Impact of Covid-19 Pandemic in the Automobile Industry: A Case Study

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ABSTRACT

The automobile industry faces a significant problem due to slow down in economy/gross domestic product (GDP). The COVID-19 is affecting tourism, traveling and auto shows. It makes transportation simple, easy, and secure by implementing new emerging technologies such as image processing, artificial intelligence, deep learning, and transforming from simple vehicles to smart & autonomous vehicles. The study in this paper aims to analyse the market using sales/production data collected from the organization Internationale des Constructeurs d'Automobiles (OICA) across different regions, measures taken to overcome the recession caused by COVID-19 by analyzing similar situations and challenges faced in smart/autonomous vehicle. The challenges faced by autonomous vehicles with reference to camera and processing of captured image/video processing are discussed. Analysis of automobile Sales/Production shows the connection between market and GDP/economy.

Keyword: Gross Domestic Product, OICA, Smart/Autonomous Vehicle, Image/Video Processing

1. INTRODUCTION:

Earlier day's people used animals or carts supported by animals such as horses, bulls, donkeys, camels, and dogs for transportation. An automobile is a wheeled vehicle designed primarily for passenger transportation [1] that usually has wheels and an engine [2]. Before the gasoline steam engine, the hydrogen combustion engine and electric cars were used, which were eco-friendly but impossible to use because of several factors. There is no particular specific inventor since there are many people who contributed to the automobile industry. The automobile industry gives more credit to Carl Benz, who created the first automobile in 1885 and Gottlieb Daimler who was the first to take an interest in the gasoline-burning internal combustion engine [3]. Earlier small distance, open model cars were replaced by long-distance, closed model cars. Even though eco-friendly cars were available, gasoline-used cars became popular since it was cheaper. Auto races, tours, auto expo were organized to increase the familiarity and popularity of the automobile with people. Many automobile manufacturers started to produce automobile at affordable prices, which boomed the automobile industry.

2. OBJECTIVES OF THE STUDY:

This paper uses the sales/production information to analyze the growth and current status of the automobile industry, provides different recommendation depending on the similar situations encountered. This also include:

(1) Sales/Production details in different region to analyse the market.

(2) Different measures to overcome recession caused by COVID-19 by analyzing similar situations.

(3) Challenges faced by smart/autonomous vehicles related to image processing.

3. METHODOLOGY:

This paper consist of sales/production analysis of automobile industry for which data is collected from OICA. Different journal articles, white-paper, websites have been referred for analysis impact,

challenges and measures of COVID-19 and Image processing on automobile industry.

4. AUTOMOBILE INDUSTRY:

The International Organization of Motor Vehicle Manufacturers known as organization Internationale des Constructeurs d'Automobiles (OICA) supports various sectors of automotive industries, develops policies, distributes and preserves information and promotes innovations and security. OICA links automobile organizations together, which will be directly responsible for development in the automobile industry. The data used for analyzing different factors in this paper are collected from OICA. OICA classifies countries/regions as Europe, America, Asia/Oceania / Middle East, Africa. In the charts below production/sales of different types of automobiles are shown according to the region i.e., Europe, America, Asia/Oceania / Middle East, India, and All Countries. The data of the Africa region are neglected or not included for analysis since its value is much less compared with other regions. The type of automobile used for analysis is Passenger and Commercial Cars include Light Commercial Vehicle, Heavy Trucks and Buses & Coaches. Table. 1. contains information about the total number of automobiles sold/produced in the above-mentioned types [4] [5]. Fig 1 shows the real GDP growth of the mentioned regions used for analysis [6]. The progress of the automobile industry is directly related to the economic status of countries and institutions that affect the economic status of the country, GDP growth, stock market.

Table. 1: Sales/Production of Automobiles

Sales/ Production	Type	Sub-type	Year	Number of Units				
				Europe	America	Asia/Oceania	India	Total
Production	Passenger Cars		2005	17677904	8816463	20049013	1264111	46862978
			2006	18109334	9331032	22203097	1473000	49982840
			2007	19331225	9293340	24094409	1707839	53049391
			2008	18373538	9238009	24646730	1829677	52637206
			2009	15247066	6954032	25289717	2175220	47772598
			2010	17239732	8228067	32414823	2831542	58239494
			2011	18271467	8768058	32525304	3053871	59929016
			2012	17403987	10124903	35159735	3296240	63070002
			2013	17383144	10426827	37242936	3138988	65462496
			2014	18028727	9799028	39219660	3158215	67530621
			2015	18515293	9397047	40022392	3378063	68539516

			2016	18947885	8815986	43854191	3677605	72291747
			2017	19595025	8190677	44964533	3952550	73456531
			2018	18,737,586	7,650,006	43,432,201	4,064,774	70,567,581
			2019	18,722,527	6,973,304	40,666,078	3,623,335	67,149,196
	Commercial Vehicle	LCV	2005	2374663	9752470	3811328	164740	16109856
			2006	2480160	8972764	3840902	208344	15484497
			2007	2587358	9159593	4220568	249839	16143329
			2008	2443624	7056582	3927861	239702	13596954
			2009	1460549	5182940	3900903	269450	10652855
			2010	2038174	7596944	5008038	395253	14767988
			2011	2,288,577	8,323,723	4,865,927	511,164	15,626,448
			2012	2,079,384	9,335,179	5,480,444	553,048	17,069,886
			2013	2069113	10028265	5433242	515708	17728042
			2014	2101847	10752616	5038128	433310	18084557
			2015	2281428	10948943	4950654	427234	18490519
			2016	2476075	11540560	4931248	465597	19135852
			2017	2250324	11907293	5034434	504116	19387815
			2018	2261868	12470675	6043483	663193	21072296
			2019	2254153	12404698	5275812	571428	20223655
		Buses and Coaches	2005	75763	71914	107934	N/A	256758
			2006	87,080	34664	382,780	N/A	511,508

			2007	90,061	68270	338,630	61,070	503,705
			2008	96,862	69870	529,719	44,101	702,672
			2009	57,322	36173	198,235	N/A	297,443
			2010	58,976	42859	247,397	N/A	359,925
			2011	45,533	52,687	244,419	N/A	349,699
			2012	53354	39506	252214	54906	350335
			2013	54208	43606	243600	43641	345279
			2014	38521	35201	237877	44057	313059
			2015	43068	21763	256928	53223	321522
			2016	39657	18705	277956	52106	337594
			2017	40902	20670	253555	42392	316258
			2018	37207	28536	208177	39622	275098
			2019	43950	27671	198587	44333	271204
		Heavy Trucks	2005	684362	686815	1582715	N/A	2980619
			2006	729,528	754,974	1764816	280,237	3,279,069
			2007	836,805	588,010	2,002,374	N/A	3,456,271
			2008	856,761	552054	2,152,074	N/A	3,589,699
			2009	292,356	358,280	2,371,300	N/A	3,039,428
			2010	457,876	475,560	3,259,997	N/A	4,216,112
			2011	340,962	655,599	2,985,168	N/A	4,007,500
			2012	320671	586870	2816738	270519	3749158

			2013	283068	630107	2879368	182601	3818186
			2014	265979	632379	2864657	204578	3805991
			2015	234156	596901	2556182	267224	3429026
			2016	233351	481587	2752028	293657	3507604
			2017	274856	550897	3288085	283838	4141930
			2018	296690	651111	3202014	407056	4227815
			2019	291452	697086	3126396	276921	4142806
		Total	2005	3134788	10511199	5501977	N/A	19347233
			2006	3296768	9762402	5988498	N/A	19275074
			2007	3514224	9815873	6561572	N/A	20103305
			2008	3397247	7678506	6609654	N/A	17889325
			2009	1810227	5577393	6470438	N/A	13989726
			2010	2555026	8115363	8515432	N/A	19344025
			2011	2675072	9032009	8095514	N/A	19983647
			2012	2453409	9961555	8549396	878473	21169379
			2013	2406389	10701978	8556210	741950	21891507
			2014	2406347	11420196	8140662	681945	22203607
			2015	2558652	11567607	7763764	747681	22241067
			2016	2749083	12040852	7961232	811360	22981050
			2017	2566082	12478860	8576074	830346	23846003
			2018	2595765	13150322	9453674	1109871	25575209

		2019	2589555	13129455	8600795	892682	24637665
Sales	Passenger Vehicle	2005	17,906,455	11,618,929	15,097,677	1,106,863	45,407,298
		2006	18,685,556	12,048,814	16,293,923	1,311,373	47,955,259
		2007	19,618,588	12,522,371	17,754,371	1,511,812	50,834,531
		2008	18,821,599	11,877,523	18,389,909	1,545,414	49,978,237
		2009	16,608,761	10,280,682	21,938,382	1,816,878	49,654,985
		2010	16,499,863	11,131,614	27,278,736	2,387,197	55,818,570
		2011	17,167,600	11,947,951	27,673,657	2,510,313	57,839,953
		2012	16,191,269	13,389,456	30,201,657	2,781,919	60,936,407
		2013	15,942,273	13,819,830	32,470,264	2,553,979	63,429,200
		2014	16,154,279	13,464,567	34,843,066	2,570,736	65,708,230
		2015	16,410,563	12,664,453	36,110,706	2,772,270	66,314,155
		2016	17,291,819	11,746,160	39,445,239	2,966,637	69,464,432
		2017	17,974,281	11,283,401	40,594,317	3,229,109	70,694,834
		2018	17,909,677	10,562,992	39,283,920	3,394,729	68,678,212
		2019	17,972,774	9,540,192	35,959,799	2,962,052	64,341,693
	Commercial Vehicle	2005	3,156,871	11,719,925	5,310,920	333,592	20,516,496
		2006	3,178,284	11,307,861	5,524,663	439,519	20,398,117
		2007	3,388,134	11,086,694	5,871,267	481,909	20,728,868
		2008	3,050,831	9,025,378	5,894,404	437,657	18,337,258
		2009	2,036,590	7,216,363	6,329,277	449,391	15,913,844

		2010	2,308,825	8,588,367	7,912,897	653,193	19,152,953
		2011	2,572,419	9,630,088	7,731,778	777,424	20,330,467
		2012	2,471,909	10,281,437	8,023,947	813,589	21,192,731
		2013	2,401,136	11,210,175	8,108,871	687,323	22,176,936
		2014	2,433,371	12,010,964	7,713,930	606,269	22,629,868
		2015	2,625,426	13,023,706	7,300,198	652,566	23,370,453
		2016	2,843,010	13,803,052	7,412,645	702,640	24,391,956
		2017	2,780,818	14,169,953	7,720,355	830,346	24,965,772
		2018	2,785,551	15,152,399	8,363,201	1,005,422	26,971,331
		2019	2,834,391	15,768,984	8,043,351	854,839	27,016,764

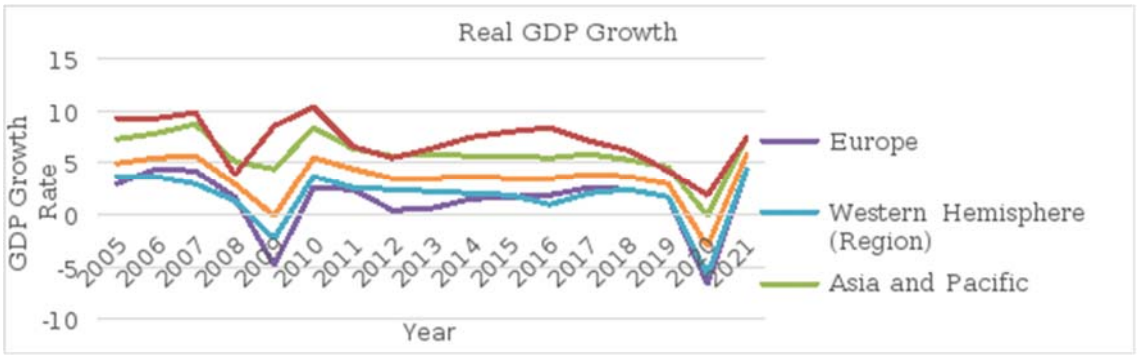

Fig. 1: GDP Growth [6]

5. IMPACT OF RECESSION:

Recession is a decline in the economic status of the country/region/world for a period, which decreases trade, per capita income, employment rate, GDP, etc. Because of the recession in 2007–2009, which started in America, then spread itself to Europe we can see a decrease in the production of Passenger cars, Light Commercial Vehicles, Commercial Vehicles, Trucks, and Buses in Europe and America in 2007–2009. Even though India and Asia/Oceania did not affect by a recession as much as America and Europe, its GDP decreased, which decreased the production of heavy buses. India and Asia/Oceania did not directly get affected by the Great Recession and the production of an automobile has increased. India's decrease in GDP in 2012–2013 affected the production of automobiles in 2013. The production of Automobile in America and Europe could not increase production to a great extent because of the recession in Europe in 2012 and 2013, which effected its GDP growth and effected other regions. The GDP of all countries decreased from 2017, which also directly affected the production of Automobiles. Due to the Great Recession in 2007–2009 and decrease in GDP the sales of automobiles decreased in

all regions. Sales of automobiles decreased from 2017 in all regions where we can see a direct link to GDP growth. In India, sales and production of automobiles decreased from 2018, mainly because of the new Motor Vehicle bill [7], and the crash requirement will be mandatory in the country after 2017 [8]. The bill will help improve the safety measures implemented in an automobile, which will save many lives. India is shifting from April 2020 BS-IV system to the BS-VI system, which will improve and support emission norms and improve air quality [9].

5.1 Impact of Corona

Globally the automobile industry is suffering even before the pandemic COVID-19 hits the world, the main reason can be a decrease in GDP growth rate from 2017. Different measures taken by the authority to improve air quality, and safety measures that need to be implemented in automobiles to decrease the fatality rate. The increase in the price of petroleum products, registration costs, insurance, etc is creating burden on the industry. To control the spreading of COVID-19 authorities implemented lockdown even though it slows down speed at which COVID-19 was spreading Lockdown affected financial status globally throughout every sector. The recession due to COVID-19 is expected to be more severe than the great recession since it is directly affecting all the countries, By analyzing the great recession and the severity of COVID-19 it is assumed that economic status will recover by 2023 [10].

(1) Travel Restrictions

COVID-19 mainly affected the automobile industry since tourism, hotel business, and transportation becomes to stop because of lockdown. People are avoiding travelling to the crowded places to be safe. Lockdown is gradually affecting the lifestyle of individuals and adopting to the simple lifestyle.

(2) Canceling and Rescheduling of Auto Shows

Auto shows is a platform for the launching of new automobile vehicles, discussion & proposal of new technologies and to attract & create interest in automobile lovers. Several auto shows have been postponed or canceled due to which launching of new automobiles has been postponed and expected investments are delayed [11]. Motor shows held in New York, Geneva, Detroit, Paris have been canceled, Bangkok International Auto Show (2020) rescheduled from March to July [12], Brussels Motor Show needs to be held in January 2021 is Postponed to January 2022 [13].

5.2 Measures to Overcome Recession

Companies should be flexible, try to improve operational quality, and should have sufficient financial resources to come out of recession. Companies with debt are in a critical position; to avoid increasing debt rate issuing equity is beneficial. Authorities should provide financial support by reducing the interest rate, tax, toll, etc, which will attract customers and ease automobile manufacturers.

(1) Importance to Developing Countries and Renewable Resources

The automobile industry concentrates its resources on the region with a young average age. From the analysis of Fig. 1, the investment should be done in developing Asian countries such as India and China where the expected GDP growth rate is more compared to other regions. More investment should be done in the research fields of renewable energy so that it can be used efficiently. The consumer is awaiting the arrival cheaper and efficient automobile, which uses renewable energy mainly due to a hike in the rate of petroleum products. Authorities are also encouraging the use of renewable energy since it reduces the burden of petroleum products and global stress is given to reduce pollution or wastage [14].

(2) Increasing Skill Set of Employees

Layoff may seem ideal to decrease loss but when the economy recovers hiring skilled and training new staff will be expensive. The layoff will also dampen the morality of personnel and decrease productivity. Companies can implement working shift-wise, which will help maintain social distancing, reduction in working hours, which in turn decreases salary need to be paid [15].

(3) Safety Item

The automobile is changing from luxury items to safe items since people are avoiding public

transportation and the sales/registration of automobiles is in a positive turn from April 2020 [16]. People are avoiding public transportation, by the effect of COVID-19. Because of its sales of an automobile are expected to increase and when analyzing the great recession it is seen that demand for secondhand automobiles increased.

(4) Adopting to New Technologies

To increase sales of automobile dealers should encourage and shift from offline to online mode like At-home test drives, VR test drives, Review videos, Digital showroom, etc [17]. Rather than canceling or postponing auto shows encouraging, conducting digital auto shows will help launch new automobile and sharing of information [18].

6. IMAGE PROCESSING TECHNIQUES FOR SMART VEHICLES :

The automobile industry is growing with the support of technology. The automobile industry is trying to implement new technologies, which will help the automobile industry to grow by making driving fun, safer, faster, and comfortable. Image processing is used in different areas of automobiles, which increase its functionality. Its main application is in ADAS and ADS systems. Currently, Automobile industry can implement Level 3 Automation and trying to implement Level 4 and Level 5 Automation. Due to the difficulty in implementing it many automobile manufacturers like Renault, Tesla, Toyata, Nexans with Google, NVIDIA, Mobileye, etc.

Image processing is used in a smart car to identify the type of road and obstacle by the continuous real-time video feed to a system that helps in reducing the harm implemented on the environment. Yixu Chen used bitmap preprocessing and cross-edge search algorithm for better performance [19]. The autonomous car should successfully identify the traffic lanes in both urban & rural areas, map formation, type of road, steering angle prediction, proximity determination, traffic signal, obstacles such as pedestrians, animals, other vehicles and speed humps, and take decisions based on identification [20] [21] [22]. Image processing is done on the video feed from the embedded camera to support autonomous cars. Shriram K V et al. used canny's edge detector for better performance in edge detection, which is helpful in lane/obstacle detection [23]. Michael Krödel and Klaus-Dieter Kuhnert used ACSD's modified nearest neighbor algorithm for estimating the road that provides commands to steering wheel control faster and used chained vector, which identifies road edges, lanes efficiently [24]. The type of vehicle can be classified using graphical dimensions of the vehicle [25]. Deep learning, convolution neural network is assisting the autonomous vehicle by an end to end learning. The video from different cameras/LIDAR is directly given to the network for training. Convolution neural network is suited for image processing, its training network provides more efficiency in image/object/obstacle recognition, scene understanding [26]. Different companies are developing autonomous/self-driving cars using computer vision and deep learning technology with a convolution neural network [27]. Automobile industry uses image processing with deep learning in a production line to detect stains, damages in paint, different faults, damages in produced parts and helpful to assembling the sensitive, tiny components, which reduced defects in the final product, fast production, and increased trust of customers on the brand [28] [29]. Ehsan Ul Haq et al. proposed a new algorithm difference of bigaussian as an edge detection method, which increased the performance in recognition of objects. The surrounding view of the car can be obtained by merging the images from different cameras embedded in the automobile body by merging them and creating a panoramic view. It will be helpful in smart vehicles, changing lanes, security, object detection, and identifying automobiles on the blindside [30].

7. CHALLENGES :

Image processing plays a main role in ADAS and ADS system. Some challenges related to image processing in automobile industry are listed below.

(1) Architecture

In the automation of vehicle cameras becomes the eye of the vehicle. Minimum of 8 - 10 cameras are required to completely cover every blind spot [31]. The implementation of the camera and creating or combining different information to create bird view become complex. Depending on the number & different types of sensors implemented the integration will be difficult. The processor should have high

processing speed and use fast algorithms such that it can collect information from different sensors, cameras, etc, process it and send commands for ADAS or ADS [32-33].

(2) Quality of Image/Video

The images/videos produced are of SD quality, more features can be extracted from if HD Quality images/videos were produced. To get good quality images linking system from camera to ADAS or ADS should have high bandwidth if not part of images/videos can be lost. The camera, linking wires processor must not be affected negatively one another. The Camera, Linking wires/Technology should not have electromagnetic influence, which may deteriorate the produced image/videos.

(3) Light

Capturing image/video through a simple camera under sunlight or natural light is easier. However, under low light, strong sunlight, night it becomes difficult which can be overcome by sensors like radars or lidar, but their effectiveness decreases as the distance increases. We can use Long wave infrared, short wave infrared camera or thermal cameras, which will rely on heat rather than visibility. Thermal cameras will work better in adverse conditions. Different types of cameras & sensors have their own advantages such as visible cameras work in better weather and for recording of Information [34]. The transition of object/vehicle from an illuminated region to dark region or vice versa complicates object recognition and time required for it due to a change in intensity. The Incandescent/fluorescent / LED headlight/street lights generate flickers or pulses of light, which will degrade the Image/video captured.

(4) Rural and Suburban Area

Lane detection, traffic sign/symbols, traffic police hand signal recognition plays an important role in the automated driving system. Lane detection is responsible for moving of the vehicle in particular lane, which can be easily identified by markings on the road. Lane detection becomes difficult task in rural & suburban areas since lanes may not be marked or no clear categorizations of lanes [35]. Traffic signs/symbols used for providing information about roads, do's and do not since there is a lack of traffic sign board in rural areas. The system must be able to recognize human signals provided by traffic personals [36-37]. Whenever there is ambiguity between traffic signals and traffic police/personnel hand signal system should give priority to traffic personnel.

(5) Weather

The ADAS and ADS system should work in all weather conditions like a thunderstorm, winter storm and windstorm. The visibility of simple camera is reduced in rain, fog, or any adverse weather conditions. Thermal or infrared cameras can be used to overcome the visibility issue. The heat and cold weather can deteriorate the performance of the system by the damage caused to the linking system and wires.

(6) Regular Checking and Testing

The ADAS and ADS system should not only increase the comfortableness of the passengers but also improve the safety of passengers, vehicles, pedestrians and other objects and decrease fatality rates. The cameras, camera linking technology, wires/connecting components, the performance of the system needs to be monitored regularly to prevent receiving/processing incomplete information, which may result in errors in commands provided. Testing and monitoring different components regularly will be time consuming and costly.

(7) External Factors

Cameras can be very easily damaged since they are mainly mounted on the body of the vehicle. Length/Weight of wiring and power consumption will increase as the number of sensors, cameras increase will directly impact the architecture and functionality. The view of cameras can be obstructed by external objects [31] and can generate wrong signals. The objects, vehicles, pedestrian should be easily separated from the environment background and prevent camouflage of objects.

(8) Cost

For the safety and security of automobile & customer the ADAS or ADS system should never fail.

Different types of cameras were implemented, such as thermal camera, Long wave infrared camera, short wave infrared camera. The cost of thermal, infrared camera is greater than that of a simple camera. Link wire must have huge bandwidth with light weight, so that a large amount of data can be transacted easily in short time. The SOC used must be high processor speed [38]. The linking wire, SOC will become costlier as the information, number of links increases.

8. RECOMMENDATIONS :

The economic growth directly effects the growth of the automobile industry. Since it is expected that the recession will hit again and the decline of the GDP will continue. The Automotive industry should concentrate on research and development with respect to ADAS and ADS rather than increasing the stock of vehicles. The automobiles require the support of both Camera, Thermal camera and infrared camera for safe and secure driving. However, as the number and types of cameras increases it burdens the system. Research needs to be done on implementing different types of camera on single entity and technology to support different camera, sensors with the same technology. The new business strategies on the vendor/dealer side should be created to prevent further loss in industry, i.e., Providing the cars for rent, services of drivers will create a new source of economy.

9. CONCLUSIONS :

The paper has analyzed sales and production of passenger and commercial vehicles from 2005 - 2019 by the data obtained from OICA. The automobile industry has been affected by corona but to what extent it is affected is not analyzed since data of complete year 2020 is not available but from April it is taking a positive turn. By taking account of the previous recession, it is expected demand for used automobiles will increase since buying new cars will not be affordable. Automobile manufacturers must concentrate on the region with less decrease in GDP growth. Image processing, Deep learning helps automobile become smart/autonomous vehicles. Researches are done to overcome the challenges faced by the autonomous vehicle in implementation of image processing.

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