

# Creativity, Innovation & Trends in Global Automobile Manufacturing

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## Abstract

The word 'Automobile' comes, via the French automobile from the ancient greek word (auto's, 'self') and the latin mobiles ("Movable"), means a vehicle that moves itself. The alternate name 'Car' is believed to originate from the latin word Carrus or Carrum ("Wheeled Vehicle"), or the English/Frence Carre ("Cart"). An automobile or car is a wheeled vehicle used for the transportation of passengers, goods on public roads. Automobile manufacturing has changed the face of the world during 20th century, particularly in the United States of America, Great Britain, India, Japan, South Korea, Germany, Canada, China, France, Australia and other industrialized nations. The manufacture and service of automobiles has become key elements of industrial economics. The typical automobile, also called a car, auto, motorcar, and passenger car, has four wheels and can carry upto five people, including a driver. Large vehicles designed to carry more passengers are called vans, minivans, omnibuses, or buses. Those used to carry cargo are called pickups or trucks, depending on their size and design. Minivans are van-style vehicles built on a passenger car frame that can usually carry upto eight passengers. Sport-utility vehicles also known as SUV's are more rugged than passenger cars and are designed for driving in mud and snow. I am a graduate in Mechanical Engineering/Osmania University'96, MBA/JNTUH, Industrial Engineering/Texas A&M University-Kingsville'99, I had the opportunity and honour of working in General Motors at Buick City, Flint, Michigan/New York, United States of America during the year 2000-2001, and my experience in Automobile Engineering is as follows.

**Keywords: Global Automobile Manufacturing, Assembly Line Methods**

## I. INTRODUCTION

An Automobile is a self-propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as car, bus, trucks, etc.,

### A. Types of Automobile

The automobiles are classified by the following ways:

#### 1) On the Basis of Load:

- Heavy transport vehicle (HTV) or heavy motor vehicle (HMV),
- Light transport vehicle (LTV), Light motor vehicle (LMV),

#### 2) On the Basis of Wheels:

- Two wheeler vehicle, for example : Scooter, motorcycle, scooty, etc.
- Three wheeler vehicle, for example : Autorickshaw,
- Three wheeler scooter for handicaps and tempo, etc.
- Four wheeler vehicle, for example : Car, jeep, trucks, buses, etc.
- Six wheeler vehicle, for example : Big trucks with two gear axles.

#### 3) On the basis of Fuel Used:

- Petrol vehicle, e.g. motorcycle, scooter, cars, etc.
- Diesel vehicle, e.g. trucks, buses, etc.
- Electric vehicle which use battery to drive.
- Steam vehicle, e.g. an engine which uses steam engine.
- Gas vehicle, e.g. LPG and CNG vehicles, where LPG is liquefied

#### 4) On the basis of Body Style:

- Sedan Hatchback car.
- Coupe car Station wagon Convertible.
- Van Special purpose vehicle, e.g. ambulance, milk van, etc.

#### 5) On the basis of Transmission:

- Conventional vehicles with manual transmission, e.g. car with 5 gears.

- Semi-automatic
- Automatic : In automatic transmission, gears are not required to be
- Changed manually.
- 6) *On the basis of Drive:*
  - Left hand drive
  - Right hand drive
- 7) *On the basis of Driving Axle:*
  - Front wheel drive
  - Rear wheel drive
  - All wheel drive
- 8) *Position of Engine:*
  - Engine in Front - Most of the vehicles have engine in the front. Example : most of the cars,
  - Engine in the Rear Side, Very few vehicles have engine located in the rear, Example : Nano car.

## II. AUTOMOBILE/VEHICLE CONSTRUCTION AND COMPONENTS

The main components of an automobile refer to the following components

### A. *Powertrain System*

- Power Engine Plant Generation
- Engine
- Fuel System
- Intake System
- Exhaust System
- Cooling System
- Power Transmission Drive Inn
- Clutch
- Gear Box/Transmission
- Wheel/Tyres

### B. *Running System*

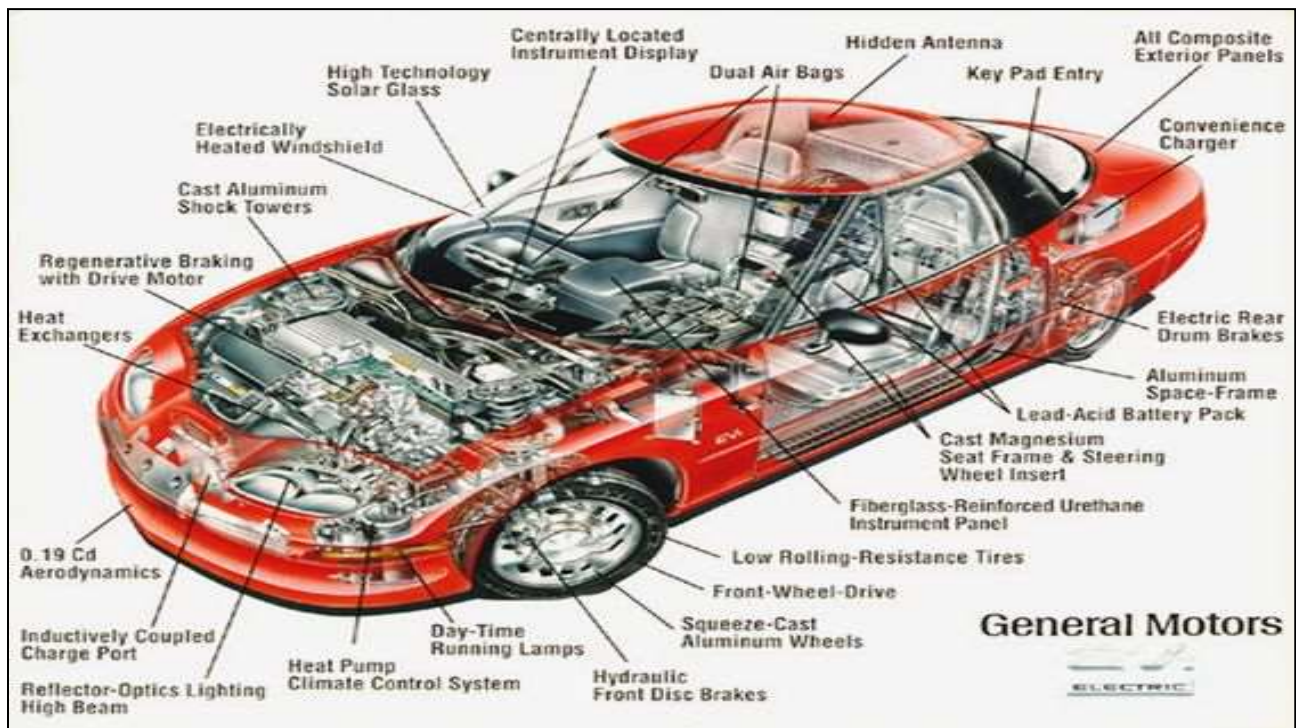
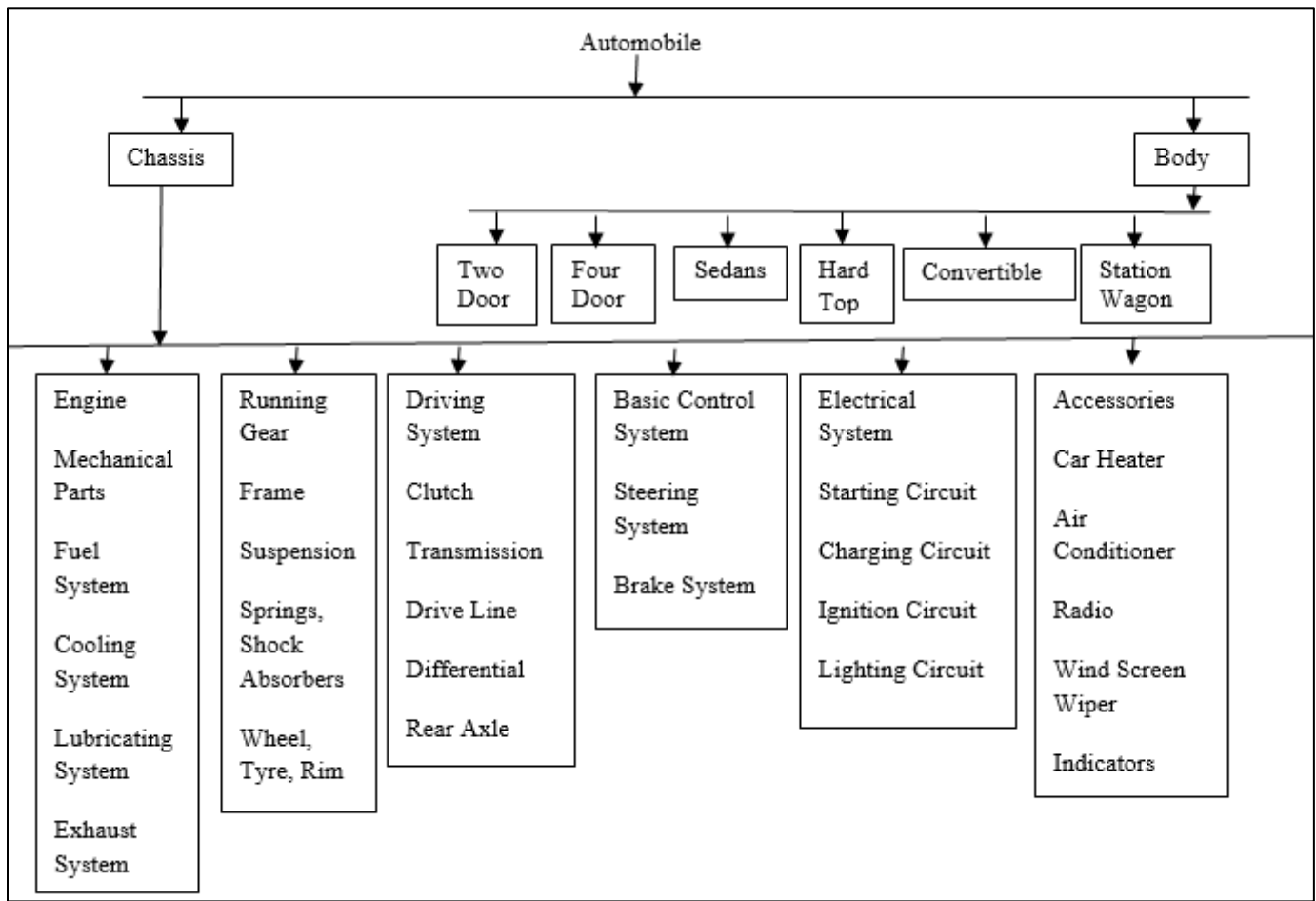
- Suspension
- Steering
- Braking

### C. *Comfort System*

- HVAC/AC/Heater System
- Seating/Upholstry/Instruments
- Audio/Video/GPS

### D. *Frame, Chassis, Body as follows*





### III. PROCESS FLOW DIAGRAM FOR CAR ASSEMBLY

- 1) Components, such as the motor components are built up as sub-assemblies. This is accomplished by taking individual sheet metal components of varying sizes, fixturing them into a precise location and then RSW (resistance spot welding) them into their final location.
- 2) Finished subassemblies are assembled and added to the floor pan and motor compartment. At the beginning a vehicle body starts flat, additional assembles add some length, but also all the components that give a vehicle body height, things like the firewall separating the motor from the passenger compartment and the waterfall section between the backseat and the trunk.
- 3) At this point you have the rough shape of a car, but still lack the external body panels that make it look like the final product, lack a roof, and have none of the swing metal parts: doors, hood, deck lid etc.,
- 4) Doors were built up in separate sub-assembly lines and are placed on a conveyor to be mounted onto the rest of the body. Doors are lifted via a specially designed piece of tooling to lift them and locate them accurately to the car body. Bolts are torqued, and verified, to a specific value to mount the doors. This (along with deck-lids and hoods) are typically the the only threaded fastener in the entire Body Shop everything else is welded into location.
- 5) A roof panel is placed on top of the sheet metal layer cake that you've created and welded into place. Hoods and deck-lids are placed in a similar manner to doors.
- 6) A final section of the production line called "body finishing". Its purpose is to identify and fix any problems or defects that would show up once painted. Workers sand and smooth the body panels to ensure no problems occur once painted. It's far easier to fix things at this point then to remove paint.
- 7) The process of making a car can be roughly divided into stamping, welding, painting, assembly and inspections, which takes about 17-18 hours in total. (It varies according to the number of cars made by a factory.)

### IV. ASSEMBLY LINE METHODS

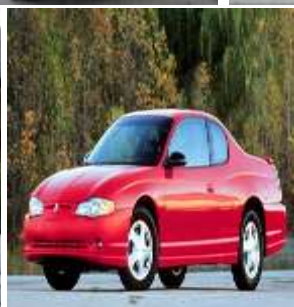
- 1) Modular Assembly—This is an advanced assembly line method that is designed to improve throughput by increasing the efficiency of parallel subassembly lines feeding into the final assembly line. As applied to automobile manufacturing, modular assembly would involve assembling separate modules—chassis, interior, body—on their own assembly lines, then joining them together on a final assembly line.
- 2) Cell Manufacturing—This production method has evolved out of increased ability of machines to perform multiple tasks. Cell operators can handle three or four tasks, and robots are used for such operations as materials handling and welding. Cells of machines can be run by one operator or a multi-person work cell. In these machine cells it is possible to link older machines with newer ones, thus reducing the amount of investment required for new machinery.
- 3) Team Production—Team-oriented production is another development in assembly line methods. Where workers used to work at one- or two-person work stations and perform repetitive tasks, now teams of workers can follow a job down the assembly line through its final quality checks. The team production approach has been hailed by supporters as one that creates greater worker involvement in the manufacturing process and knowledge of the system.
- 4) U-shaped assembly "line"—A line may not be the most efficient shape in which to organize an assembly line. On a U-shaped line, or curve, workers are collected on the inside of the curve and communication is easier than along the length of a straight line. Assemblers can see each process; what is coming and how fast; and one person can perform multiple operations. Also, workstations along the "line" are able to produce multiple product designs simultaneously, making the facility as a whole more flexible. Changeovers are easier in a U-shaped line as well and, with better communication between workers, cross-training is also simplified. The benefits of the U-shaped line have served to increase their use widely.

By reducing the amount of time required to produce an item, assembly line methods have made it possible to produce more products with less effort.

### V. COMPARISON OF SALES OF PASSENGER CARS AND LIGHT COMMERCIAL VEHICLES IN UNITED STATES OF AMERICA DURING 2017 & 2018 FOR DIFFERENT CAR MANUFACTURERS

		Dec. 2018	Dec. 2017	y-o-y Share fluctuation	Jan.-Dec. 2018	Jan.-Dec. 2017	y-o-y Share fluctuation
GM	Total	296,632	308,112	-3.7%	2,951,200	2,999,605	-1.6%
	Share	18.2%	19.2%	-1.0 pt	17.1%	17.4%	-0.3 pt
Ford	Total	219,632	240,910	-8.8%	2,485,222	2,575,200	-3.5%
	Share	13.5%	15.0%	-1.5 pt	14.4%	14.9%	-0.6 pt
Toyota	Total	220,910	222,985	-0.9%	2,426,674	2,434,518	-0.3%
	Share	13.6%	13.9%	-0.3 pt	14.0%	14.1%	-0.1 pt
FCA	Total	196,520	171,946	14.3%	2,235,204	2,059,376	8.5%
	Share	12.1%	10.7%	1.3 pt	12.9%	12.0%	1.0 pt
Honda	Total	155,115	149,317	3.9%	1,604,828	1,641,429	-2.2%

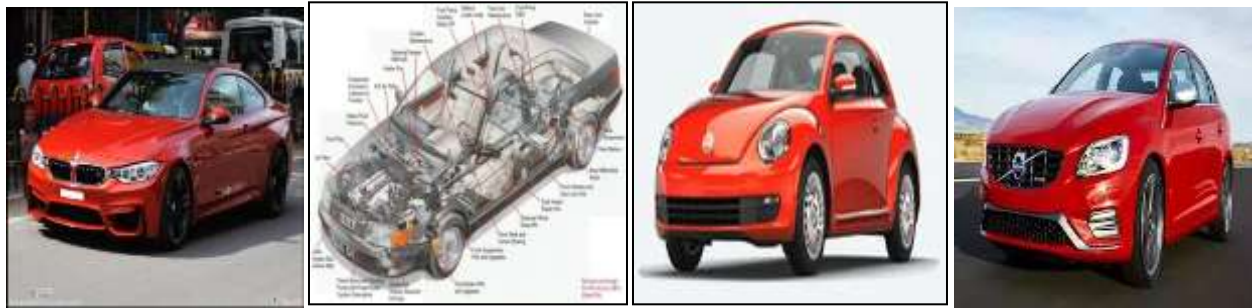
	Share	9.5%	9.3%	0.2 pt	9.3%	9.5%	-0.2 pt
Nissan	Total	148,720	138,226	7.6%	1,493,877	1,593,464	-6.2%
	Share	9.1%	8.6%	0.5 pt	8.6%	9.2%	-0.6 pt
Subaru	Total	64,541	63,342	1.9%	680,135	647,956	5.0%
	Share	4.0%	4.0%	0.0 pt	3.9%	3.8%	0.2 pt
Hyundai	Total	65,721	63,594	3.3%	677,946	685,555	-1.1%
	Share	4.0%	4.0%	0.1 pt	3.9%	4.0%	-0.1 pt
Kia	Total	47,428	43,039	10.2%	589,673	589,668	0.0%
	Share	2.9%	2.7%	0.2 pt	3.4%	3.4%	0.0 pt
Mercedes Benz	Total	36,132	39,250	-7.9%	354,144	372,240	-4.9%
	Share	2.2%	2.4%	-0.2 pt	2.1%	2.2%	-0.1 pt
VW	Total	32,047	30,281	5.8%	354,064	339,676	4.2%
	Share	2.0%	1.9%	0.1 pt	2.0%	2.0%	0.1 pt
BMW	Total	34,357	34,253	0.3%	311,014	305,685	1.7%
	Share	2.1%	2.1%	0.0 pt	1.8%	1.8%	0.0 pt
Mazda	Total	25,870	26,893	-3.8%	300,325	289,470	3.7%
	Share	1.6%	1.7%	-0.1 pt	1.7%	1.7%	0.1 pt
Audi	Total	22,765	26,977	-15.6%	223,323	226,511	-1.4%
	Share	1.4%	1.7%	-0.3 pt	1.3%	1.3%	0.0 pt
Tesla (Est.)	Total	20,100	3,540	467.8%	126,150	43,860	187.6%
	Share	1.2%	0.2%	1.0 pt	0.7%	0.3%	0.5 pt
Mitsubishi	Total	8,986	8,501	5.7%	118,074	103,686	13.9%
	Share	0.6%	0.5%	0.0 pt	0.7%	0.6%	0.1 pt
Volvo	Total	8,826	9,679	-8.8%	98,263	81,507	20.6%
	Share	0.5%	0.6%	-0.1 pt	0.6%	0.5%	0.1 pt
Land Rover	Total	10,617	7,980	33.0%	92,143	74,739	23.3%
	Share	0.7%	0.5%	0.2 pt	0.5%	0.4%	0.1 pt
Porsche	Total	4,086	3,913	4.4%	57,202	55,420	3.2%
	Share	0.3%	0.2%	0.0 pt	0.3%	0.3%	0.0 pt
MINI	Total	2,797	4,611	-39.3%	43,684	47,105	-7.3%
	Share	0.2%	0.3%	-0.1 pt	0.3%	0.3%	0.0 pt
Jaguar	Total	3,462	3,414	1.4%	30,483	39,594	-23.0%
	Share	0.2%	0.2%	0.0 pt	0.2%	0.2%	-0.1 pt
Smart	Total	122	166	-26.5%	1,276	3,071	-58.5%
	Share	0.0%	0.0%	0.0 pt	0.0%	0.0%	0.0 pt
Others	Total	2,095	2,200	-4.8%	19,346	21,101	-8.3%
	Share	0.1%	0.1%	0.0 pt	0.1%	0.1%	0.0 pt
Grand Total		1,627,481	1,603,129	1.5%	17,274,250	17,230,436	0.3%





**VI. COMPARISON OF CAR SALES OF DIFFERENT CAR MANUFACTURERS IN DIFFERENT COUNTRIES DURING 2017-2018**

Rank 2017	Rank 2016	Country	Sales 2017	Sales 2016	% Variation 2017
1	1	China	2,82,71,791	2,76,49,428	2.3
2	2	USA	1,72,37,702	1,75,58,919	-1.8
3	3	Japan	50,90,408	48,27,456	-5.4
4	4	Germany	37,00,758	35,56,264	4.1
5	6	India	32,23,429	29,64,282	8.7
6	5	UK	29,03,058	30,68,537	-5.4
7	7	France	25,41,321	24,22,685	4.9
8	8	Brazil	21,72,452	19,90,188	9.2
9	9	Italy	21,40,248	19,63,422	9.0
10	10	Canada	2,04,36,15	19,51,658	4.7
11	11	South Korea	17,84,399	18,34,784	-2.7
12	13	Russia	15,95,667	14,25,791	11.9
14	12	Mexico	15,30,624	16,04,148	-4.6
15	15	Spain	14,20,671	13,04,329	8.9
16	16	Australia	11,63,440	11,57,478	0.5
17	17	Indonesia	10,48,819	10,21,113	2.7
19	20	Argentina	8,85,092	6,87,900	28.7
20	21	Thailand	6,87,002	6,03,921	13.8
23	25	Poland	5,49,641	4,91,589	11.8
24	19	Saudi Arabia	5,44,721	7,15,472	-23.9
25	24	South Africa	5,32,304	5,23,659	1.7
26	26	Netherlands	4,88,529	4,56,443	7
28	28	Sweden	4,33,128	4,23,783	2.2
30	30	Austria	3,93,255	3,58,414	9.7
31	33	Chile	3,60,231	3,05,468	17.9
36	39	Portugal	2,61,061	2,40,997	8.3
41	42	Norway	1,94,468	1,90,604	2.0
43	46	Peru	1,63,666	1,53,876	6.4
44	43	Ireland	1,55,551	1,69,687	-8.3
47	40	Egypt	1,33,872	2,11,487	-36.7
48	42	Finland	1,31,796	1,31,331	0.4
53	55	Slovakia	1,04,279	88,965	17.2
57	57	Greece	94,710	84,490	12.1
58	62	Ukraine	87,439	65,588	33.3
60	59	Slovenia	82,809	73,516	12.6



**VII. THE TIMELINE OF INDIAN AUTOMOBILE INDUSTRY IS SUMMARIZED AS FOLLOWS**

- 1897- First person to own a car in India-Mr.Foster of M/s Crompton Greaves,Mumbai
- 1901- First Indian to own a car in India-Jamshedji Tata
- 1911- First taxi in India
- 1924- Formation of traffic police55
- 1945- Tata Motors
- 1947- Mahindra Motors
- 1981- Maruti Suzuki
- 1994- Mercedes Benz
- 1994- Opel Motors
- 1995- Ford Motors
- 1997- Fiat Motors
- 1997- Toyota Kirloskar Motors
- 1998- Hyundai Motors
- 1998- Mitsubishi Motors
- 2001- Skoda Auto
- 2003- Chevrolet
- 2005- BMW
- 2007- Audi
- 2009- Land Rover
- 2010 - Jaguar

**A. List of Current Modern Cars in India**

S.No	Company Brands	Models
1	Maruti Suzuki	Alto 800, Swift, SX4, Alto K10, Ritz, Wagon R, Eeco, S-Cross, Omni, Ertiga, Baleno, Vitara Brezza, Dzire, Celerio, Ignis, Ciaz
2	Hyundai	Eon, Santro, i10, i20, Verna Tucson, Santa Fe, Sonata, Accent, Veloster
3	Chevrolet	Spark, Beat, U-va, Cruze, Sail, Enjoy, Captiva, Tavera, Trail Blazer
4	Honda	Brio, Jazz, Amaze, City, Accord, WR-V, BR-V
5	Toyota	Etios Liva, Etios, Corolla Altis, Innova, Highlander, Fortuner, Camry, Yaris, Hilux
6	Tata	Nano, Manza, Indigo, Indica Vista, Sumo, Safari, Storm,Tigor, Tiago, Nexon, Zest, Bolt
7	Ford	Figgo, Fiesta, Endeavour, Eco Sport, Aspire, Classic
8	Mahindra	Bolero, Scorpio, Xylo, XUV 500, TUV300, KUV 100 NXT, Verito, Thar, Marazzo
9	Mercedes Benz	C 200, C 250, C 220, E 200
10	Nissan	Micra, Sunny, Terrano.
11	Skoda	Fabia, Laura, Superb, Rapid, Octavia
12	Fiat	Punto, Linea, Avventura, Urban Cross
13	Jeep	Compass
14	Volkswagen	Polo, Vento, Jetta, Ameo, Tiguan, Passat
15	Isuzu	Isuzu D-Max V-Cross, Isuzu Mux
16	Audi	A3, A4, A6, A8, Q3, Q5, Q7
17	Mitsubishi	Pajero
18	Volvo	V40, V90, S60, S90, XC60, XC90.
19	Datsun	Go, Go+, Redi-Go
20	Renault	Captur, Duster, Kwid, Lodgy.
21	Jaguar	Jaguar XF, Jaguar F-Pace, Jaguar XJ, Jaguar F Type, Jaguar XE
22	Kia Motors	-
23	Other available car models include Porsche, Lamborghini, Maserati, Ferrari, Bugatti, Peugeot, Aston Martin, Vauxhall, Bentley, Rolls-Royce, Mazda	

**B. Comparison of Car Sales in India in the year 2017 & 2018 for different Car Manufacturers**

Rank	Original Equipment Manufacturer (OEM)	CY 2018	CY 2017	% Growth
1	Maruti Suzuki India	17,31,450	16,02,522	8.05
2	Hyundai Motor India	5,50,002	5,27,319	4.30
3	Mahindra & Mahindra	2,49,301	2,42,386	2.85
4	Tata Motors	2,37,217	1,91,107	24.1 3
5	Honda Cars India	1,74,859	1,78,755	-2.18
6	Toyota	1,51,480	1,39,566	8.54

7	Ford India	97,804	88,184	10.91
8	Renault India	82,368	1,12,489	-26.78
9	Nissan Motor India	41,586	53,390	-22.11
10	Volks Wagen India	37,018	47,749	-22.47
11	FCA India	18,408	15,837	16.23
12	Skoda Auto India	16,692	17,438	-4.28
13	Others	5520	5478	0.77
14	Grand Total	33,93,705	32,22,220	5.32

**C. Comparison of Car Sales in India in the Year 2017 & 2018 for Luxury Cars**

Rank	Original Equipment Manufacturer (OEM)	CY 2018	CY 2017	% Growth
1	Mercedes Benz	15,538	15,330	1.36
2	BMW	11,105	9800	13.32
3	Audi	6463	7876	-17.94
4	JLR	4596	3954	16.24
5	Volvo	2638	2029	30.00
Great Grand Total		40,340	38,989	3.47

**VIII. KEY FACTORS THAT INFLUENCE CONSUMER/CUSTOMER CAR BUYING DECISIONS**

- 1) Political factors include trade barriers and incentives to the public to buy new cars
- 2) Economic factors include interest rates, disposable income, unemployment rates, retail price index (inflation), gross domestic product(GDP), and exchange rates
- 3) Social factors include the cultural aspects and include awareness, communication, population growth rate, age distribution, career attitudes and emphasis on safety. Trends in social factors affect the demand for a company's products and how that company operates.
- 4) Technological factors include ecological and environmental aspects, such as Research & Development activity, automation, technology incentives and the rate of technological change. Furthermore, technological shifts can affect costs, quality, and lead to innovation. The internet has affected just about every industry in the world and has also had a huge impact on the automotive industry.
- 5) Brand and price is where Buyers take into account the various benefits being offered by the showroom like cash discount, exchange bonus, free extended warranty, lower insurance premium and so on, with flexible budget
- 6) Styling is appealing to one, Fact is nowadays cars are used to flaunt success, make a style statement and are considered to be an extension of our personality. So prospective buyers want their car to stand out in a crowd.
- 7) Fuel economy and performance It is true that every human being is unique and has different expectations from their vehicle. However, the one common bit that strings all car buyers together is their obsession for good fuel economy.
- 8) Space as buying decision is governed by how much room or interior space the car offers. If the boot is spacious and can accommodate large bags and suitcases, then it is an added advantage
- 9) Comfort and safety features when buyers prefer features like good quality speakers and tweeters, steering-mounted audio controls, electrically adjustable wing mirrors and reverse camera.
- 10) Aftersales and service costs for the repair and maintenance of car parts is preferred to be low by consumers
- 11) Dealership experience includes interaction with automobile sales executives, where we choose a plan whether to lease a car or buy a car and discuss about easily payable monthly installments
- 12) Resale value is good for some cars and is low for other car after a period of time, as the market value of the car depreciates over a period of time. Hence cars with good resale value must be chosen to buy.
- 13) Family requirements is how many number of people in the same family need the car.
- 14) Interest rates on automobile/car financing plan to buy a car
- 15) SWOT(Strength, Weakness, Opportunity, Threat) analysis
  - Strength include large market share, brand loyalty, new automobile technology
  - Weakness include poor organizational structure, poor alternative energy movement
  - Opportunities include alternative energy movement, low interest rates, the power of buyers and availability of substitutes, develop new vehicle styles and models
  - Threats include rising fuel prices, growth of competitors, pension payouts, increased health care costs

**Comparison of Two-Wheeler/Motor Cycle/Scooter Sales in India in the year 2017 & 2018 for different Manufacturers**

Rank	Original Equipment Manufacturer (OEM)	CY 2018	CY 2017	% Growth
1	Hero Motor Corp	78,24,067	70,23,363	11.40
2	Honda Motor Cycles & Scooter, India	58,84,911	54,56,364	7.85
3	TVS Motor	31,51,097	27,14,662	16
4	Bajaj Auto	24,28,813	18,90,529	28.47
5	Royal Enfield	8,37,669	7,52,880	11



6	<i>Yamaha Motor, India</i>	7,96,234	7,86,787	1
7	<i>Suzuki Motor Cycle, India</i>	6,27,991	4,64,551	35.18
8	<i>Piaggio Vehicles</i>	79,629	63,342	25
9	<i>Mahindra Two Wheelers</i>	5197	18,404	-71
10	<i>H.D.Motor India</i>	3148	3339	-6
11	<i>Kawasaki Motors, India</i>	2666	1470	81
12	<i>Lohia Two wheelers</i>	2628	5753	-54
13	<i>Triumph Motorcycles</i>	1110	1130	-1.70
14	<i>Grand Total</i>	2,16,45,160	1,91,82,574	12.83

### IX. CONCLUSIONS & RECOMMENDATIONS

- 1) The festive season is considered a prime sales period for automakers as about 30 percent of annual car sales happen during this festive period, other occasions for car sales include gifts for marriage, birthday etc.,
- 2) All automobile imports and manufacturing are free from licensing and approvals.
- 3) 100% Foreign Direct Investment (FDI) is permitted in the automobile sector.
- 4) Import tariffs have been reduced from 35% in 2001 to 12.5% in 2006 and 7.5% in 2009-10
- 5) To promote a globally competitive automotive industry & emerge as a global source for auto components
- 6) A smart source of leadership as global manufacturing hub for cars
- 7) To be a hub to provide the high standard of modern product design, process manufacturing, research and development in automobile industry
- 8) To develop automobile safety standards, quality standards, and environmental standards to prevent pollution and improve automobile productivity and consumer/customer usage and hence promote and encourage entrepreneurship skills and industrial management skills among people.
- 9) To raise and make shine the automotive sector with industrial growth and employment to much higher level
- 10) Vision: To manufacture world's best cars
- 11) Mission: Strive for continuous improvement of automobile design & manufacturing with reference to factors like improving safety, quality, productivity, cost reduction, good market reputation, customer satisfaction, employee satisfaction, good maintenance, resale of cars, sales and service
- 12) Goals: To create 100% customer satisfaction and employee job satisfaction by selling cars

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