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End-of-Life Vehicles Initiatives in the Middle East

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Abstract: Many of the governments in the Middle East have overlooked recycling end-of-life vehicles (ELV) for far too long. This is probably because ELV activities are not in line with the governments' strategic short-term objectives. This research evaluates Gulf Cooperation Council (GCC) countries and selected countries in the Middle East such as Egypt and Iran's standard operating procedures (SOP) for disposing of the cars and method in keeping unroadworthy-cars off the road. The elements studied here regarding ELV are relevant acts, emission control initiatives, and the disassembly of car procedure. The methods used here are desktop benchmarking and analysis of statistics regarding registered and deregistered cars which include surveys to users and relevant government officials. It is found that generally the governments in the Middle East are lacking in implementing clear directions to ensure sustainable and environmentally friendly ELV as compared with East Asian nations such as Japan, Taiwan and Malaysia. Among the Middle Eastern countries, Qatar provides much more clear directions regarding their ELV methods. The outcome here sheds some light on the entire procedures taken via these nations in managing ELV initiatives and public awareness. This study will benefit the nations as the governments can implement ELV initiatives, as in Europe and East Asian countries.

Keywords: End of Life Vehicle (ELV), Gulf Cooperation Council (GCC), material extraction rates, circular economy

1. Introduction

A wide range of controls on the manufacture and disposition of materials related to vehicles have been initiated by the government around the world to address the increasing environmental concerns. Vehicles are one of the essential products where their use and disposal processes cause considerable ecological effects. Yet, by implementing a good disposal plan which can include extracting and recycling some good components, significant environmental and

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economic benefits can be expected. Ferrous materials, a good recycling candidate, are the main component of a vehicle and represent 71 % of the weight of an automotive. Plastics, non-ferrous metals, rubber, crystal glass, and fluids are also the primary materials in the car ranging around 8, 7, 5, 3, and 2 % correspondingly [1]. An appraisal of the growing partnership [2] added that a rapidly rising global trend in recycling ELV is a substantial growth demand opportunity in the Gulf Cooperation Council (GCC) countries.

Vehicle manufacturing has generally improved over the decades, the power and energy efficiency has improved along with it. In the European Union (EU), a report shows that older cars are failing in the CO_2 emission tests. A recent study shows that vehicle manufacturing and its disposal produce 4 and 1 tonne CO_2 respectively and data from the report stated that most vehicles will need to be replaced right after 22 years of age [3].

Nomenclature and abbreviation
CAGR Compound annual growth rate
CSB Central Statistical Bureau (Kuwait)
ELV End of life vehicle
EPR Extended producer responsibility
EU European Union
GCC Gulf Cooperation Council
GDP Gross domestic product
HC hydro-carbon
HDV Heavy duty vehicle
IDRO Industrial Development & Renovation Organization of Iran (Iran)
LDV Light duty vehicle
LEZ Low emission zone
MENA Middle East/North Africa
NIDC National Industrial Development Center (Saudi Arabia)
OEM Original Equipment Manufacturer
PSA Planning & Statistics Authority (Qatar)
QARP Qatar Automobile Reprocessing Plant (Qatar)
SOP Standard operating procedures
STATS General Authority for Statistics (Saudi Arabia)
SWOT Strengths, weaknesses, opportunities, and threats

Egypt is probably one of the model vehicle manufacturing hubs in the Middle East. The production of vehicles continued to increase and in 2007 hit 101,319, up 118 % from 2003. More than 360 vehicle production companies are manufacturing automotive components. Egyptian Automotive Manufacturers Association (EAMA) figures indicate that overall demand for vehicles in Egypt rose from 70,834 units in 2003 to more than 227,488 units in 2007, up from 70,834 in 2003. In 5 years, there is an increase of more than 200%. The car industry recently expanded due to the variety of financing schemes provided by car distributors and banks [4]. Soon, African most populous country will have to deal with old cars as there are no clear procedures for scrapping these cars. Qatar, on the other hand, flushed with oil & gas-related revenues and expanding car purchases to support economic expansion by expatriates, adds 12,000 cars/year since 2012 to the small state. It is projected to have 2.5 million registered cars by 2030. The small state established the Qatar Automobile Reprocessing Plant (QARP) to overcome the piling up of retiring vehicles. The model in QARP promotes a circular economy model where reused parts are remanufactured and sold. Although there are many issues yet to be addressed, the QARP model is seen as a very sustainable ELV in the Middle East [5].

In comparison with China, the world's most populous nation which produced a quarter of the world's vehicles in 2015 (24.5 million) [6], ELV initiatives in the Middle East are still in their infancy. For example, material recoveries in 2018 are 656.9 kg/vehicle of iron, 150.2 kg/vehicle of aluminum and 7.9 kg/vehicle of copper are recovered from end-of-life passenger cars in China, thanks to the high demands due to the rapidly growing economy [7]. These recoveries rates are matured and they are not going to increase anymore. In the Middle East, there are not too many demands for materials directly available from ELV dismantling facilities such as scrap irons. In the world second most populous nation, India, the material extraction and the recycling rates are much below the standard i.e. only 7 % of aluminum and 76% of iron could be recovered from ELVs [8]. The recycling industries are not well-equipped with advanced technologies that enable them to recover and recycle certain economically valuable and rare materials made worse by the informal economy [9].

2. Methodology

Rapid economic developments in the Middle East have made the automotive industry grow and become one of the most important sectors. However, as in many other countries, as the purchase and use of vehicles increase, so are issues with regards to vehicle disposal. At present, in many parts of the Middle East, ELV disposal processing is manual, labour-intensive, and time-consuming. Moreover, this procedure is not energy-efficient on a large production line scale.

Therefore, establishing a correct procedure by developing an efficient producer or engaging third party scrapping plants to disassemble the ELV is vital to achieving a sustainable manufacturing industry in the Middle East. Dismantling of the ELV has attracted some of the policymakers as higher productivity of recyclable materials means more business opportunities and at the same time, it can be the government's efforts in reducing carbon footprint. The flow chart in the figure below shows the research activities involved in identifying the likely cause of ELV in the Middle East. To reduce the amount of waste generated by ELV by encouraging and initiating the collection, reuse, and recycling of their components, to achieve a sustainable climate.

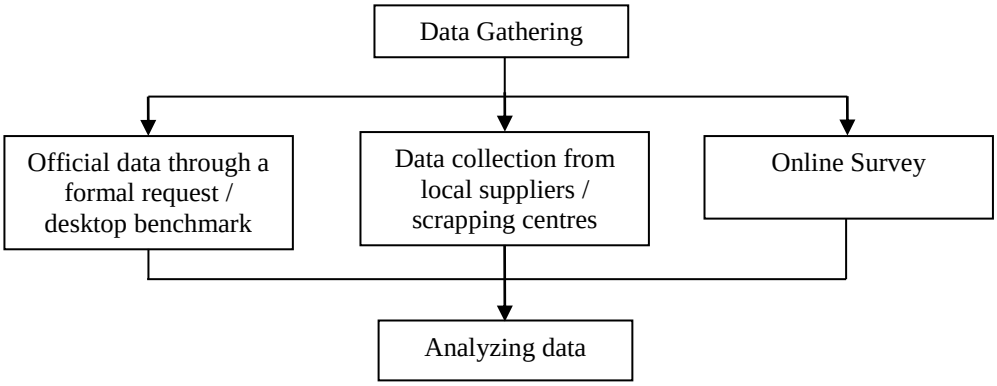

Fig. 1 - Methodological approach

This article includes the methodological procedure developed using the literature findings regarding ELV as shown in Figure 1. Many previous studies adopted case-study approaches in a particular country. This type of study usually addressed current problems i.e. increasing landfill requirements and decreasing landfill areas, social problems arising from abandoned vehicles by the streets or parks and the use of unroadworthy/unregistered vehicles. A lot of important information is not readily available in the literature, therefore official request via letters and email has to be sent to government agencies. There are no official dismantling facilities in this region, therefore there is no official data from this category. However, this study does outline the legislation recommendations for efficient ELV processing in the Middle East. Due to the Covid-19 pandemic, data collection was carried out through an online survey. Respondents from six Middle East countries to the online survey. To ascertain the validity of responses from the online survey, all respondents are required to indicate their country of origin. Data collection methods are divided into three categories which are formal request/ desktop benchmark, data collection from suppliers /dismantlers and finally from online surveys. Data analysis is performed only after the completion of collection.

3. Results

3.1 ELV Management in Kuwait

The ELV processing has not been given a lot of consideration in Kuwait in the past; however, it gets critical as Kuwaitis purchase new cars and have to give up by selling or by disposing of the older ones. Kuwait may seem to start with decades-old legislation policies from the EU, with examples from Finland, Germany, and other European Union (EU) countries. Since the EU has identified the ELV is a priority with many countries establishing their laws, the Kuwaiti government has initiated some efforts to emulate some of the procedures from the EU countries. It is heading towards the best practice of establishing the ELV processing legislation based on the number of registered cars and geographical location. The EU Commission recognised ELV as necessary for ELV Waste Management during the 1989 EU meeting. In 1997, the "Proposal for a Council Directive on End-of-life Vehicles" (COM 97-358) law passed, and in 2000 the European Parliament accepted this suggestion 2000/53/EC, demanding the contentment of this Instruction by 2002 by all EU countries [10].

In comparison with the EU, the EU-15 has 242 million light trucks and cars in 2019. The EU market of automobiles in 2016 was 229 million [11]. This clearly shows the acceleration in the automobile market in the EU. The disposal procedure from this vast vehicle market has been studied and some have been addressed in Kuwait. The unprecedented growth of registered vehicles in Kuwait has been observed especially due to economic development post-war. It was also observed that unlisted vehicles and missing registration number cases have increased due to illegal exports from foreign countries. No road tax is required in this tiny kingdom. Insurance and technical inspection are compulsory before the renewal of a vehicle's certificate. The charge for a technical inspection is about USD6 and another USD15 for a stamp or a certificate [12].

There is an option for a 'first party' or full-pledged insurance coverage or the 'third party'. The 'first party' plan covers also damages to the owner's vehicle if the latter caused the accident, and in contrast, a 'third party' plan covers

only damages to the others (vehicles, people, premises, etc). The insurance fees depend also on the company / insuring organisation [12]. For a 2016 2753 cc Toyota Prado, the insurance fees are USD60/year for 'third party' coverage.

3.2 ELV Management in Qatar

The Qatar ELV organization scheme includes special significance to the present product concerned with the legislation of Qatar. The Qatar automotive industry started to address the ELV-related issues in early 2018 in the study by Al-Quradaghi et al. [5]. In arrears to the high significance of Qatar automotive manufacturing in GCC, the extensive section of the refusals in the ELV processing can come to Qatar. However, the government directive implications can present a massive influence in the encouragement of ELV processing. Moreover, the study highlighted the high rate of increase in the number of registered cars in Qatar as the registered car number is expected to grow up to 35,000 in 2030 from 14,000 in 2012. Insurance and technical inspection are the main conditions to renew a certificate of a vehicle. The insurance price and technical inspection and fees of yearly registration are about USD175 [13]. In her latest optimisation model simulation, Al-Quradaghi et al. (2022), emissions and car dismantling volume were simulated. Based on the mixed-integer programming model (MILP) model, as the volume of ELVs sent to dismantler grows, profit increases. Although doubtful parameters such as steel companies, glass companies, tyre-recycling companies – too ambitious for a nation with a small population, were considered in the model, friendly municipal policies can positively support such sustainable ELV dismantling processes. Other than the QARP system, the Qatari Ministry of Municipality and Environment holds auctions for reusable vehicles, this makes it easy for ELV initiatives. The ministry also has its own special garages for confiscated cars for a certain cooling-off period [14]. This is important for notices for ELV legally served.

3.3 ELV Management in Egypt

To encourage improved air quality in Cairo, the Cairo Ministry of the State for the Environment has initiated a project to replace 100 old taxis, circulating in Cairo over 35 years old, with new natural gas vehicles. The scheme proved successful and, between 1965 and 1979, a total of 1000 taxis were replaced in 2008. In addition, to provide financial benefits for taxi owners to upgrade their old cars, the Ministry for the Environment and Finance worked together. The rebate was 10,000 pounds per automobile [1].

The present ELV organizations in Egypt and Bahrain do not seem like there are any directions with regards to the scrap collections and recycling ferrous and nonferrous materials. The current attempt to control the ELV-related industry. In the last few decades, well-developed countries have developed regulations to manage and process the ELV and increase recycling. The right program will establish the proper guideline for common ELV processing business practice and environmental and safety.

A SWOT analysis of ELV recycling in Egypt can be found in [15]. Two weaknesses of establishing the system in Egypt are 1) the absence of vehicle deregistration, therefore, more than 25% of the circulating vehicles are over 30 years old and 2) the lack of the infrastructure required for ELV recycling. Owners of small workshops and scrap yards practice improper dismantling and recycling of ELV parts, resulting in environmental pollution due to leakages of oil and other harmful substances into the rivers and soil.

One attempt to establish an ELV system cars was the Egypt Vehicle Scrapping and Recycling Program [1]. The project was supported by World Bank and extended between 2010 and 2021. The project involved a mechanism through which owners of public transportation road vehicles may voluntarily surrender their vehicles for managed scrapping and recycling, in exchange for financial incentives that may be used towards the purchase of new vehicles from participating vehicle dealers, under a closely monitored process. A total of 49,000 taxis were scrapped throughout the project. However, scrapped vehicles were only set aside for storage.

3.4 ELV Management in UAE

The biggest issues regarding road and transport matters in the United Arab Emirates (UAE) are the increasing number of accidents and related damages and fatalities as well as the difficulties to regulate vehicle inspection across the emirates [17]. Seven emirates form UAE, they are Abu Dhabi, Dubai, Sharjah, Ajman, Um-Al-Qween, Fujairah, and Ras Al-Khima. In 2009, the country experienced 3 fatalities and more than 75 injuries in a day causing an annual economic loss of USD6 billion representing 2.5% of the UAE's GDP. Economic activities and rapidly increasing car ownership are likely to worsen the situation. According to Selim et al., vehicles are checked annually in one particular emirate where the vehicle has been registered [17]. Based on the data compiled by Selim et al., 5–9% of traffic accidents were caused by mechanical defects with the state of tires, brakes, and lights often being the problem.

The designated inspection centers are mostly operated by private entities under the authority of the police traffic departments in each emirate. The problem lies in the inspection method and records where there is little information being shared and the consistency of applying the federally deployed vehicle inspection regulations. There are 54 inspection centers across the emirates. Vehicles are categorised into two types the light duty and heavy duty vehicles (LDV and HDV), some centers provide inspections for both and some only offer inspections on either one. Selim et al.

conducted a survey involving vehicle owners, inspectors and experts and port owners to appreciate the inspection inconsistencies. The major things found are the significant difference in inspection time and costs.

Since fatalities and damages are major things, the data surveyed by Selim et al. is reproduced here in Table 1. Table 1 shows that exhaust emissions as well and the conditions of the brakes are the most common cause of vehicle failure. This is followed by chassis deficiency or frames. The least important items resulting in failures were painting, spotlight malfocusing or vehicle modifications. The authors realised the link between the causes of failure and the inspection equipment used at centers. Most centers (82%), for example, have exotic equipment to address these common failures i.e.a brake testing system exhaust gas analyzers (71%). Insurance and technical inspection are the main condition in UAE to renew a certificate of vehicles. The insurance price and technical inspection and fees of yearly registration sum up to around $250 [18]. It is worth mentioning that UAE has also emerged as the centre of distribution of use cars and vehicle parts in the Middle East and Northern African (MENA) region. Used cars are subjected to record tremendous growth in coming years due to export opportunities which contribute in generating revenue. According to Ken Research, UAE used car market is expected to reach AED 112 bln in revenue by 2025 [19].

Table 1 - Typical Outcome from Technical Inspection of a Vehicle. (Selim et al. 2011) [13]

Value	Percentage
Painting	20
Rust	7
Spotlight	13
Brakes	67
Chassis	47
Frames	47
Gases and Smoke	67
Modified Vehicle	7
General Safety	40

3.5 ELV Management in Saudi Arabia

According to the latest census in 2020 by Saudi Arabia's General Authority of Statistics, the population of Saudi Arabia is slightly over 35 million [20]. About 83% population live in cities. 7 major cities occupied by 50% of the total population – Riyadh, Jeddah, Makkah, Madinah, Buraydah, Dammam and Huffuf-Mubarraz. The population growth rate in recent years is reported to be around 1.6% annually [21]. There are more than 16 million vehicles on the road making the ratio of 336 vehicles / 1000 people. The average age of cars in Saudi Arabia is around 11 years [22]. Saudi Arabia is the leading vehicle market in the Middle East/North Africa (MENA) which shows annual growth of 36%. Saudi Arabia accounted for almost 52% of the vehicles sold in the GCC countries and 35% in the MENA region in 2020. Total annual vehicles sold in Saudi Arabia in the recent year are around 450,000 and is expected to reach nearly 550,000 units by 2025. According to the Kingdom's vision 2030, Saudi Arabia aims to attract up to four OEMs (Original Equipment Manufacturers) across the road transport value chain. This will enable the production of 300,000 vehicles annually with a 40% local content by 2030. The initiative is authorised by the National Industrial Development Center (NIDC), which will provide incentives to enable industrialization through loans, tax incentives and tariff exemptions [23] With a high local content goal, this can spark the interest for more vehicle recycling activities in the kingdom.

Vehicle registration as well as vehicle scrapping in Saudi Arabia is under the jurisdiction of the General Department of Traffic under the Ministry of Interior. The procedures are available online [https://www.moi.gov.sa/]. Even though new and annual vehicle registration renewal subjects to annual inspection and fees, there is no cost incurred to vehicle owner in the scrapping procedures. In most major cities, several vehicle recycling business establishments can be found.

3.6 ELV Management in Iran

Third-party vehicle insurance is mandatory in Iran. It is essentially a form of liability insurance according to which, in the case of an accident, the insurer is required to compensate the inflicted party for the physical or financial loss according to the reimbursement ceiling set by the High Council of Insurance, affiliated to the Central Insurance company of Iran [24]. Yearly technical inspection is compulsory in Tehran in 2016 after a series of public complaints regarding emission. Tehran is home to 12 million people and 4 million cars. Twenty officially registered vehicle inspection centers are active across Tehran. Only half a million cars have technical inspection certificates in 2017, therefore the Tehran Vehicle Technical Inspection Bureau launched mobile units to ease congestions [25]. In the advanced phase of emission control, the low emission zone (LEZ) scheme went into effect in November 2018. Some 25

% of vehicles that referred to technical inspection centers in Tehran to receive inspection stickers have failed the tests due to producing a high level of emission in a 2019 progress report [26]. These statistics suggest aging cars in Tehran.

4. Technical Inspection for Vehicles between Kuwait & Gulf Countries

Technical vehicle inspection centers are spread through various places in Kuwait. Consider a case study performed in Kuwait by Alkheder et al. (2020) regarding vehicle inspections [27]. All vehicles should pass vehicle inspection every two for cars less than six years, older than this, all vehicles should undergo annual vehicle inspection. This study provides insight into the trend of data collected from the test centres. All data were collected from the test centres in the six governorates. Out of 196 vehicles were tested, only 152 cars were recorded for CO emission violations and 157 vehicles for hydrocarbon (HC) emission violations. European standards were used as the basis for emission violations. In addition, independent variables are included with the place of vehicle manufacturers, such as vehicle age and odometer reading. A multinomial logit algorithm was employed to identify the important predictors and determine the correlation between the dependent and independent variables. An artificial neural network (ANN) was used and to estimate the multinomial logic algorithm. These results ranked the vehicle manufacturer and vehicle age, odometer readings and the significant information related to standard CO_2 emission violations.

Vehicles made in Asian countries were called Asian vehicles. Asian vehicles which recorded more than 150,000 km, are categorised as 15-year-old vehicle and has a higher probability of failing the CO_2 test compared to initial conditions when the car was first released from the factory. In contrast, the odometer reading was the significant indicator for vehicles that had failed the HC test, specifically with the 150,000 km-cars [27]. Figure 1 shows the ownership of vehicles per 1000 people in selected Middle East countries. It can be seen from this figure that Egypt, Iraq, and Iran trail their counterparts, and have they have less than 200 cars per 1000 people. In contrast, in the rich emirates among GCC countries such as Kuwait, Qatar, and Bahrain, car ownership is generally more than double as compared to Egypt, Iraq, and Iran. Car ownership in Kuwait, Qatar, and Bahrain are more than 500 cars per 1000 people. Obviously, with more vehicles, there is more economic activity in the latter, which is an indication of the viable implementation of the ELV legislation.

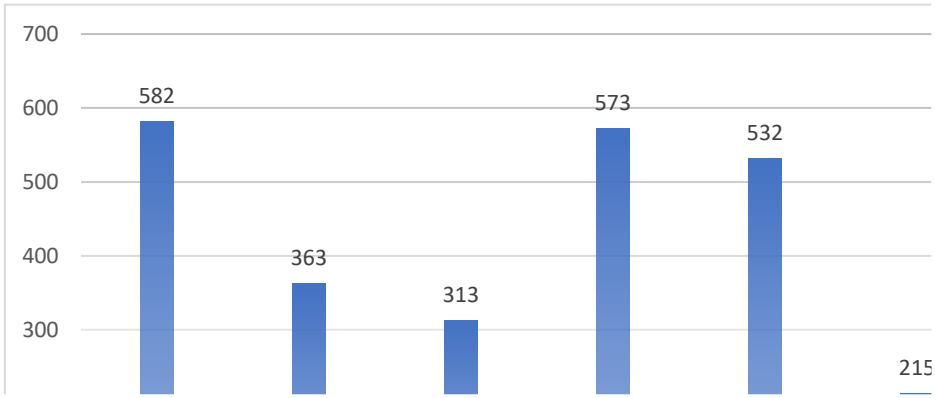

Fig. 2 - List of countries by vehicles per 1000 people - Wikipedia, 2022 [28]

4.1 Scrap Vehicles in Kuwait

According to Colonel Nawaf Alhayyan, the Head of the Awareness and Information Department at the General Traffic Department, Kuwait, via private official communication [29], 42,011 vehicles were scrapped in 2017. The data for 2017-2020 is shown in Table 2. The vehicles categorised as scrapped are for many reasons for example technical issues, accidents and not passing the periodic technical inspections. The number of registered vehicles in the kingdom is 2,213,777 in 2017, therefore 1.90% of the vehicles were scrapped this year (2017). This reflects quite a small percentage of total vehicles being scrapped. In contrast, the percentage of scrapped vehicles from new vehicle sales is 41.5% in 2017 and stays about the same until 2020 except for 2019 (23.5%). With quite a high percentage of cars being scrapped, there is a clear need for legislation to process ELVs. Table 3 shows vehicles registration in other countries neighbouring Kuwait in recent years (2018-2020). Data have been collected from most countries i.e. Saudi Arabia, Kuwait, UAE, Qatar, Oman, Bahrain, Iraq, Egypt, and Iran's from different sources i.e. news agencies, magazines, official government press releases and statistics. Data in certain countries in a few particular years are not available. Vehicle sales growth in 2019 were positive in Kuwait (9.1% - Table 2), Saudi Arabia (29%) and Iraq (47.5%). In the same year, vehicle sale growth were negative in UAE (-2.1%), Qatar (-0.35), Egypt (-5.56%) and Iran (-25%). Vehicle sales growth in 2020 were positive in Saudi Arabia (15.8%), Egypt (28.8%) and Iran (7%). In the same year, it is negative in Bahrain (-18.0%) and Iraq (-17.5%). It is not clear if Covid-19 pandemic started is 2020 affected sales because the growth trend in 2019 and 2020 are mixed. GCC passenger car market is projected to register positive

growth at a compound annual growth rate (CAGR) of 8.73% by 2026. By 2026 also Iran is projected to have a passenger car sale growth of 9.57%. Generally, the entire Middle East region is projected to register strong positive sales growth in the next four years. Therefore, ELV management must be planned properly and shall start immediately too as some of these countries like Saudi Arabia and Egypt have registered vehicles beyond 10 million.

Table 2 - Scrapped vehicles in Kuwait, 2017: 2020

Year	Scrapped vehicles [29-30]	Sales of new vehicles [31]	Registered vehicles [32]	% of Scrapped vehicles	% of scrapped vehicles from new sales	Sale growth (%)
2017	42,011	101253	2,213,777	1.90	41.5	
2018	43,891	103,235	2,203,723	1.99	42.5	2.0
2019	26,471	112,663	2,368,680	1.12	23.5	9.1
2020	36,595	85,287	-	-	42.9	-24.3

Table 3 - Automotive market growth, registered, annual sales, and expected for next years

County	Year	Sales of new vehicles [41-51]	Registered vehicles [33-40]	% of cars sales growth rate [41-51]	CAGR [52-66] Figures in USD
Saudi Arabia	2019	542,538	15,050,251	29%	
Saudi Arabia	2020	387,709	-	15.8%	GCC passenger car market is projected to grow at a CAGR of 8.73%, to reach $46.13 billion dollars by 2026
UAE	2018	240,000	3,400,000	-9.9%	
UAE	2019	235,000	-	-2.08	
Qatar	2018	47,700	1,587,815	-7.49%	
Qatar	2019	47,550	1,655,700	-0.31%	
Oman	2021	74,381	1,539,994	0.5%	
Bahrain	2020	24,760	731,060	-18.01%	
Iraq	2019	76,700	6,888,201	47.50%	Iraq vehicles sales are expected to reach $1.439 billions of by 2026 CAGR of about 4.73%
Iraq	2020	63,250	7,026,106	-17.54%	
Egypt	2019	170,000	11,500,000	-5.56%	- Egypt vehicles sales are expected to reach $39.87 billion by 2026 of 5.55% -
Eygpt	2020	219,000	10,800,000	28.82%	
Iran	2019	-		-25%	Iran vehicles sales are expected to reach $45.56 billion-dollar by 2026 CAGR of about 9.57% -
Iran	2020	59,937	21,780,000	7%	

4.2 Gross Domestic Product (GDP)

Gross domestic product (GDP) per capita is the standard measure of the value-added created through the production of goods and services in a certain period, usually annually. GDP per capita provides generally could indicate the economic wellbeing of all people in the country and this includes extra money that could be spent on purchasing new cars or small contributions to dispose of old cars properly. GDP per capita is the USD is shown in Table 4. This region is particularly interesting because of the obvious big gap between the poor and the rich. An Egyptian produces the least with USD3,234/year per capita in 2013-2017. After the Egyptian Revolution in 1952, the government realised that industrialization had to replace the agricultural-based economy to lift the socio-economy of its people. The automotive industry was viewed to have a great potential to enhance development as it included many supporting industries and provided a big number of employment opportunities [4]. In 2010, the automotive industry headed in the right direction; there were 83 car manufacturers in Egypt which included giants like GM, BMW, Hyundai, Toyota and Nissan. In 2010. The vehicle production increased to 116,683 [67]. The Egyptian Revolution of 2011, also known as the *January 25 Revolution* which deposed then-president Hosni Mubarak, caused significant harm to the industry. The main car manufacturers above either shifted or scaled down their operations. A decade after the revolution, the

automotive industry is back and now with a different scenario. A boom in Egypt's automotive parts industry is being fuelled by a burgeoning population, vehicle sales growth, and government moves to combat auto emissions. Egypt is also taking steps to replace internal combustion engines with more environmentally friendly alternatives. In 2020, the government announced an initiative to encourage consumers to replace old vehicles with new ones operating on CNG engines. Egyptians purchase of new cars has recently surged to more than 200,000 units per year, with around half of this figure assembled locally [67]. Iraq is the second from bottom and should not be a surprise because the nation has not fully recovered from the post-Iran-Iraq war, the Arab Spring and the current political uncertainties. In 2015, the country had 3.9 million registered cars [68], this is a relatively small market.

Due to a prolonged economic embargo, the Iranian government has taken initiatives to develop its sustainable supply-chains in the major industries i.e. oil, gas and automotive industries. The automotive industry is the third most active industry accounting for 4% of Iran's GDP and 4% of the direct and indirect workforce (900,000 people) [69]. Iran's auto industry has a potential production capacity of around two million vehicles, making it the biggest auto industry in the Middle East. Iran ranks 16th world's biggest automaker and one of the largest in Asia in 2006 with annual production above 1 million units and 1.3 million in 2009, resulting in almost 1.5 % of total world production of vehicles. In 2008, the Industrial Development & Renovation Organization of Iran (IDRO) reported that Saipa accounts for 54 % and Iran Khodro for 46 % of the output. The biggest issues with the industry are quality and state dependency. The rest of the GCC countries have GDP per capita between USD15,000 – 60,000 - 2016-2020 average. Generally, GDP per capita or the economic status of a country is the major indicator to be considered as a developed economy alongside other parameters such as security, economic growth level of industrialization, the standard of living, and technological infrastructure. GDP per capita of USD20,000 is generally accepted for the economic scenario consideration. This data reflects that many households possess the availability or economic willingness to pay extra duty with regards to contributions toward ELV fees.

Table 4 - Average GDP per USD between GCC & Egypt 2016 : 2020 [69-78]

Country	GDP per capita (USD)
Kuwait	30,796
Saudi Arabia	21,454
Qatar	59,018
United Arab Emirates	23,426
Oman	36,222
Egypt	15,420
Bahrain	3,014
Iran	3,954
Iraq	4,993

5. Survey

An online survey was conducted among the targeted Middle Eastern individuals at the end of 2021. The targeted respondents are the public who own or used to own vehicles. Questions were in Arabic. Only a few demographic-type questions were asked i.e. country of origin and income. 121 responses were collected and the distribution of the country of origin of the respondents is shown in Figure 3. The majority of respondents are from Kuwait (30%), this is followed by Saudi Arabia (16 %), Qatar (15 %), UAE (15 %), Bahrain (11 %), and Oman (13 %). However, there is no respondent from Iraq, Iran and Egypt.

Respondents indicated their annual income bands: below $35,000 (13 %), $35,000 - $50,000 (27 %), - $50,000 - $75,000 (16%) and above $75,000 (44 %). Qatari respondents reported more high-income individuals compared to the rest of GCC countries. Overall, this information suggests that GCC countries have strong socio-economic standings which can benefit ELV implications. Further implementation of ELV acts that involve monetary contributions from workers will not hurt households and could be economically viable.

Respondents indicated that they do have ELV laws in their respective countries (21 %) followed by those who do not (79 %). Figure 4 indicates that 79 % of respondents agree that there is no proper legislation for the regulations of ELVs. There might be existing laws that support the regulation of ELV but these laws are embedded in categories that are separated from vehicles and roads, causing respondents not to realize them. However, the significantly large number of respondents voting that their respective countries do not have such laws shall be addressed constructively by the relevant ministries in these countries.

Respondents indicated that the government must prepare a policy and eventually enforce laws (60 %) followed by those who disagree (40 %) as shown in figure 5. The feelings among the people regarding the need for such a policy are welcome. The perspectives regarding ELV laws among Middle Eastern people are the same as those in Malaysia where people are in support of such laws [79]. The next question asked: 'Are ELV laws good for your countries?'in figure 6, the answer is inconclusive as 35 % votes *Yes*, 15 % voted *No* and 49 % chose neither agree nor disagree – *Maybe*. The governments in these countries must provide some information on the needs of sustainable automotive sectors which start from the design, production and disposal. Respondents indicated that the way to make the people accept this law ELV is to work to educate people (41 %) followed by those who think that such an initiative should be an alternative (59 %) as in figure 7. Finally, as a conclusion of this survey question, the respondents from various countries have shown that more than half of the respondents welcome an ELV law. This is a good sign that ELV law could be implemented to meet the Middle East its future environment-friendly goals.

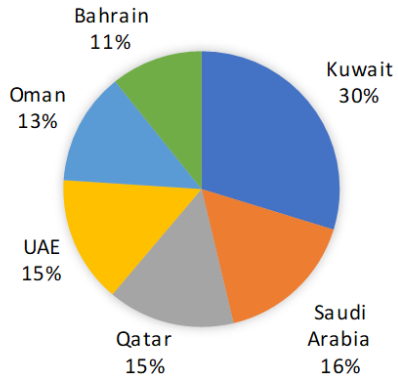

Fig. 3 - Country of origin of respondents

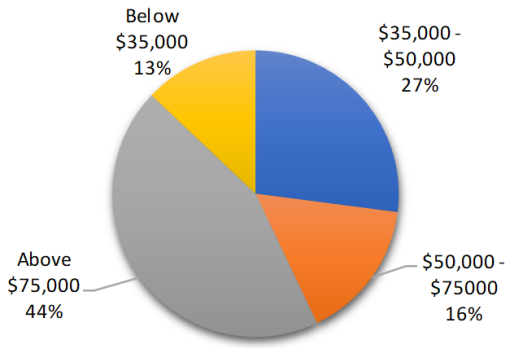

Fig. 4 - Annual income

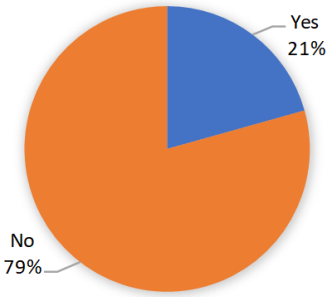

Fig. 5 - Are the any ELV laws in your country?

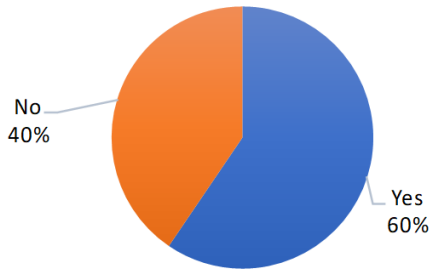

Fig. 6 - Government should impose laws to process the ELVs

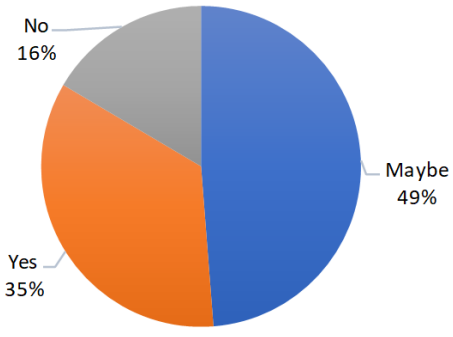

Fig. 7 - Are ELV laws good for your countries?

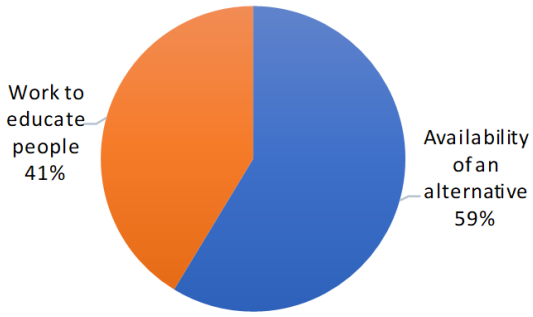

Fig. 8 - ELV laws acceptance level from respondents

6. Conclusion

The increased economic activities in the Middle East countries cause high demands for cars which eventually results in ELV issues. Sooner or later, the Middle East countries will face similar problems in many Asian countries. where ELV left abandoned by the streets. There are many challenges such as inconsistencies in inspection methods and

records in UAE, the price users have to pay in economically poorer countries such as Iran, Iraq and Egypt and the fact that ELV is not within the countries' intermediate and long-term goals. Sprawling cities like Tehran need the ELV initiatives sooner than the others because of the emissions issue. The implementation of LEZ and compulsory annual inspection can be a good start as complementing acts such EPR [80] and finally ELV itself. Countries like Iran and Egypt with high projected vehicle purchases shall prioritise ELV initiatives and can emulate steps taken by the Qatari government such as the QARP model in promoting sustainable automotive industry and creating opportunities such as strengthening circular economy. Generally, the survey results indicate that the people are very positive about accepting the ELV laws and appreciate the ELV laws implementation. The key findings were found and addressed to help governments in the Middle East to start policies regarding ELV.

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