

An Open Window for Emissions and Pollutants Shifting Resulting from Used Car Parts from the United Kingdom (UK) To Cameroon Propagating Continuity of Automobile Environmental Damage

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Abstract: *This study examines an open window existing between the UK and Cameroon favorable for used car business but propagating a continuity in environmental pollution. It exposes an enormous amount of used car parts with existing potential high rates of emission and pollution possibilities originating from used cars in the UK with a failed MOT test and destined for a vehicle with a valid road worthiness certificate (Visit technique) in Cameroon. These emissions and pollutants shifting process is increasing damaging communities and environments particularly in Douala which is the economic capital of Cameroon visibly at skyrocketing levels. About 96 containers enter Cameroon per year only from the UK full of used car parts especially engines with emission problems and parts that are non-recyclable at the end of their lifespan mindful of Cameroon's state of underdevelopment. These used parts have less than 50% chance of not getting bad or faulty in 5 years. For every 150 Cameroonians, 55% would prefer to buy a used car part. These emissions and pollutants shifting practices are also felt by many developing countries in Africa hence it's a continental environmental issue. It was noted that, with high MOT failure rate and the decrease in the reliability of used car parts, there is both continuous and increasing emission and pollution of the environment. Our aim is to bring awareness through this scientific analysis with some proposed solutions to the city councils and the government of Cameroon about this phenomenon so that they can implement new strategies to manage this sector.*

Keywords: emissions and pollutants shifting, failed mot, valid road worthiness report, used cars parts.

INTRODUCTION

In almost every country, the ministry of transport has laws put in place to govern vehicles that ply the motorway. They generally insist on testing vehicles for road worthiness and making sure they pass the test before they are used on the motorway, especially for vehicles less than 3 years old as it's in the United Kingdom (UK) which is classified as a developed country [1]. There, the test is a valid Ministry of transport (MOT) document with specific guidelines on her official website [2]. Cameroon being an underdeveloped and a bilingual country [3], this test is called Road worthiness certificate or 'Visit technique' for the Anglophone and Francophone regions respectively with respect to guide lines from the Ministry of transport [4], [5] & [6]. In either country, this test is carried out only in designated vehicle testing centers or stations and is valid only for 12 months. The test checks the effective working condition of various aspects, including the general state of car parts as well as the operating conditions of car systems particularly the attached accessories, brakes, lights, tyres, and emissions. The scenario here is that an enormous quantity of used car parts are exported from the UK, obtained from a vehicle with a failed MOT certification or a faulty car with a partially valid MOT and destined to be mounted on a vehicle with a valid road worthiness report (MOT) in Cameroon. This also involves some other African countries comes. This is an open window favoring the movement of parts between two used cars that is good for business but harmful to the environment and unnoticed by both governments.

This is the window where used car parts extraction from vehicles with partial or no compliant for use on a motor way in a developed country like the UK are timely or randomly exported to be mounted on cars found in an underdeveloped country like Cameroon with valid documents but has just broken down. After mounting these parts, the vehicles shall to be used on the motor way and considered to be problem-free meanwhile they're not. Most of these car parts are petrol and diesel engines with emission problems while others are used vehicle parts that have a reduced functional reliability and or problematic and cannot be recycled in the underdeveloped country of destination thus causing pollution. The term Emission and pollutants shifting (ES) used here refers to transferring an item tested and proven to cause emission or environmental pollution from one location to another on planet earth thereby enhancing emission and pollution continuity in the new location but forgetting the effects of climate change that's noticed globally [7] & [8]. This practice is promoted by used car business owners with little or no knowledge of the negative consequences it contributes to environmental pollution and global warming. Emission shifting brought up here could be noticed locally within a country or internationally between two countries like the case of Cameroon and United Kingdom (UK) in this study.

The UK is a giant and favorable supplier of used car parts to underdeveloped countries like Cameroon encouraged by her now policies to go net zero by 2050 visible to her open website [9] which is partially linked to pollution resulting from automobile emissions.

Looking at the origin of these parts and their destination is important to every government understand and actively get involved in the making of positive policies towards fighting emissions

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 originating from this sectorial track. The images below show a brief vivid process with its initial and final destinations.



Figure 1: Initial and final destination of use car parts

After a MOT test in the UK, car owners with a failed MOT result will either go in for immediate repairs within the time frame given by the vehicle testing office or delayed repairs done away from the dead line given by the test office. Some factors that influence the decision of the car owner to quickly repair or delay to repair the car after a failed road worthiness test include those in the table below.

Table 1: Factors leading to scrapping a car in UK.

S/N	Factors leading to Scrapping a Car by an owner		
1)	Cost of spare parts	7)	Rate of admiration of the car
2)	Cost labour to repairs	8)	Use of the car
3)	Frequency of use	9)	Service history
4)	Age of the vehicle	10)	Cost of road tax
5)	How long it's been off road (SORN)	11)	Cost of insurance
6)	Vehicle's millage	12)	New laws put in place by government against old cars.

Other psychological reasons for scrapping a car comes as a result of legislations put in place by the UK government such as reduced or no road tax for some category of new cars, bringing public awareness and encouraging zero emission vehicles like electric cars, using bikes or walking on foot where possible and taking public transport systems like e-tramps, e- bus and trains [10] in chapter 5. The automobile sector contributes enormously to emission. Apparently, there is that evaporative emissions from refueling, spills onto heated engine parts, and emissions from the tailpipe. In addition, analyses have indicated that a significant source of emissions from vehicles is abrasion and wear of tyres and metallic components, resulting in the emission of a variety of metals and carbon compounds. The primary emissions from motor vehicles come in two

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predominant forms namely; major gaseous and particulate air pollutants, which can be found in relatively high amounts in the atmosphere, and so-called air toxics [11], which usually are found in lower amounts in the atmosphere but can have important health implications with figures as follows:

Table 2: Global Percentage of pollutant in the environment

Pollutant	Percentage %
Carbon monoxide	~90
PM_{2.5}	~25–30
Nitrogen oxides	~40
Volatile organic compounds	~35
Average air toxics	~21
Urban air toxics	~42
Carbon monoxide	~90

Most environments in Cameroon and Africa in general are not left out as they also contribute significantly but not efficiently monitored, recorded and attention given to [12]. The increase in the number of vehicles in Cameroon [13] & [14] has resulted in a continuous growth in the consumption of fuel in Cameroon; and has contributed to the increase of Cameroon's Green House Gas emissions [15]. The Cameroon's road transport sector emits into the atmosphere an average of 1421.4 kilotons of CO₂ equivalent per year, 852.5 (59.98%) and 568.9 (40.02%) kilotons of CO₂ equivalent per year for gasoline and diesel vehicles respectively with a steady increase over the past years [16].

Continently and through the use of diverse techniques, CO₂ emissions in African transport networks needs to reduce. According to the analysis [17], it is expected that, North Africa, Southern Africa, Eastern Africa, and West Africa should see a reduction in CO₂ emissions of around 23.70%, 24.72%, 23.68%, and 23.86% by 2050 respectively. According to these statistics, different African regions have varying CO₂ emission reduction potentials. Cameroon belongs to one of these zones in Africa and it is expected to reduce the most by 2030, 2050, 2070, and 2100. This implies that Southern Africa has the greatest capacity for CO₂ emission reduction in the near future, making it a key focus for implementing sustainable transport solutions and close to net zero emission strategies.

Theory and Methods.

In the business line of used car parts imported into Cameroon economy, [18] it is noted that a huge quantity of used vehicles parts are being imported into Cameroon. In recent years, Cameroon can even be considered a dumping ground for European used and weary vehicles; the UK is not left out. However, it is worth noting that the UK uses right hand drive and Cameroon uses left hand drive, thus very few cars are exported to Cameroon where there are later converted to left hand

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drive by local mechanics with some imperfections of course. Thus, more of used car parts go to Cameroon from the UK than cars. According to [18] & [19] right hand drive cars potentially increase the risk of accidents on motorways in emerging countries.

After a feasibility survey at Rowley scrap yard in Coventry and Bradnock Marsh business center in Solihul, west midlands-UK, where used cars parts activities are notorious, it was noticed that the following used car parts have a high market value when exported and star rated to quantify how high there's the demand in developing countries and Cameroon in particular.

Table 3: Commonly sold used car parts and stated market value.

S/N	Used Parts	Rated needs (5 * =most wanted)
1.	Functional engines (petrol and diesel)	*****
2.	Shock absorbers	*****
3.	Steering linkages	**
4.	Tyres	*****
5.	Head and tail Lights	****
6.	Bumpers	****
7.	Fuel pumps and casings	***
8.	Side mirrors	****
9.	Engine accessories	**
10.	Doors and burnets	***
11.	Electrical and electronic accessories (ECU, radios, wipers, fans, motors, dashboard monitors etc)	***
12.	Radiators	****

Mindful of how there are many road accidents in Cameroon leading to deaths [my article] and link to second hand cars or used car parts, most of them are head on collision, tale on collision there by affecting more frequently the components on the frontage and tail of vehicles like bumpers, front and tail lights, the radiator and the engine. This is the reason why they are in high demand. In other to get used cars for scraping, dealers buy the used cars from private owners with difficulties as mentioned in the paragraphs above or from contracted dealers who get the parts from the police or council impounded vehicles and vehicles with accidents Insurance claims related issues. The most

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popular market for this practice is the Face book market. Here cars tagged with MOT failures and uncountable adverts pub up nearly every day. One would see information such as follows:

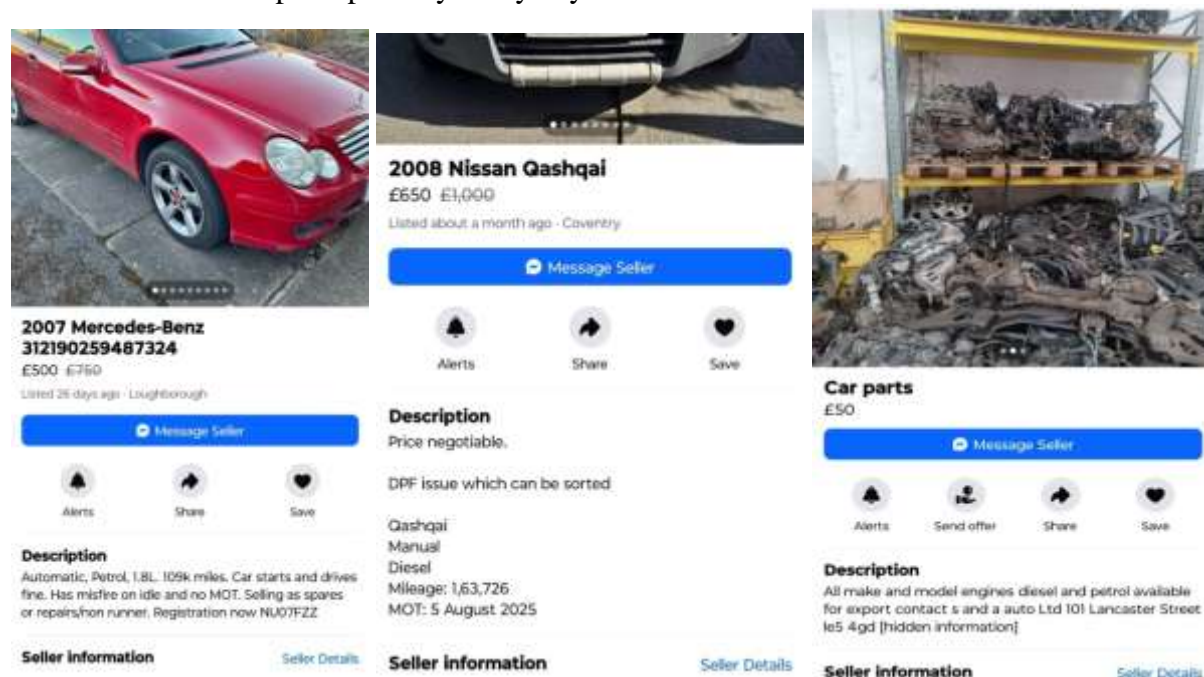


Figure 2: Examples Face book Market used cars with MOT or Emission related issues.

The first advert talks of a vehicle without MOT and misfiring hence the engine is a perfect source of pollution especially if bought while it's mounted on a car with a defective exhaust system in Cameroon. The second image shows an advert of a car with a defective DPF, meaning most components are worn showcasing a reduced engine parts reliability because of the blocked DPF over time. This thus leads to emission. The third image shows UK based whole sellers making money without any prove of emission levels for the various engines being sold.

Automobile emission causes serious pollution and most of sources of these emissions are directly linked to engine functioning and management systems which are rated as follows in terms of severity:

Table 4: Common Sources of Emission from a used Engine/Car

S/N	Systems link to emission	Star rating
1-	Combustion process	*****
2-	Fuel line	***
3-	EGR system	*
4-	Exhaust system	****

Impact of environmental pollution from imported used Cars and parts on Cameroon's environment

One of the greatest environmental challenge of our time is air pollution resulting from the transport sector [8] since it is the fastest-growing source of fossil fuel carbon dioxide emissions in the world and is responsible for 24% of direct vehicular carbon dioxide (CO₂) emissions from fuel combustion. Other emissions generated from fuel combustion by internal combustion engines include oxides of nitrogen (NO and NO₂, together called NO_x), unburned hydrocarbons (HC), also known as volatile organic compounds (VOCs) or non-methane hydrocarbons (NMHC), carbon monoxide (CO), and particulate matter of sizes 10 microns (PM₁₀) and 2.5 microns (PM_{2.5}), including black carbon. Particulate matter emitted by automobiles contributes to air pollution, causes negative health effects global climate change, human health problems, and ground-level ozone formation at both regional and national scales [16], [20] & [21]. A United Nations report on Environment shows that Cameroon is second on the list of the top countries with the worst ambient air pollution in Africa with a PM_{2.5} reading of 196.7 g/m³, which is well above the World Health Organization's minimum recommendation of 10 g/m³. She is also one of the countries in Sub-Saharan Africa with no working vehicle emission control standards. Douala being its economic capital, has recently noticed a steady increase in these solid pollutants from imported vehicles. The inability of Cameroon to effectively manage waste material of products effectively is a major contribution concern.

After conducting a ground zero visual inspection feasibility checks, and in connection with the local council authorities and clean-up campaign strategy put in place by the Douala city mayors taking place every Thursday from 6 a.m to 11 a.m, we confirmed that unused imported items and material including house whole equipment, industrial equipment as well as damaged vehicles and unwanted car parts from abroad end up abandoned in the communities of Douala 1, 2, 3 & 4 council vicinities with Ndoboh and Camp Yabassi recording the highest levels. It was noted that many varieties of undefined liquid spillage were littered all over on the ground with no or unorthodox sewage management practices put in place or carried out in these vicinities. The following popular available companies: HYSACAM for domestic trash management, NEME Lt for plastics recycling and SOCAFERE for metal recycling are overwhelmed by the demand. We have witnessed over and over between 2016 and 2023 how old imported vehicles or unused tyres are burnt in open air along the stretch of the new road (Nouvelle route) beside the Douala 4 city council up to the roundabout in Deido by unscrupulous individuals for fun or in search for tyre metallic wires for selling. The tyre burning process produces huge flames full of sooty black smoke made up of CO, CO₂ and PM.

Because of the lack of adequate awareness, poverty, poor governance, and corruption, the state of Cameroon is undermining the effects of environmental pollution from imported used cars and car parts that contribute to environmental pollution, hence, there is laxity in the implementation of key strategies to fight environmental pollution from this domain in order to join the global fight for climate change in general and possible net zero emission vision as in the UK.

Impact of environmental pollution Cameroon's Agricultural.

Given that Cameroon's economy depends largely on agriculture, the protection of the environment is not something we should take for granted anymore. The effect of climate change due to environmental hazard and destruction poses many threats to the quality and quantity of water resources and crop productivity [22], [23], [24] & [25]. Water tables are dropping, temperatures are rising and drought is visible, unfortunately, the quest for money and wealth by humans has overridden our desires to protect the environment in which all are a part. One will note that were there's a corridor for humans to make money or wealth like in container shipping business, there is a chance for mother earth to cry out loud because of the potential high risk to environmental destruction. I am always heartbroken each time I see the burning of tyres by the road side along the stretch of the main road in Douala 4^{eme} producing uncontrolled terrifying flames and thick sooty black smoke (CO & CO₂) into the air by unscrupulous indigenes who just want to extract the metallic wires and sale for less than 50CFAFr per kg (~ 0.065 pounds per kg) just to smoke cigarette. This is currently still occurring spottily and happens on an average of 3 to 5 times a week in this locality of 890km².

In Cameroon, just about 40% of potential vehicles owners love to and can get genuine brand new vehicle parts. The remaining 65% depend solely on used imported car parts. Amongst the many goods transported in containers heading to Cameroon via the Douala or Kribi Sea ports are used car parts. In the business world of cars and parts in Cameroon, words like "occasion" (Pronounced as "Okasion" with a French phonetics) Belgique, occasion Etas, occasion Japan, and Occasion UK or Angletere are often used between car owners, mechanics and spare parts dealers referring to used car parts from Belgium, USA, Japan and the England respectively. This study focuses on Bonabéri in Cameroon where it is the largest car parts arrival point for further distribution with a surface area of 203.9 km² and against Coventry in the UK where we pin our origin of used car part heading to Cameroon with a total surface area of 98.54 km². Many customers in Cameroon prefer used car parts from oversea compared to new parts because they are cheaper, available and in some rare cases are stronger and reliable since they are extracted from the original car that was put into circulation by the manufacturer.

We decided to carry out an outreach field investigation on which type of car parts people would prefer the most in Douala and in Coventry and the following data was gotten

Table 5: Comparing desires for used Car parts in UK and Cameroon

A: Douala Cameroon				
Location	Total Samples	Description	Those for new car parts	Those for used car parts
ENSET-University of Douala	85	Mechanic students	35%	55%
Ndoboh Bonaberi	45	Vehicle owners with no car repair knowledge	73%	27%
Gare Routier Bonaberi	30	Mechanics	55%	45%
B: West midland - UK				
Solihul	20	Jaguar, Land Rover workers and friends	100%	0
Coventry	22	Coventry veteran football club members	100%	0
Tile hill	10	Local neighbours	100%	0

The two tables above show a wide range in believes and practices from car owners in the UK who do not need used car parts against those in Cameroon who desperately rely on used car parts up to an average value of 55% in love with used parts. While the UK stands out very tall in terms of car manufacturing worldwide quantitatively and qualitatively thus rarely needing second hand or used car parts, all unwanted cars go to the scrap yards or are recycled. At the scrap yard, valued parts or components are selected for export abroad propagating emission shifting.

Comparing Common car systems that lead to failures at test centers.

Based on data collected from Mercia Auto garage/MOT testing center and Rowley Auto scrap yard/MOT center all in Coventry-UK where an average of 30 vehicles were randomly tested within a week and comparing it with a combined result gotten from Cameroon at Nacho vehicle testing center in Bamenda, the Center for High Engineering Technics (CHETEC)-Bafut, and Vehicle testing center at Gare Routier Bonaberi – Douala where an average equal number of 30 vehicles were also randomly tested (data collected from follow up feedback from customers after a MOT test within a week); Common faults that lead to a vehicle potentially failing the MOT were classified as follows:

Table 6: MOT Failure rate in a Coventry-UK based test center and a Douala-Cameroon based test center per week

S/N	Rate of failed vehicles per week in Coventry UK	%	Rate of failed vehicles per week in Cameroon	System linked to failure	%
a.	4	13.3%	7	Suspension system	23.3%
b.	3	10%	5	Steering geometry	16.7%
c.	3	10%	4	Lighting system	13.3%
d.	3	10%	7	Emission system	23.3%
e.	5	16.7	5	Tyres	16.7%
f.	0	0%	2	Mirrows, wind screens etc)	6.7%

Generally, for the same number of cars in the UK and Cameroon, very few will fail the MOT test in the UK compared to those that will fail the road worthiness test in Cameroon. The 16.7% rise in MOT failures linked to tyres is as result of the minimal tyre wear limit of 1.6mm [26] & [27] put in place by the government and the fact that most company cars do not actually respect the expiry date of tyres to make sure they are suitable for all road conditions especially in winter. Meanwhile in Cameroon, a majority of local motorist rely on buying fairly used tyres. These fairly used tyres are gotten as a result of rejected tyres after a failed MOT or expired tyres from abroad. The following are the reasons that account for a majority of vehicle owners in Cameroon relying on imported used car parts.

Table 7: Reasons for the trust in used car parts.

Reasons why a majority of vehicles owners in Cameroon rely on imported used car parts	
A	Genuine brand new parts from retailers and car companies are expensive to buy
B	Brand new parts are difficult to get in terms of time management and availability or proximity.
C	The influx of fake goods or poorly manufactured new car parts having low longevity and durability from other countries has killed the desire and believe on the efficiency of new car parts.
D	Imported used car parts are cheap and readily available.

Because of the poor state of roads in Cameroon the tyres, the suspension and steering systems are highly affected as seen in the table below.

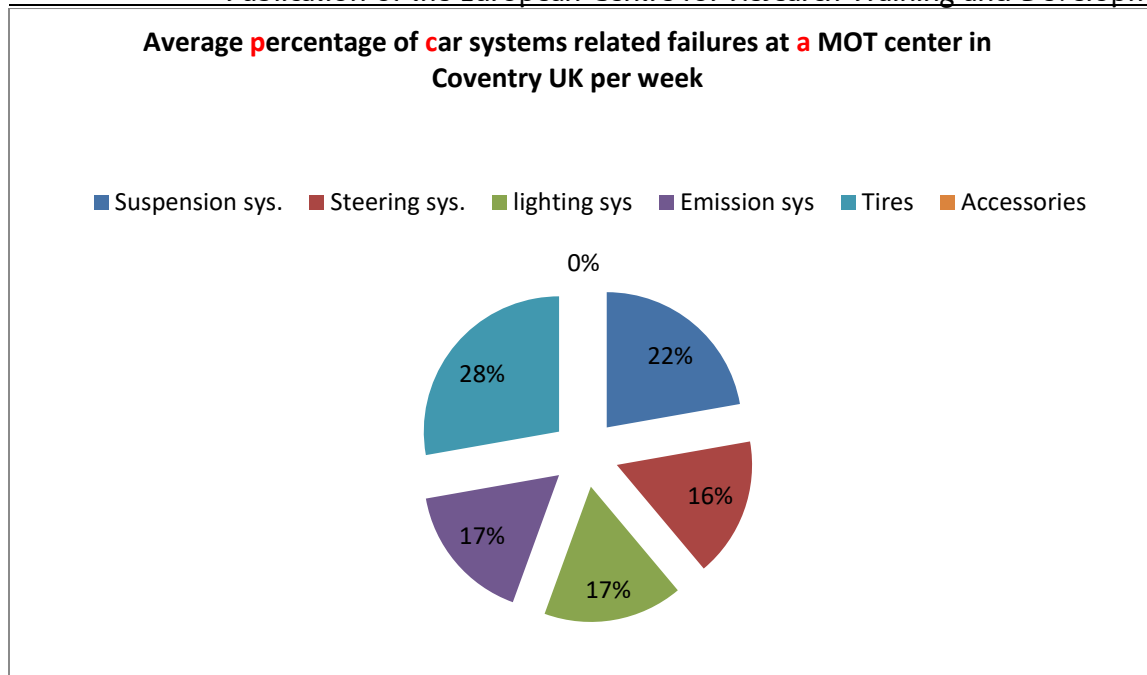


Figure 3: Percentage of car system failures in Coventry-UK based test center per week

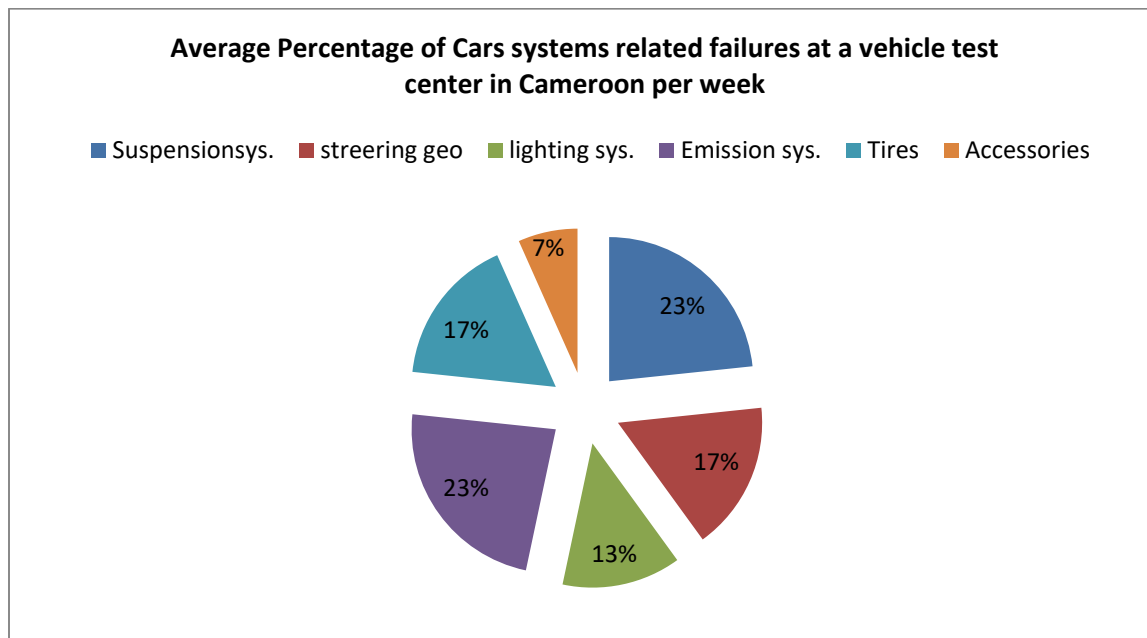


Figure 4: Percentage of car system failures in Douala-Cameroon based on test center per week.

Age related Corrosion and Acidic level as a facilitator to scrapping cars.

Many vehicle and engine components are made from metallic material that corrode when exposed to the environment [28] & [29] and particularly accelerate corrosion in a low PH environment. The influence of corrosion on car bodies and parts depends on age, exposure and millage. In environments with low pH, uniform corrosion tends to occur at a higher rate, as the acidic solution facilitates the breakdown of the metal's surface. Pitting corrosion, which leads to the formation of localized pits on the metal's surface, is also strongly influenced by pH. However, there are some vehicle parts that generally will expire after a certain period especially items made from rubber and plastics such as the tyres, bushings, dust covers, due to heat, corrosion and acidity of the environment. The pH level in the UK varies across different environments [30] & [31] with values ranging from 5.5 to 9.5 depending on the area. In many areas of Cameroon and Douala in particular, the pH levels range from 4.5 to 5.0. Hence, Douala boost of pH levels lower than pH levels in Coventry thus accelerating material decay or corrosion.

This directly means that used imported cars and car parts will quickly get rusted and decay due to corrosion when exposed to the environment. To this effect no one wants to buy these components later and with very few companies capable of recycling metals, some species of plastics and no company to recycle rubber, they end up abandoned in the communities and causes pollution. Mindful of how the water table in Douala is which is very high, the rust from these abandoned parts get washed by rain water and completely pollute the nearby streams. To this effect and till date, all streams flowing around the communities of Douala and Bonaberi in particular have blue-black colours with odor.



Figure 5: Example of a polluted community running streams

Continuous Emission due to declining reliability of used engine parts

The reliability of a complete engine and/or engine parts depends on age and millage [32], [33] & [34]. However, because of reduced reliability of all engineering components with time, the engine parts loose efficiency over time thus tend to fail and facilitate emission particularly when the system put in place to limit or stop the release of toxic emissions like oxide of nitrogen (NO_x) into the environment has failed.

Table 7: Sample Parts reliability examination with respect frequency of Engine parts faults

Components			Frequency			
	Failure type	Action taken	MDG1	MDG2	MDG3	MDG4
Turbo charger	Black smoke	Replaced and repaired	8	10	12	12
Lube oil cooler	Oil leakage	1.Replaced	16	18	15	16
	External leakage	2.Cleaned and the zinc anode replaced	10	8	8	12
Oil cooler valve	Failed	Remove/repared	1	1	2	1
Cylinder head		1. Liner, O-ring replaced (G1, G3)			1x (A1, A2); 3x (A2, liner); 2x (A2 head);	
	1. Oil leakage.	2. Cylinder replaced (G3, G2)	20	19		
	2. Fresh water leakage from A2 exhaust.	Replaced gasket (G3)	20	14	1x (A3,B2 gskt)	20
	3. Unable to start.	O-ring Holding bolts	28 18	32 17		23 16
Cylinder Jacket/sleeve	1. Scuffed x 4 2. Cracked x 2	Replaced	11	12	11	12
Piston	Rings	Replaced	12	13	13	14
	Cooling/crown		8	13	15	14
Connecting Rod	Bent		7	9	8	9
	Gudgeon pin		8	6	8	6
Drive belt	Failed	Replaced	8	8	9	11
	Torn(wear)	Replaced	11	5	9	3
Mechanical Injection pump		1 Replaced bolt and drive (G1, G3)				
	1. Cracked bolts. 2. Broken bolts. 3. Broken shines	2 Replace bolt and pulley and set injector timing (G1, G2). 3 Replaced shims defects	16	12	12	13
	Drive		22	20	21	24

These systems include:

- Exhaust gas recirculation system (EGR)
- Positive crank case ventilation (PCV)

These systems fail due to damages during transportation of the used engines in containers, poor mounting processes by mechanics and age-related factors. Below are some samples of engine components that overtime, they tend to fail including possible actions as experimented and noticed in the garage.

Reliability and Emission potentials of an imported used engines and mechanical car parts.

From an engineering point of view, the ability to predict the lifetime of a whole system or a component is very important. Such lifetime can be predicted by using a statistical approach using

appropriate distributions. Be its used, a petrol or diesel engine ready to be mounted on another car is made up of many mechanical and electronic parts that have the potential to fail over time. Mindful of how of a used engine emission/pollution rate is linked to age, let's take a looking at the length of its component prior to failure (the age prior to failure). Lifetime distributions are functions of time [35] and may be expressed as probability density functions and so we may write

$$F(t) = \int_0^t f(t)dt$$

This represents the probability that the system or component fails anywhere between 0 and t.

The probability that a system or component will fail only after time t may be written as:

$$R(t) = 1 - F(t)$$

The function R(t) is usually called the reliability function. In practice engineers are often interested in the hazard function or conditional failure rate function which gives the probability that a system or component fails after it has been in use for a given time. An example of this is a used engine. This function is defined as:

$$H(t) = \lim_{\Delta t \rightarrow +\infty} \left(\frac{P(\text{failure in the interval } (t, t+\Delta t))/\Delta t}{P(\text{survival up to time } t)} \right) \quad (1)$$

$$= \frac{1}{R(t)} \lim_{\Delta t \rightarrow +\infty} \left(\frac{F(t+\Delta t) - F(t)}{\Delta t} \right) \quad (2)$$

$$= \frac{1}{R(t)} \frac{d}{dt} F(t) \quad (3)$$

$$= \frac{f(t)}{R(t)} \quad (4)$$

This gives the conditional failure rate function as follows:

$$H(t) = \lim_{\Delta t \rightarrow +\infty} \left(\frac{\int_0^{t+\Delta t} f(t)dt / (\Delta t)}{R(t)} \right) \quad (5)$$

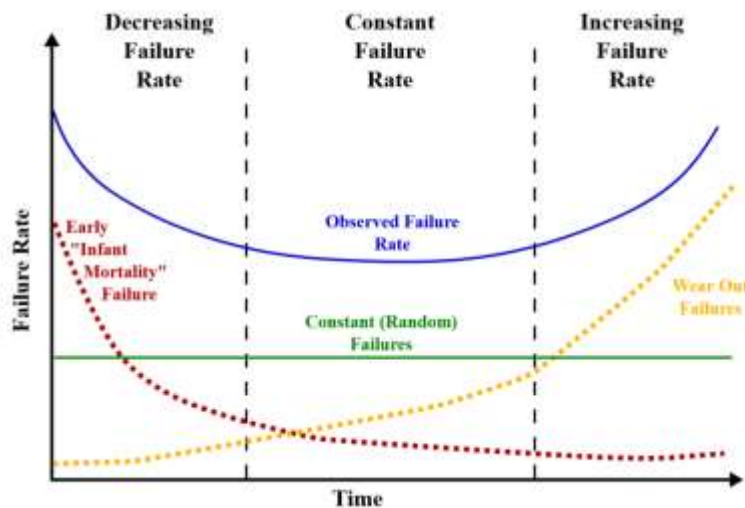


Figure 6: Bath tube graph in relation to used car parts failures

On the bathtub curve potential reliability of used car parts above:

1. The first region has a decreasing failure rate due to early failures.
2. The middle region is a constant failure rate due to random failures.
3. The last region is an increasing failure rate due to wear-out failures.

Not all car parts exhibit a bathtub curve failure rate. Actually, most car parts follow the bathtub curve in the early stages of their life. The failure rate then decreases as defective products are identified and discarded, and early sources of potential failures such as manufacturing defects or damages during transit are detected. In the mid-life of a part or component, the failure rate is constant. In the later life of the engine part, the failure rate increases due to its wearing out. Many electronic car components life cycles follow the bathtub curve [36].

The exponential distribution as a means to predict use car parts failure

Many used car parts from newer vehicles like less than 3years old cars can still fail, likewise from older vehicles. This can be due to accidents, shocks, uncontrolled interruption of electrical supply, manufacturing defects and poor maneuvering of the car. This can increase the chances of a Fail MOT and/or urge the car's owner to scrap the it. The exponential distribution function helps us to predict failure not related to the age of a used car part or component.

General form: $f(t) = \lambda e^{-\lambda t}$, $t \geq 0$

Applied form: $f(t) = \frac{1}{\mu} e^{-t/\mu}$, $t \geq 0$

where, μ is the mean time to failure and λ is the hazard function independent of time.

Thus the probability of failure is independent of age consider the following.

$$F(t) = \int_0^t \frac{1}{\mu} e^{-t/\mu} dt = \frac{1}{\mu} [-\mu e^{-t/\mu}]_0^t = 1 - e^{-t/\mu} \quad (6)$$

Hence the reliability function under the curve $F(t) = 1 - e^{-t/\mu}$ is unity and equals

$$R(t) = 1 - F(t) = e^{-t/\mu}, \quad (7)$$

Hence the hazard function or conditional failure rate function $H(t)$ is given by

$$H(t) = \frac{F(t)}{R(t)} = \frac{\frac{1}{\mu} e^{-t/\mu}}{e^{-t/\mu}} = \frac{1}{\mu} = \text{Constant independent of time}$$

The failure of the components listed above leads to increased emission for vehicles in the UK and if the same used parts are shipped to Cameroon or Africa as a whole as second hand or used parts, the reliability decreases rapidly and longevity drops thereby propagating the continuity of previous pollution noticed UK in Cameroon. Consequently, the lifespan becomes even shorter but the need to keep running the car remains the same by the car owner thus he orders another used part with the same unsure reliability or similar quality. At CHETECH garage in Bamenda and Gare Routier in Bonaberi Douala where on average 40% of the weekly tasks are engine replacement with imported used engines being frequent, we noticed after a random sampling of 25 customers (19

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 taxi drivers and 6 private car owners) that this cycle may be repeated up to 3 times particularly for vehicles used as taxis within a period of 3 to 5years and 1 to 2 times for private vehicle owners for a period of 2 to 7years.

Star rating of potential sources of problems leading to emission from imported engines.

Knowing fully that most of the sources of emitted pollutants from used car parts that are directly linked to engine functioning and management systems which are star-rated as follows in terms of severity:

Table 9: Most common Problems leading to emissions from imported engines.

S/N	Engine channels to emission	Star rating	Possible causes
5-	Combustion process	*****	<ul style="list-style-type: none"> - Worn internal engine parts - Incorrect imported part matching - Poor electrical module settings and configurations
6-	Fuel line and tank caps	***	<ul style="list-style-type: none"> - Defective fuel tank cap - Defective canister. - Faulty leaks in fuel line
7-	Positive crankcase ventilation (PVC)	**	<ul style="list-style-type: none"> - Broken, blocked or defective PCV pipe - Excessive Blowby due to worn piston rings, pistons and or cylinders
8-	EGR system	*	<ul style="list-style-type: none"> - worn valve seals - clogged pipes or orifices
9-	Exhaust system (DPF and Catalytic converters)	*****	<ul style="list-style-type: none"> - Defective or blocked DPF - Defective or Blocked Catalytic converter. - No DPF or Catalytic converter in the exhaust line.

If a vehicle happens to fail a MOT test due to emission surge above standards, it means one or more of these systems are bad or faulty.

Catalytic converter business and DPF elimination bad practices.

A catalytic converter's primary purpose is to reduce harmful emissions from the vehicle's exhaust system by converting them into less harmful substances. It does this through chemical reactions, typically involving oxidation and reduction, using catalysts like platinum, palladium, and rhodium. These reactions transform pollutants like carbon monoxide, hydrocarbons, and nitrogen oxides into less harmful gases like carbon dioxide, water, and nitrogen. However, these in-built elements are very expensive thus making catalytic converters a profitable business. On the other hand, the primary purpose of a Diesel Particulate Filter (DPF) is to reduce harmful emissions from diesel

engines by capturing and storing soot particles. DPFs help to reduce air pollution and protect human health by filtering out exhaust fumes, including soot that would otherwise be released into the atmosphere. Once a DPF is blocked, the vehicle is likely to lose power, stop or go into a limp mode. This inconvenience encourages the car owner to scrap the car or get rid of the DPF system to continue using the vehicle within a valid MOT period.

Many car owners who's check engine warning light come on because of a faulty catalyst and who do not know the gravity of the effects of emission and pollution it brings will simply get rid of the system and connect the exhaust pipe directly to continue using their vehicles before the next MOT is due. The market of catalytic converter elements is really booming in the UK because of its many industries thus favoring vehicle scrapping for parts. You see adverts on Facebook market and other used car selling parts platforms with image like this bellow.



Figure 7: Catalytic converter business that disfavors car emission

RESULTS AND DISCUSSION

Case study: Tracking of used car parts and Emission potentials from the UK to Cameroon.

We sort to investigate and confirm the validity of our findings by tracking the whole used car parts business strategies from the UK to Cameroon and to deeply understand the loop holes involve linked used engines and other car parts that directly potentially leads to pollution. A total of 13 vehicles were involved with the following characteristics. Note that, Euro 6 standards [23], which are currently in effect for new vehicles in the UK, specify emission limits for both petrol and diesel engines, with different limits for each fuel type. For example, Euro 6 diesel cars can emit a maximum of 0.08g/km of NO_x, while petrol cars have a limit of 0.06g/km. Euro 6 also sets limits for other pollutants like carbon monoxide (CO), particulate matter (PM), and particle number (PN). The parts were all transported on two different containers with the tracking information as seen below.

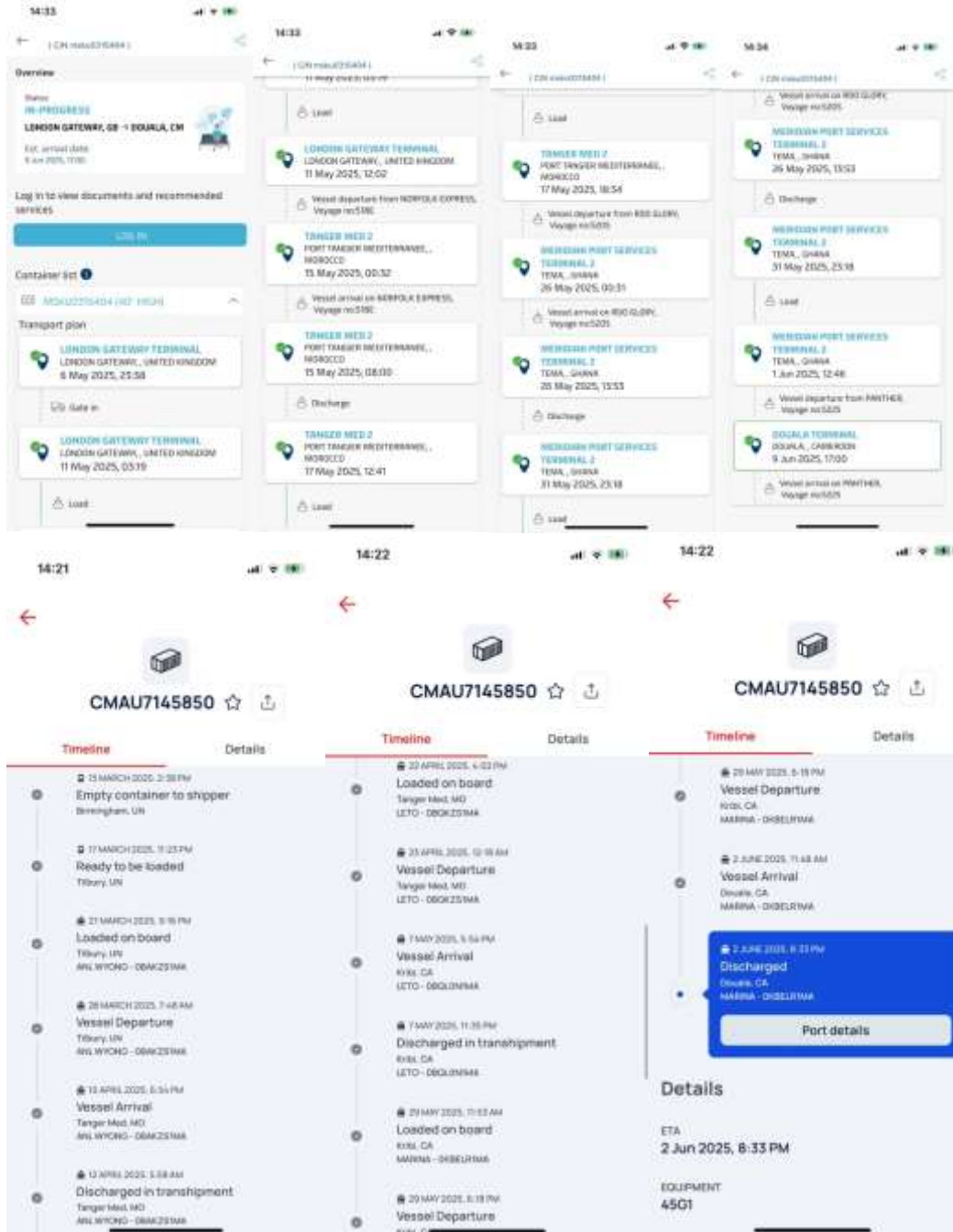


Figure 8: Screen shorts of 2 container movements carrying our sample experimentally used car parts from UK to Cameroon.

From the images above the average time frame for a container of goods to arrive the Douala Sea port from the UK is 3 weeks making it a profitable business in terms of its quick turn over. The following data carries information about sample vehicles that were tested. Note that we decided to

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choose the age group of cars between 10 and 20 years old for our findings. This is the age group of cars easily affordable to an average Cameroonian and very common on the motorway. The procedure or steps involved include:

Step 1: Searching for a vehicle for sale on Face book market, community apps and in my locality and identifying or verifying if it has a valid MOT or not.

Step 2: Identifying the problem why the car owner wants to sale it to suit our intentions (engine running or in good condition but with poor emission records raised).

Step 3: Verifying car information and service history on UK's "Car check" app.

Step 4: Buying the car, dismantling the engine and other components with high market values then shipping the parts to Douala – Cameroon.

Step 5: Looking for a customer based in Cameroon in need of a particular engine or used car parts and engaging a business deal with him/her. If not available, store the used engines and parts in Douala based shops for potential future customers.

Step 6: Sale the car's body for metal recycling if it's too old or buy a corresponding used engine from Rowley auto / scrap yard in Coventry and replace it particularly if the car is worth re-selling and/or MOT is still valid within a year. At <https://Car-checking.com/report>, We were able to retrieve the percentage MOT pass history to get the Percentage fail from each car.

Table 10: Useful characteristics of sample cars

MOT fail rate history (%)	Car Reg. in UK.	Millage	Type of engine	Emission		Age	Reasons linked to be sold for scraping	Awaiting action in Cameroon
				Standard emission values	CO ₂ values			
25%	PX60ORU	176646	Diesel	CO<0.05 NO _x <0.08 PM<0.005	0g/km	15Years	Accident	Booked while in Uk
35%	PF10OOH	90372			135g/km	15 years	Failed MOT	Sold
41%	WA56UF L	157350			0g/km	19 Years	Failed MOT	To be sold later on
38%	LB59JPF	105813			150g/km	16 Years	Failed MOT	Sold
24%	BG10TLO	116794			0g/km	15Years	Accident	Sold
36%	FE15ONK	151018			103g/km	10 Years	SORN & Age related concerns	To be sold later on
19%	BP06FWD	121339			138g/km	19 Years	Failed MOT	To be sold later on
30%	YR12HB A	152332	Petrol	CO<1.0 NO _x <0.06 PM<0.005	158g/km	13 year	Accident	Sold
25%	YD63DB V	153122			138gkm	12years	Failed MOT	To be sold later on
37%	KY59JBE	142750			125g/km	16years	Failed MOT	Sold
26%	MM57UM Z	119451			141g/km	18years	Accident	Sold
25%	EA59XO V	193163			184g/km	16year	Failed MOT	Sold
20%	LO14TTJ	36939			113g/km	11 Years	Pass MOT but faulty	To be sold later on

Evaluating the probability of the sample tracked & tested car currently in Cameroon having a used engine from the UK

Knowing fully that these vehicles have an engine, a car in UK being mounted on the same vehicle mark and model but different body, the vehicles will only function efficiently if the two essential components (engine and car body) both function correctly. The lifetime of both components can be determined through an exponentially distributed in hours. So, we need to find the proportion of them that may be expected to fail before the slated hours of use. Averagely, a common Cameroonian with a private car intent to be using his/her car forth and back for commuting like going to church or to the mosque (30 min), job site (1hr), the market (1hr) and weekend outings/traveling to village meetings/events (12hrs). This sums up to approximately 58hrs per month thus in 12 months it will be 696hrs per year. With the taxi operating for an average of 10hrs daily (excluding Sundays and service times) this totals up to about 2880 hours a year. Also, goods vehicles are in service for up to 48hrs a week thus making 2304hours per year. Then from the various mileages of the cars, let's consider private (P) car owners to drive at an average speed of 50miles per hour while taxis (T) at an average speed of 40miles per hour. Through this we can obtain the time each car has to function before it is expected to fail.

The assumption made is that the components (imported engine and Cameroon based car body) operate independently.






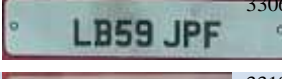
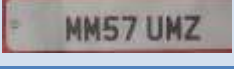
For the first component (engine) = $A = F_e(t) = 1 - e^{-t/d_e}$.

For the second component (car body) = $B = F_c(t) = 1 - e^{-t/d_c}$

The probability that the vehicle will continue to function after the given guaranteed lifespan in hours is given by an expression of the form $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Hence the probability that the vehicle in Cameroon (CMR) will continue to function after about two years of use is as seen in the table below.

Table 11: Useful Characteristics of sold engine corresponding cars bodies in Cameroon

Car Reg.	Ave. Millage of Engine in UK for 5 years	Millage of body in Cameroon for 5 years	Use of Car in CMR	Age	Time before fail Of engine (hrs)	$F_e(t) = A = 1 - e^{-t/d_e}$	$F_c(t) = B = 1 - e^{-t/d_c}$	Probability P(A U B) (%)
	64388	65144	G	15	11520	0.164	0.162	30%
	44609	48235	T	16	14000	0.27	0.252	45%
	58589	59644	T	13	14000	0.213	0.2092	38%
	41408	41848	G	19	11520	0.243	0.241	43%
	30124	44001	T	15	14000	0.372	0.273	54%
	33067	39141	T	16	14000	0.345	0.301	54%
	33181	43222	T	18	14000	0.344	0.277	49%

An estimated rate of exportation of car parts from the UK to Cameroon

From the following statistics we can estimate the rate of containers with used car parts being exported to Cameroon.

Table 12: Table of rate of exportation of used car parts to Cameroon from Coventry only

Name acronyms of dealers	Avg. Approx. No of containers loaded in 3 months	Annually	Container size	Destination Country	Avg. Approx. No of dealers in UK.	Total containers	Remark
EV	2	8	40ft	Cameroon	12	96 per year	960 in 10 years is too much pollutant for Cameroon alone
SA	2	8		Cameroon			
FA	2	8		Cameroon			
RT	2	12		Benin	unknown	unknown	unknown
AB	2	12		Togo	unknown	unknown	unknown
FC	2	12		Uganda	unknown	unknown	unknown

Up to 32 containers leave Coventry in the UK only for Cameroon annually. While investigating on the ground at the Douala Sea port, we observed that there are about 12 regular and known used car parts dealers whose line of business is UK to Cameroon. Many refuse to participate in this research for fear of the unknown and do not want to be mentioned here in any form, thus making up to approximately 96 containers of used car parts yearly into Cameroon.

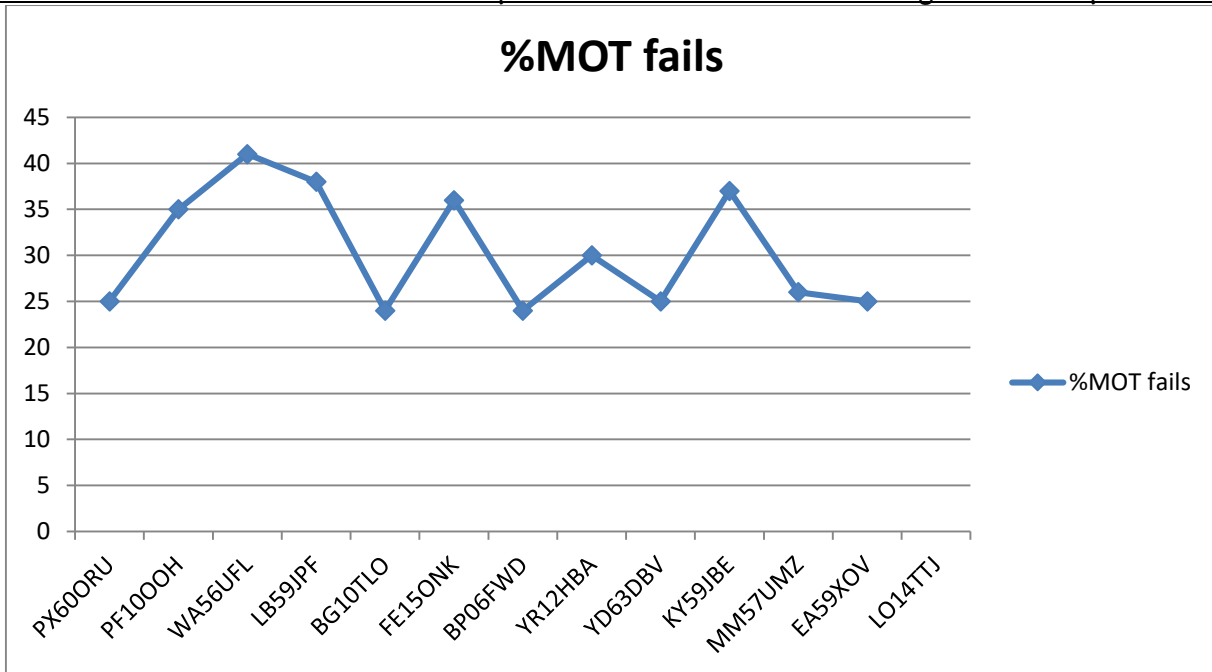


Figure 11: Graph of MOT fails of various cars

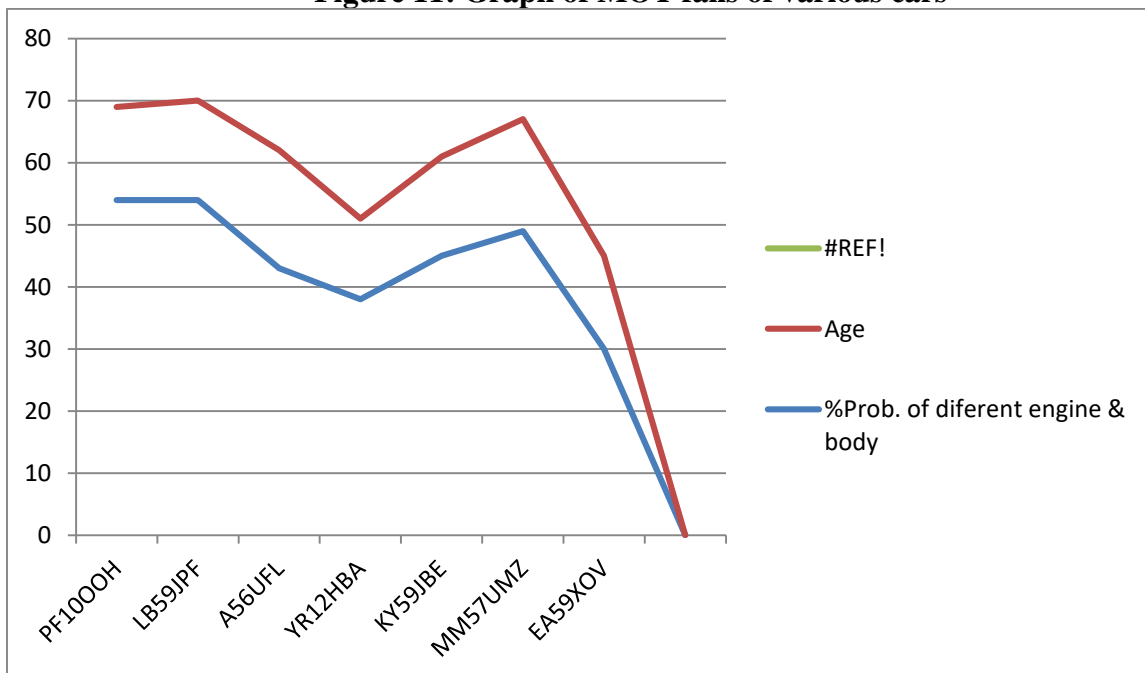


Figure 12: Graph of already sold used engines and their probability of failure before 5 years with the car bodies.

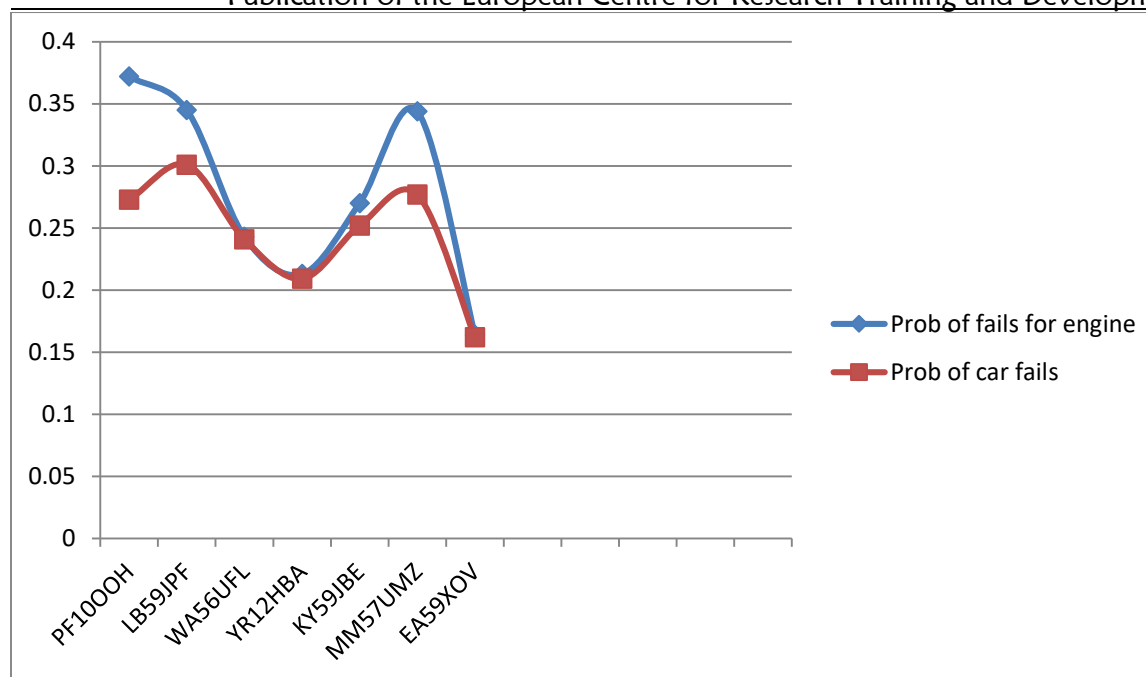


Figure 13: Independent failure probabilities of sold engines and car bodies.

CONCLUSION

A lot is happening in the black market of used car parts that many know nothing about such that it is slowly but steadily damaging the environment due to emission and pollutant shifting of these used components. There is a massive influx of used cars of more than 10 years old from overseas with a corresponding demand for the need for used spare parts to repair these cars. A good quantity comes from the UK because of her net zero vision of emissions and pollutants by 2050. About 96 containers enter Cameroon per year only from the UK full of used car parts especially engines with emission problems. Many of these used car parts are gotten vehicle with a failed MOT and destined to be mounted on a car with a valid MOT in Cameroon causing a conflict of validity of vehicle documents and unknown to the government. These vehicles have less than a 50% chance of not getting bad or faulty in 5 years and increases the risks of accidents. When they broke down or are no longer useful, they are left to rot in the environment because of the lack of effective recyclability and waste management industries thereby causing continuous pollution. To reduce this influx of used car parts the government of Cameroon should encourage emerging and current car parts recycling business, put in place measures and strategies to encourage citizens to use new or newer vehicles, take public buses, bring in environmentally friendly public transport systems like electric cars including bikes and consider joining the net zero emission strategic vision of the UK. This will affect the market of corresponding spare parts positively thereby improving on environmental protection. The UK should strengthen her net zero emission dream and put up a

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mechanism to control and stop potential emission of used cars and spare parts from within rather than allowing them to be shipped to another location on planet earth.

Conflicts of interest.

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the unethical issues, including plagiarism, informed consent, misconduct, data fabrication and falsification, double publication and submission, and redundancy have been completely observed by the authors.

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- Center for High Engineering Technics (CHETEH) in Bafut NWR & Mabanda Douala, Cameroon
- The vehicle testing center at Gare Routier Bonaberi Douala, Cameroon.
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Some of our results here are based on data gathered from a personal experience as a motor mechanic and a teacher in Cameroon and the UK for many years.

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