to introduce forecast function in its navigation service for its telematics system.

**Continental**
Seamless connectivity inside the car
Partnering with IBM to develop fully connected mobile vehicle solutions, Continental is set to leverage its automotive prowess while IBM uses its big data and cloud computing expertise for the project.

**Komatsu**
Creation of new product offerings
Komatsu analyzes the data collected by its Komtrax telematics system to spot new industry and market trends and accordingly develop new products.

**Toyota**
Cloud technology to make driving more personal
Toyota is leveraging Microsoft’s Azure cloud technology to develop services in order to make driving more personal (basis customers’ individual preferences), intuitive and safe.

**Ford**
Selection of vehicle features
The R&D team wanted to determine if the Ford Escape SUV should have a standard liftgate or a power liftgate. Ford reached out to social media, analyzed results along with other survey results and came up with a power liftgate, ultimately leading to high customer satisfaction.

**Nissan**
Optimal sales and inventory management
Nissan analyzes multiple data streams, including cars sold, customer search preferences and broad economic data, such as employment and housing stats across the country, on a big data platform to come up with optimal sales forecast and inventory management.

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 ...

- Ineffective collaborative planning
- High risk of out-of-stock situations
- Difficulties in managing inventory costs
- Inability to integrate mass customization
- Low OEE in manufacturing
- Bullwhip effect “noise” adding cost and complexity to operations
- Lag in responding to competitive pressures with limited resources

End result: Low supply chain synchronization

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

Source: EY analysis

1. Synchronize planning across different nodes to reduce work-in-process inventory
   - Use sophisticated models and analytics to optimize demand forecasting

2. Improve supply chain efficiency
   - External function
     - OEMs collaborate to optimize supply chain transparency and reduce risks
     - Enable supplier management

3. Streamline the supply chain by reducing the number of suppliers for each part
   - Reorganize supply chain network consolidation centers
   - Localize production

Variables across the automotive ecosystem
- Production scheduling
- Economic scenarios
- Low supply chain visibility
- Volatile costs
- Demand forecasting
- Supplier management

Automotive Industry Agenda - Special Edition 2019
Digital technologies will thus be integral for a high degree of integration of the core processes.

Advanced analytics
- Multi-enterprise and predictive analytics would aid in improved demand sensing, thus resulting in the reduction of bullwhip effects and efficient production scheduling.

3D printing
- Customized and complex products can be manufactured to meet changing customer preferences.

Blockchain
- 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
- 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
- AR and VR technologies would enable enhanced visual picking of products as well as reduce errors in picking.

IoT cloud
- IoT aids in developing a fully connected and monitored supply chain to improve efficiency and agility, along with improving interoperability between entities.

Source: EY analysis

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

Supply chain synchronization

Integrated supply chain operating model

Supply chain network and flow optimization

Supply chain resilience

Supply ecosystem
- Organic ecosystems driven by information flows focused on cost and benefit optimization

Local Motors’ Rally Fighter, the first car openly developed and built using crowd-sourcing

Transaction costs marginal if not zero

Download “Digital advisory GSA CSO Team”

Today

Information flow
Physical flow

Potential

Digitalized

Supply networks
- Cost reduction, efficiency global sourcing adding real-time transparency (IoT, big data and analytics)

Digitalized

Supply chains
- Linear vertical integrated (classical)

Analog

Transaction costs high

Credit: Digital advisory GSA CSO Team

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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 centrally controlled 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.

... 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.

 Source/s: EY analysis

 Source/s: EY analysis

Automotive Industry Agenda • Special Edition 2019 | 61
However, supply chain transformation should be backed by digitally optimized supporting processes ...

Key business challenges

1. Difficulty in information sharing
2. Error-prone processes
3. Ineffective reactive approach
4. Uninformed decision-making
5. Disconnected data sources
6. Time-consuming processes

Digital technologies that can improve operational efficiency in the automotive industry

- People
  - Cognitive technologies
  - Advanced search engines
  - Mobile

- Data
  - Advanced visual technologies
  - Advanced analytics
  - Cloud

- Process
  - RPA
  - Blockchain
  - IoT
  - Self-learning systems

Business benefits

- Ubiquitous availability of expertise
- Incessantly connected resources
- Productivity increase through augmenting humans

- Centralized data repository
- Easy and efficient information sharing
- Effective monitoring systems

- Highly scalable and flexible
- Highly efficient and automated

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

Digital technologies

- AR and VR
- RPA
- IoT and cloud
- Cognitive Intelligence
- Blockchain
- Advanced analytics
- Cobotics

Emerging outcome

- Agile workforce
- Real-time implementation
- Skill upgradation
- Improved collaboration

Need to integrate new digital workforce into the system

- Technological savviness
- Cognitive flexibility
- Emotional intelligence

Few automotive players have already started using digital technologies to enhance workforce productivity.

- BMW introduced a slow-moving collaborative robot in its factory in Spartanburg, South Carolina, which cooperates with a human worker to insulate and water-seal vehicle doors.

- Ford motivated dealership employees to make more use of the courses and resources available to them through gamification within a collaborative online community.

- Mercedes-AMG piloted a real-time quality assurance platform that harnessed the IoT and predictive analytics to optimize engine-testing processes when manufacturing its vehicles. This leads to lowered internal cost and faster resolution without losing time.

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.

- Create an aspirational experience enabling people experience and watch their car being "born" (through 3D printing)
- Enable direct retailing of innovative vehicle products through micro factory’s retail
- Offer customers an experience of loyal, uncompromising, personal service
- Engage with the community to facilitate innovation and empower the maker community

- Low inventory, high cash conversion, low capital intensity assembly facilities, using technology such as 3D printed cars
- A national network of local units with each capable of manufacturing, sales, and service.
- The individual units are supplied by a global "value network" of integrated suppliers (parts and sub-assemblies)
- Collectively, the units are linked to a small headquarters, providing support for process migration, design commonality and purchasing functions
- Styling and features to match customer requirements are done through virtual/web 2.0 community, enabling full retaining licensing rights
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

**Agreed security limit**
- Key suppliers
- Distributors
- Manufacturers
- Data hosting providers
- Contractors and support services
- Clients

**Variable factors**
- Software developers
- Secondary distributor networks
- Online prospects
- Employee agency
- Advertising agency
- Packaging
- Social media

**Uncontrollable factors**
- Climatic disruptions
- Economy
- Government regulations
- World events

**Automobile company**

**Open collaboration**
- API
- Third party development unit
- Sensitive data
- Competitors

**DAO model**
- Order products
- DAO
- Contractor
- Build
- Products

 DAOs are not legally recognized

Sources: News releases

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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 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.

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.

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

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

Most exposed units of a connected car

Manoeuvring
- Advanced Driver Assistance Systems
- Tire pressure monitoring system

Communication
- V2X communications
- Bluetooth
- OTA updates
- GPS

Mobile device
- Mobile applications

Body control
- Remote key or keyless
- Lighting systems
- ECU

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.

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

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.

<table>
<thead>
<tr>
<th>Alliance of Automobile Manufacturers draft privacy fundamentals</th>
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<tbody>
<tr>
<td><strong>Fundamentals</strong></td>
</tr>
<tr>
<td>Transparency</td>
</tr>
<tr>
<td>Choice</td>
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<tr>
<td>Respect for context</td>
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<tr>
<td>Data minimization, de-identification and retention</td>
</tr>
<tr>
<td>Data security</td>
</tr>
<tr>
<td>Integrity and access</td>
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<tr>
<td>Accountability</td>
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</table>

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?

Are there any hazardous materials in this car?

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

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

Now

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

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?

*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

A steady growth in HEVs is expected as a result of lower marginal costs compared with BEVs during the next few years

However, PHEVs and BEVs are expected to increase their share by 2023 across majority of the markets

Huge EV growth is expected to result in a multitude of opportunities in the electric vehicle battery market

16 countries holding around 95% of the total EV stock during 2014

During 2015, Japan and the US accounted for 72% of the global sales volume (BEV, PHEV and HEV)

China is expected to become the biggest alternate fuel market with a focus on BEVs

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

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

Sources:
- Analyst reports, LMC Automotive, EY analysis
- EY analysis

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

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.

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.

**Global EV sales volume (in mn) by key regions**

- **North America**
- **China**
- **Europe**

**2017 vol: 0.6m | CAGR 2017-30f: 18%**
Rapid penetration expected in states with zero emission plans (e.g., California), uptake remains contingent on Trump administration's policy on emission norms

**2017 vol: 0.7m | CAGR 2017-30f: 26%**
Tightening emission standards (many nations considering ICE bans) and high fuel taxes will boost the EV market going forward

**2017 vol: 0.8m | CAGR 2017-30f: 27%**
China is expected to retain its position as the biggest market for EVs in coming years on back of credits and subsidies, which are driving investments from global EV manufacturers

Sources: Analyst reports, LMC Automotive, EY analysis

**Sales in million units**

**BEV**

- **2017:** 1
- **2018f:** 2
- **2019f:** 3
- **2020f:** 4
- **2021f:** 5
- **2022f:** 6
- **2023f:** 7
- **2024f:** 8
- **2025f:** 8

**PHEV**

- **2017:** 0
- **2018f:** 1
- **2019f:** 1
- **2020f:** 1
- **2021f:** 2
- **2022f:** 3
- **2023f:** 3
- **2024f:** 3
- **2025f:** 3

**MHEV**

- **2017:** 0
- **2018f:** 2
- **2019f:** 2
- **2020f:** 4
- **2021f:** 6
- **2022f:** 8
- **2023f:** 9
- **2024f:** 11
- **2025f:** 14

**FHEV**

- **2017:** 2
- **2018f:** 2
- **2019f:** 3
- **2020f:** 3
- **2021f:** 3
- **2022f:** 4
- **2023f:** 4
- **2024f:** 4
- **2025f:** 4

**Growth Drivers**

- **BEVs:** Ever stricter emission norms and improving battery technology
- **PHEVs:** Consumer range anxiety and lack of charging infrastructure along longer route
- **MHEVs:** Better fuel economy at lower cost will attract automaker investments in 48V systems
- **FHEVs:** Growth expected to slow down with new 48V mild hybrids taking over the market

Sources: LMC Automotive, EY analysis
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)

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

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

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
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

<table>
<thead>
<tr>
<th>Group/brand</th>
<th>Market share (2017)</th>
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<tbody>
<tr>
<td>BYD</td>
<td>16%</td>
</tr>
<tr>
<td>BMW</td>
<td>14%</td>
</tr>
<tr>
<td>Toyota</td>
<td>12%</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>11%</td>
</tr>
<tr>
<td>SAIC</td>
<td>8%</td>
</tr>
<tr>
<td>Mercedes-Benz</td>
<td>8%</td>
</tr>
<tr>
<td>Geely</td>
<td>5%</td>
</tr>
<tr>
<td>GM</td>
<td>5%</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>5%</td>
</tr>
<tr>
<td>Ford</td>
<td>4%</td>
</tr>
<tr>
<td>Others</td>
<td>12%</td>
</tr>
</tbody>
</table>

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
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.

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

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

**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**

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</thead>
<tbody>
<tr>
<td><strong>EU</strong></td>
<td>140g/km</td>
<td>130g/km</td>
<td>95g/km</td>
<td>-15% by 2025</td>
<td>-20% by 2030</td>
<td>baseline</td>
<td></td>
</tr>
<tr>
<td><strong>USA</strong></td>
<td>180g/km</td>
<td>160g/km</td>
<td>103g/km</td>
<td>Not finalized</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Japan</strong></td>
<td>110g/km</td>
<td>130g/km</td>
<td>106g/km</td>
<td>Not finalized</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>China</strong></td>
<td>180g/km</td>
<td>130g/km</td>
<td>117g/km</td>
<td>Not finalized</td>
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</tbody>
</table>

**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.

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

**Sources:** EY analysis, News articles, Navigant Research, Canalsys
The regulatory support provided by governments to EVs in many countries is likely to fuel EV growth.

<table>
<thead>
<tr>
<th>Area</th>
<th>Action</th>
<th>China</th>
<th>France</th>
<th>Germany</th>
<th>India</th>
<th>Netherlands</th>
<th>Norway</th>
<th>UK</th>
<th>USA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EV purchase incentives</strong></td>
<td>Rebates at registration/sale</td>
<td></td>
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<td>Sales tax exemptions (excl. VAT)</td>
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<td>VAT exemptions</td>
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<td>Tax credits</td>
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<td><strong>EV use and circulation incentives</strong></td>
<td>Circulation tax exemptions</td>
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<td>Waivers on fees (tolls, parking)</td>
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<td>Electricity supply reductions/ exemptions</td>
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<td>Tax credits (company cars)</td>
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<tr>
<td><strong>EV use and circulation incentives</strong></td>
<td>Access to bus lanes</td>
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<td>Access to HOV lanes</td>
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<td>Access to restricted traffic zones*</td>
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<tr>
<td><strong>Tailpipe emission standards</strong></td>
<td>Fuel economy standards</td>
<td>China 5</td>
<td>Euro 6</td>
<td>Euro 6</td>
<td>Bharat 4</td>
<td>Euro 6</td>
<td>Euro 6</td>
<td>Euro 6</td>
<td>Tier 2</td>
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<tr>
<td></td>
<td>Road vehicles tailpipe pollutant emissions standards</td>
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</tbody>
</table>

- 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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Ford: New small SUV</th>
<th>Mercedes: Generation EQ</th>
<th>BMW: X3</th>
<th>Jaguar: i Pace</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
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<td>2017</td>
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<td>2019</td>
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<tr>
<td>2020</td>
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</table>

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

Sources: Company websites, news, EY analysis

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

<table>
<thead>
<tr>
<th>Year</th>
<th>Jaguar Land Rover</th>
<th>Ford</th>
<th>BMW</th>
<th>Volvo</th>
<th>Renault Nissan Mitsubishi</th>
<th>Baic</th>
<th>Toyota</th>
<th>PSA Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>All models to have EV option</td>
<td>40 EVs (16 BEVs, 24 PHEVs)</td>
<td>25 EV and hybrid models</td>
<td>Tail new models to be only hybrids / pure EVs</td>
<td>12 pure EVs, a range of hybrids</td>
<td>Only EVs post 2025</td>
<td>All models to have EV option</td>
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<tr>
<td>2019</td>
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<td>2020</td>
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</table>

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.

<table>
<thead>
<tr>
<th>Ownership based models</th>
<th>Access based models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td><strong>Cash purchase</strong></td>
</tr>
<tr>
<td>Ownership</td>
<td>Customer</td>
</tr>
<tr>
<td>Upfront cost</td>
<td>High</td>
</tr>
<tr>
<td>Monthly payment</td>
<td>NA</td>
</tr>
<tr>
<td>Examples of automakers</td>
<td>VW, Nissan, Toyota, Tesla</td>
</tr>
</tbody>
</table>

*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

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

80%

90%

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

Automakers are following varied manufacturing approaches to develop EVs

Future focus area for OEMs and suppliers

<table>
<thead>
<tr>
<th>Innovation potential</th>
<th>Expected growth</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High</strong></td>
<td><strong>High</strong></td>
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<tr>
<td><strong>Low</strong></td>
<td><strong>Low</strong></td>
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<tr>
<td>ECU</td>
<td>Brakes</td>
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<tr>
<td>Electric motor</td>
<td>Tires</td>
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<tr>
<td>Onboard software</td>
<td>Transmission</td>
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<td>Batteries</td>
<td>Turbo chargers</td>
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<td>Power electronics</td>
<td>Chassis</td>
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<td>HUdS</td>
<td>Fuel cells</td>
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<tr>
<td>Transmission</td>
<td>Steering</td>
</tr>
<tr>
<td>Turbo chargers</td>
<td>Chassis</td>
</tr>
</tbody>
</table>

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

Source: EY analysis

*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...”

1. Developing Enabling Structure
   - Funding the capital requirement
   - Mitigating technical obsolescence
   - Developing technology standards & regulations
   - Designing tariffs for charging stations
   - Planning & deploying charging stations
   - Integrating with other demand-side offerings
   - Resolving customer complaints & liability
   - Managing large spikes in localized grid demand

2. Delivering Complex Programs
   - Delivering leading-edge innovation projects
   - Defining policies and regulations
   - Integrating multiple IT systems
   - Complying with regulatory milestones
   - Managing complex stakeholder environment
   - Integrating with existing Smart programs
   - Coordinating all aspects in concert

3. Driving Customer Adoption
   - Providing effective stimulus measures
   - Battling supply-side constraints
   - Engaging the customer
   - Changing customer behaviours
   - Staging effective marketing campaigns
   - Overcoming technology maturity concerns
   - Countering customer apathy
   - Appealing to business & commercial customers

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

**Forms of manufacturing**

- Tier 0.5/ Contract manufacturing (outsourcing)
- OEM to OEM (electric vehicle platform and technology sharing)
- In-house R&D and innovation (battery innovation)
- Crowd sourcing (for mass customization)

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

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

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

Source: Analyst reports

Source: EY analysis
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.

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.

Sources: International Economic Development Council, EY analysis
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The Presidency of the Republic of Turkey, Investment Office

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