Employment in Automotive Parts with Electric Vehicle Market Penetration in South Africa

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Abstract: *There have been numerous debates around employment impacts and socio-economics in South Africa with the market diffusion of electric vehicles (EVs), however, a definite consensus of whether the impacts are positive or negative cannot be established unless all the driving factors affecting employment in the internal combustion engine vehicle (ICEV) and EV value chains have been modelled. This study used a system dynamics methodology to develop a simulator to determine the impact of EVs and hybrids on employment in the parts and accessories segment of the automotive industry. Results indicate that the introduction of pure EVs could result in a 14% decrease in employment whereas 34% hybrids could result in a 4% decrease relative to the baseline of ICEVs only. In year 2040, employment in new part sales for ICEVs only was calculated to be 141,067 and dropped to 120,915 with EVs only and decreases to 135,807 with 34% hybrid cars. In the same year, employment in used part sales for ICEVs only was calculated to be 2,175 and dropped to 1,864 with EVs only and decreases to 2,094 with 34% hybrid cars.*

Keywords: electric vehicles; employment; system dynamics; parts

1. Introduction

With 23% of greenhouse gas emissions originating from the transport industry, countries have pledged commitment to work on strategies and regulations to decrease emissions in accordance with Article 4 of the Paris Agreement (UNCC, 2015). As part of the initiatives to reduce emissions, the global automotive industry is undergoing significant changes especially with respect to the transition towards electrified transport such as electric vehicles (EVs). Global EV sales reached 783,000 units in the first half of 2018 with a projected 21 million units to be sold in 2030 (Deloitte, 2019). South Africa's submission to the Paris Agreement included a commitment for over 2.9 million EVs by 2050, with the Department of Transport developing a Green Transport Strategy to encourage EV technology uptake and reduce emissions by 5% in the transport sector by 2050 (DoT, 2019). However, by June 2019 there were only 1007 EVs on South African roads with estimates by Knight & Thompson (2018) indicating that within seven to ten years, South Africa could possibly have around 200,000 passenger EVs on the road (using Norway's EV growth data). Despite the continued discussions around EV forecasts, recent discussions have now extended into other controversies such as employment impacts in the automotive industry due to EVs (Briscoe, 2019).

Some speculations indicate job losses in the automotive sector due to EVs requiring less assembly and far fewer components (200 compared to 1,400 for the internal combustion engine vehicles (ICEVs)) (Transport and Environment, 2017); whilst other sources indicate an increase due to charging infrastructure, battery manufacturing, software development, machine learning, data science etc. (Cimate Nexus, 2019).

Following discussions between several stakeholders in South Africa on employment impacts in the automotive industry, a research study was initiated to include the impact of EV market penetration on various segments of the automotive chain. This paper focuses on the results obtained specifically in the new and used parts and accessories segment. A system dynamics methodology was followed to develop the Automotive Employment Simulator (AES) so that scenarios could be run to further understand the impacts.

2. Literature Review and Problem Context

2.1 Employment in the Automotive Industry

The South African Masterplan (Barnes, Black, Comrie, & Hartogh, 2018) is very clear in its six objectives to be achieved by 2035, which include growing the S.A. vehicle production to 1% of the global output (to 1.5 million units) and doubling the total employment in the automotive value chain. An increase in employment is assumed to be supported by increasing the localised skills in the assembly segment to 60%, increasing the overall vehicle production, and improving competitiveness with international markets. The introduction of fuel efficient vehicles and new technology has been identified as a possible development challenge within the Masterplan but the quantification of the impact has not been determined. What has been established is that EVs are set to dominate the future of the automotive industry, but this is expected to be accompanied by a high potential for disruption in the long term (>10 years) as shown in Figure 1 (Breitschwerdt, Cornet, Kempf, Michor, & Schmidt, 2017).

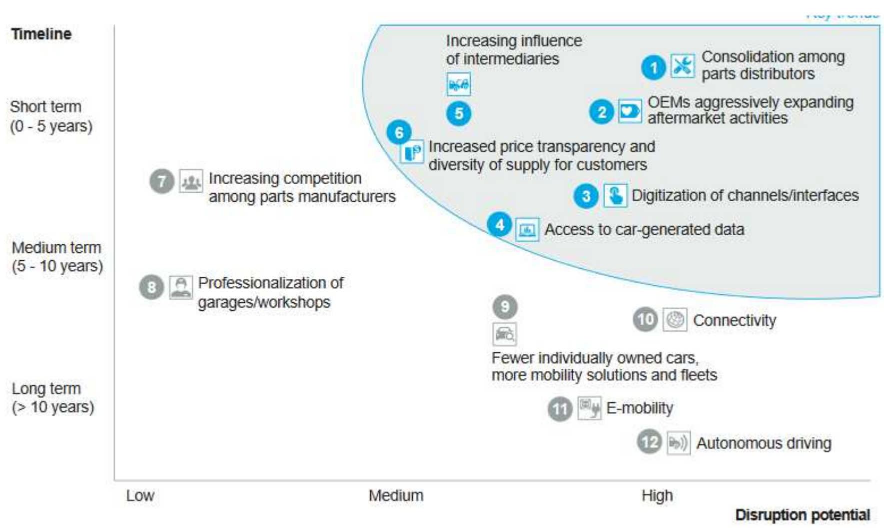


Figure 1: Possible Disruptors in the Automotive Industry

Source: Expert survey and interviews with 20 aftermarket experts; McKinsey (2017)

Although EVs have been recognised as presenting risks, questions still remain around the exact impact on automotive employment. Data by Econometrix (Jordaan, Dinham, Fieldgate, & Rolland, 2018) indicates that in South Africa, every one job opportunity in the auto manufacturing industry creates 8.4 jobs in the overall economy with a 6.9% contribution to

South Africa's GDP, which means that any risks to employment in the automotive industry will disrupt the overall economy.

According to a report by UBS Bank, mass electrification will mean around 17% fewer parts and components in the automotive industry, which in turn will affect employment, besides the impact on maintenance and repairs with fewer services expected with EVs (Briscoe, 2019). According to Bloomberg News, automakers are planning on 80,000 job cuts largely concentrated in the United Kingdom (UK), Germany and the United States of America (USA) (Rauwald, Welch, & Kotoky, 2019). Industriegewerkschaft (IG) Metall, the German union for autoworkers estimates 75,000 job cuts linked to building engines and transmissions by 2030 due to EVs (Isidore, 2019).

Deloitte (2019) indicates that despite the number of highly skilled workers in the automotive industry, the design and manufacture of EVs will require an investment in new skills and retraining of current skills to be able to work with components such as battery packs and the higher number of electrical parts. The observation is that versatile business models can accommodate the shift in skills and repurpose their production lines to adapt for EVs.

Some concerns are largely due to pure EVs as opposed to hybrids since hybrid cars combine electric drive hardware with a conventional, internal combustion engine, and require more labour with about 9.2 man hours compared with 6.2 hours for a typical gas vehicle (Eisenstein, 2019). If hybrid vehicles enter the market, chances of additional spare parts relative to the ICEV demand is greater, however, if there are pure battery EVs then the demand is affected negatively.

Optimism to stimulate employment even with EVs stems from battery production requirements of raw materials; battery end-of-life management including second-life applications of automotive batteries; and developing and servicing charging infrastructure. The National Renewable Energy Laboratory (NREL) suggests that the growth of electric vehicles may lead to an average net employment gain of over 100,000 jobs per year through 2040 and the Boston Consulting Group forecasts that self-driving and electric cars may create 100,000 jobs in the next decade (Cimate Nexus, 2019). Although various discussions around different segments of the automotive value chain have taken place, it was important to capture as much of the integrated impact as possible. This research focused on looking at the impact of EVs on the following segments of the automotive value chain (Figure 2) after using a system dynamics method to develop the Automotive Employment Simulator (AES).

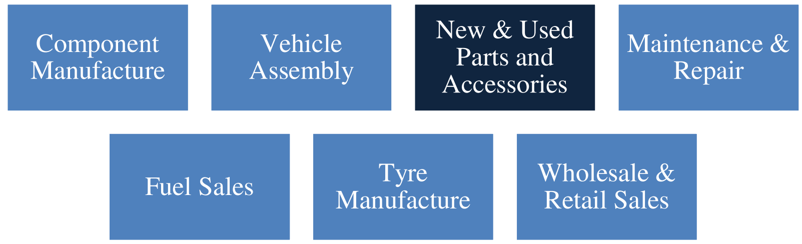


Figure 2: Segments in the Automotive Value Chain

This paper focuses on the results obtained from running scenarios using AES for the new and used parts and accessories segment. The parts and accessories segment includes brakes, gearboxes, axles, road wheels, suspension shock absorbers, radiators, silencers, exhaust pipes, catalysers, clutches, steering wheels, steering columns and steering boxes; as well as the manufacture of parts and accessories of bodies for motor vehicles: safety belts, airbags, doors, bumpers.

2.2 Employment in the Parts and Accessories Segment of the Automotive Industry

In S.A., from 2007 until 2016, there has been an increase in the sales of parts and accessories, likely as a result of the increase in the sales of used vehicles (5.8%), compared to new vehicles sales (3.5%) (StatsSA, 2018) (Figure 3). The European automotive industry also confirmed that consumers are less likely to buy new vehicles since vehicles have improved in terms of efficiency and reliability (Jetzinger, 2017).

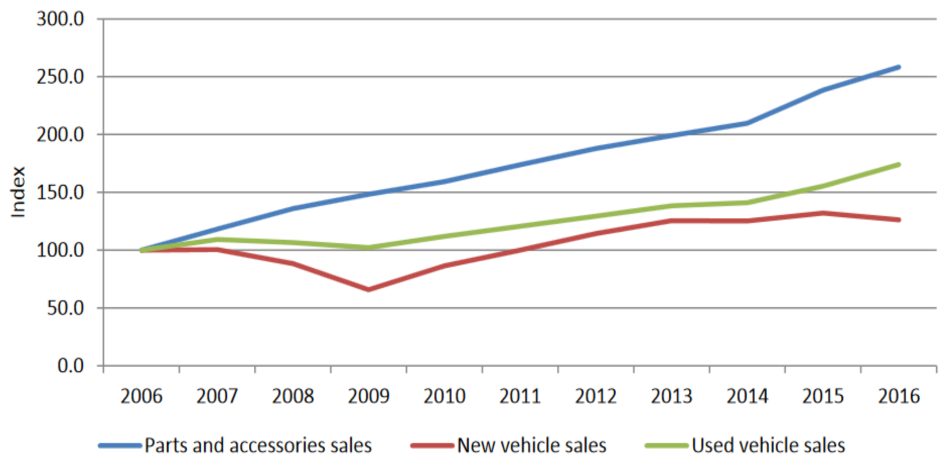


Figure 3: Motor Trade Sales
Source: StatsSA (StatsSA, 2018)

Based on the study which was conducted by Dombrowski & Engel (2014), it was found that the factors which influence the negative development of this segment due to EVs include: decreasing share of mechanical and moving parts, longer service intervals, immature battery technology, less additional units, and limited self-service possibility. If hybrid vehicles enter the market, chances of additional spare parts relative to the ICEV demand is greater, however, if there are pure battery EVs then the demand is affected negatively.

3. Methodology

A system dynamics (SD) modelling process was followed, which included system conceptualization, model formulation, and decision making, with elements of group model building, explained in the steps shown in Figure 4.

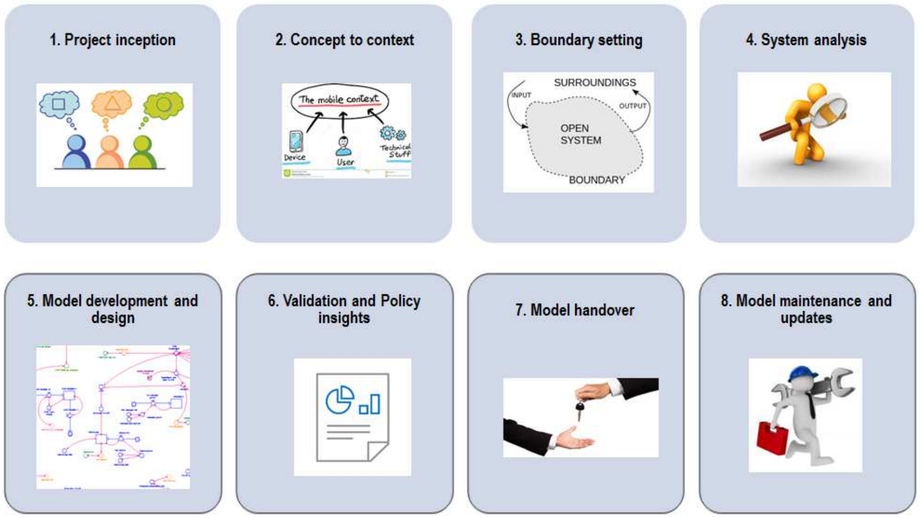


Figure 4: System Dynamics Method (Pillay, 2018)

Project inception involved establishing the focusing question linked to the system problem, and alignment with business strategic objectives. In this case it was determining the impact of EVs on employment in the parts and accessories segment of the automotive value chain. The members who formed the working group were part of the eMobility Program currently running over the next few years within Research, Testing and Development at Eskom State Owned Company (SOC).

In taking the concept towards contextualisation, it was important to determine the modelling time frame for the simulation which ran from 2008 until 2050 at a yearly resolution, with future projections using logistic curves and based on historical trends. The system boundary was set after discussions with the eMobility team and included the model boundary chart shown in Table 1. The table includes exogenous variables (those not affected by the state/ feedback loops of the model), endogenous variables (those dependent on the system state), and excluded variables (those not taken into account in the model for this study).

Table 1: Model Boundary Chart

EXOGENOUS VARIABLES	ENDOGENOUS VARIABLES	EXCLUDED VARIABLES
• Number of ICEVs • Number of hybrids • Driving forces such as self-service opportunities, length of the service intervals, and the share of mechanical and moving parts.	• Number of EVs in 2040 • Employment in used parts and accessories • Employment in used parts and accessories	• Battery costs and price parity • Customer behaviour • Financial trade-offs

Boundary setting also included the establishment of a causal loop diagram shown in Figure 5.

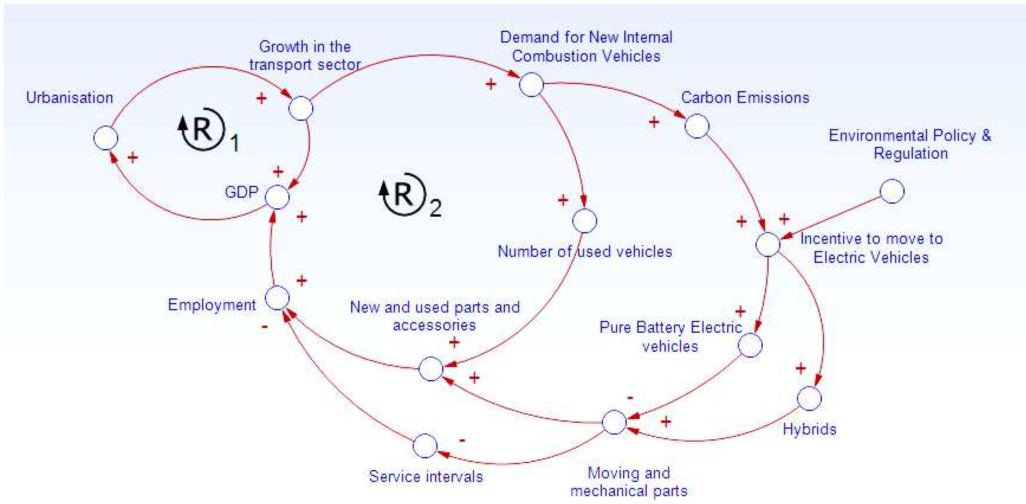


Figure 5: Causal Loop Diagram

Starting with Reinforcing Loop 1 (Figure 5), a growth in urbanisation is transformative on the environment and requires road and transport infrastructure. An increase in transport infrastructure supports the increase in new ICEVs to facilitate mobility. Linked to this ICEV increase would be a rise in environmental and carbon emissions. With the requirements of countries to conform to environmental policies and regulations to control greenhouse gas emissions, the transport sector has to consider new technologies such as pure EVs or hybrid vehicles. An increase in the substitution of ICEVs with pure EVs results in less mechanical and moving parts in vehicles and a reduced need for new and used parts and accessories, which results in a decrease in automotive employment. A reduction in employment in the transport sector negatively impacts GDP. Over time, there is a demand for used vehicles which require new and used parts and accessories and support the increase in employment related to this sector completing Reinforcing Loop 2. Whereas pure EVs have fewer moving parts and a decreased need for parts in general, an increase in hybrid vehicles will result in more mechanical parts besides electrical components when compared to pure EVs.

System analysis included preliminary computations after which modules and sub-modules were identified as part of the model development step that would enable the relevant state variables to be modelled and parameterized with the necessary mathematical linkages. Using iSee Stella Architect allowed for the development of engagement interfaces where various scenarios could be run to test relevant policies.

Model Assumptions and Scenario Definition

The simulator was used to generate scenarios shown in Table 2 based on the module linked to the employment in new and used parts and accessories. The Baseline assumed no EVs just the business as usual expected projection for ICEVs. Scenarios 1 and 2 included a market penetration of the following electrified vehicles by 2040:

a) Electrified Cars (eCars) – 319,200 (2.38% electric cars (Bloomberg New Energy Finance (BNEF's) forecast of 56 million passenger eCars globally by 2040, corrected by the GDP factor); ICEV Cars – 8,889,903.
b) Electrified Minibus Taxis (eMBTs) – 34,116; ICEV Minibus Taxis (MBTs) – 345,000.
c) Electrified Low Drive Vehicles (eLDVs) – 41,498; ICEV LDVs – 2,598,626.

Scenario 3 included a hybrid fraction of 34% of all electric cars which was based on the 2017 values in a study by McKinsey & Company (2018).
Obviously the results will change if the EV targets changed.

Table 2: Scenarios

Scenarios	Description
Baseline	No EVs or Hybrids
Scenario 1	EVs (only eCars, eLDVs & eMBTs)
Scenario 2	EVs with Factor Impact
Scenario 3	EVs with 34% Hybrids and Factor Impact

Model Structure

The iSee Stella Architect software was used to build the model structures, the model structure to calculate the employment in the parts and accessories segment is shown in Figure 6. The factors which were built into the new and used parts and accessories model structure included:

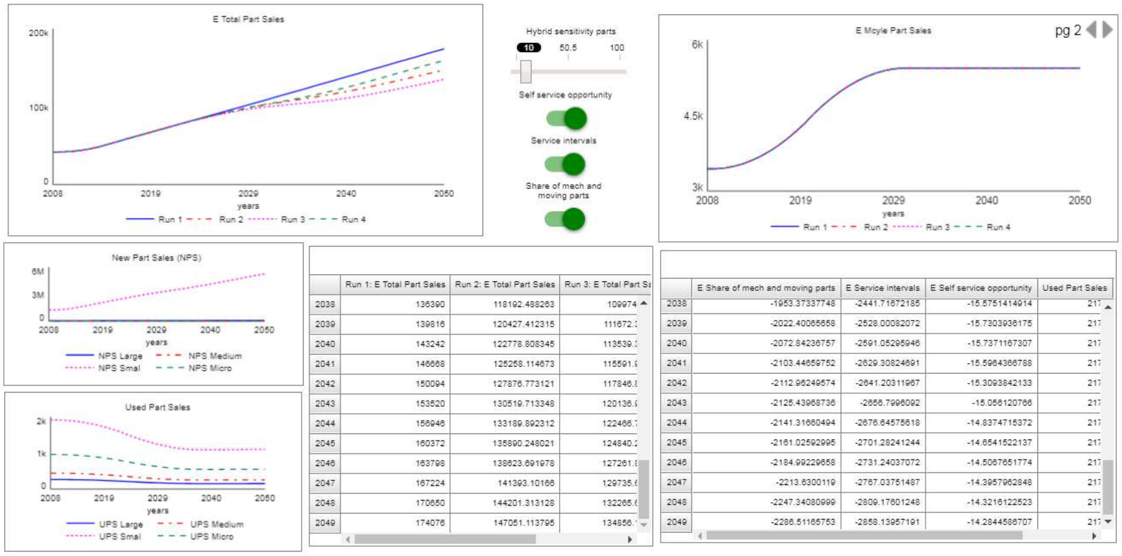
- Share of moving and mechanical parts (Fraction of 0.2): far fewer in an EV compared to an ICEV,
- Service intervals (Fraction of 0.25): longer periods compared to ICEVs,
- Self-service opportunities (Fraction of 0.1): less with EVs due to the increased electrical parts.

The fractions assigned to the driving forces will have to be calibrated once empirical statistical information becomes available. The default values were based on discussions and agreement using judgement and experience by the working group members. The model structure includes two separate stocks for New Part Sales and Used Part Sales. Equation 1 was used in the model structure, which determines that the Stock at time *t* is found from the Stock at a previous point in time, *(t–dt)*, by adding the net quantity accumulated as the result of the inflow and outflow during the period *dt*.

$$Stock\ (t) = Stock(t - dt) + (Inflow\ Rate - Outflow\ rate)\ x\ dt \qquad (1)$$

Stella Architect allowed for the development of engagement platforms or interfaces. Figure 7 shows the graphical user interface for employment in the parts and accessories segment. Tables were included on the interface to export the comparative results for the various scenarios.

Figure 6: Model Structure



	Run 1: E Total Part Sales	Run 2: E Total Part Sales	Run 3: E Total Part Sa
2038	136390	118192.488263	109974
2039	139816	120427.412315	111672.
2040	143242	122778.808345	113539.
2041	146668	125258.114673	115591.
2042	150094	127876.773121	117846.
2043	153520	130519.713348	120136.
2044	156946	133189.892312	122466.
2045	160372	135890.248021	124840.
2046	163798	138623.691978	127261.
2047	167224	141393.10166	129735.
2048	170650	144201.313128	132265.
2049	174076	147051.113795	134856.

	E Share of mech and moving parts	E Service intervals	E Self service opportunity	Used Part Sales
2038	-1953.37337748	-2441.71672185	-15.5751414914	217
2039	-2022.40065658	-2528.00082072	-15.7303936175	217
2040	-2072.84236757	-2591.05295946	-15.7371167307	217
2041	-2103.44659752	-2629.30824691	-15.5964366788	217
2042	-2112.96249574	-2641.20311967	-15.3093842133	217
2043	-2125.43968736	-2656.7996092	-15.056120766	217
2044	-2141.31660494	-2676.64575618	-14.8374715372	217
2045	-2161.02592995	-2701.28241244	-14.6541522137	217
2046	-2184.99229658	-2731.24037072	-14.5067651774	217
2047	-2213.6300119	-2767.03751487	-14.3957962848	217
2048	-2247.34080999	-2809.17601248	-14.3216122523	217
2049	-2286.51165753	-2858.13957191	-14.2844586707	217

Figure 7: Engagement Platform

4. Results and Discussion

Figure 8 shows the impact of EVs and various factors on employment in the new and used parts and accessories segment of the automotive value chain. Scenario runs indicate that in year 2040, ICEVs with no impact from EVs may have up to 143,242 employees.

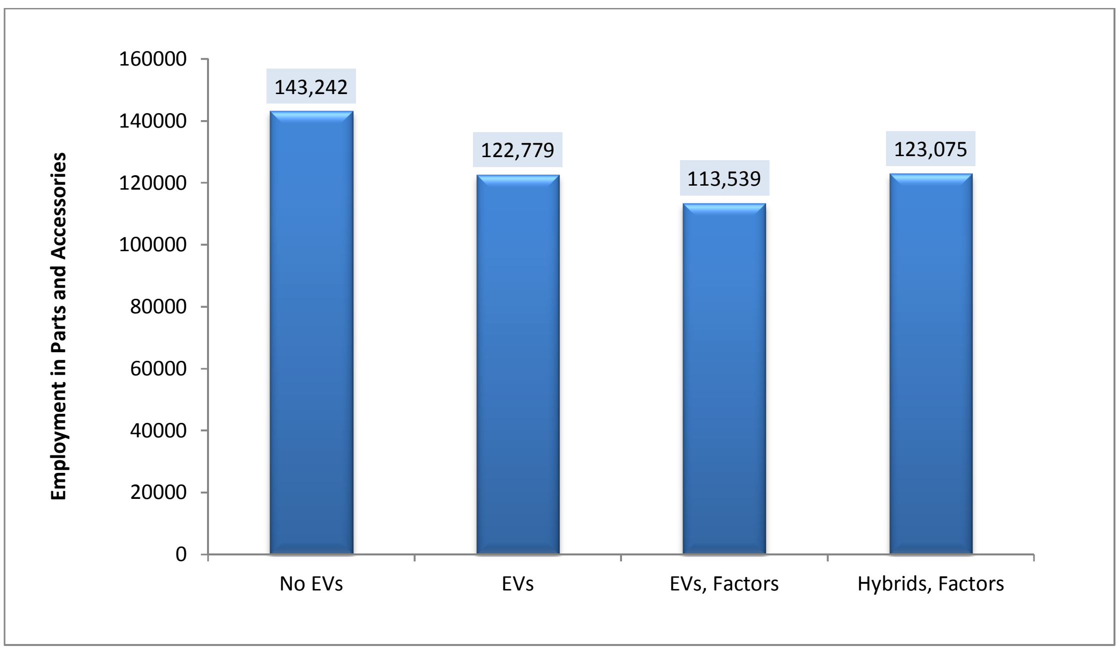


Figure 8: Employment in Parts and Accessories in 2040

The introduction of EVs results in a decrease to 122,779 employees. If due to EVs; self-service opportunities decrease, service intervals increase, and the share of mechanical and moving parts decreases, then the employment decreases further to 113,539. If hybrid cars are introduced, then employment still remains lower than the baseline with 123,075 employees; however, this is higher than any scenario with pure EVs.

Figure 9 shows the employment in new parts and accessories and Figure 10 shows the employment in used parts and accessories.

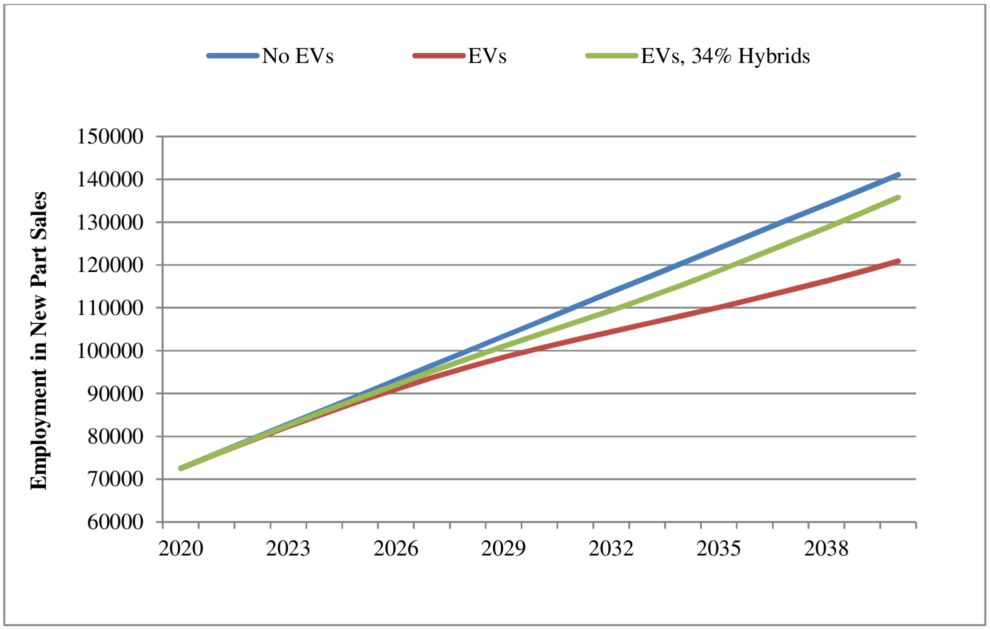


Figure 9: Employment in New Part Sales and Accessories

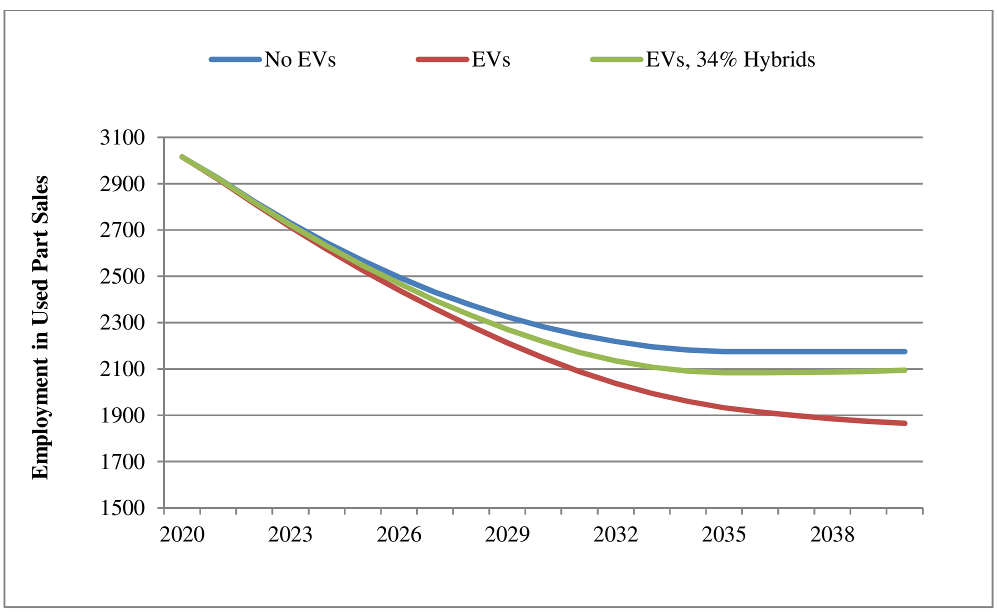


Figure 10: Employment in Used Part Sales and Accessories

Results indicate that the introduction of pure EVs could result in a 14% decrease in employment whereas 34% hybrids could result in a 4% decrease relative to the baseline of ICEVs only. In year 2040, employment in new part sales for ICEVs only was calculated to be 141,067 and dropped to 120,915 with EVs only and decreases to 135,807 with 34% hybrids cars. In the same year, employment in used part sales for ICEVs only was calculated to be 2,175 and dropped to 1,864 with EVs only and decreases to 2,094 with 34% hybrids cars.

Figure 11 shows the impact of various factors on employment in the new and used parts and accessories segment when EVs are introduced and when hybrids are introduced.

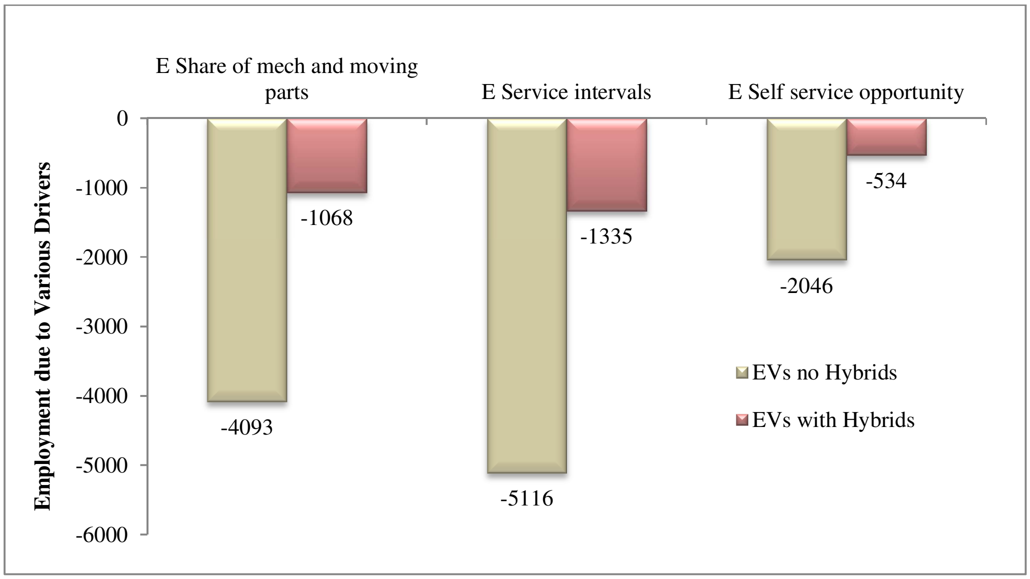


Figure 11: Employment in Parts and Accessories

All the factors will result in a decrease in employment with the most significant impact if service intervals had to increase. For all the factors, employment is more promising in the case of hybrids.

5. Conclusions

As far as employment in new and used parts and accessories is concerned, scenario runs indicate that in year 2040, ICEVs with no impact from EVs may have up to 143,242 employees. The introduction of EVs results in a decrease to 122,779 employees. If due to EVs; self-service opportunities decrease, service intervals increase, and the share of mechanical and moving parts decreases, then the employment further decreases to 113,539.

If hybrid cars are introduced, then employment still remains lower than the baseline with 123,075 employees; however, this is higher than any scenario with pure EVs. Results indicate that the introduction of pure EVs could result in a 14% decrease in employment whereas 34% hybrids could result in a 4% decrease relative to the baseline of ICEVs only. In year 2040, employment in new part sales for ICEVs only was calculated to be 141,067 and dropped to 120,915 with EVs only and decreases to 135,807 with 34% hybrids cars. In the same year, employment in used part sales for ICEVs only was calculated to be 2,175 and dropped to 1,864 with EVs only and decreases to 2,094 with 34% hybrids cars.

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