5.6 Proposed framework for End-Of-Life vehicle recycling system implementation in Malaysia

Muhammad Azmi 1, Muhammad Zameri Mat Saman 1, Safian Sharif 1, Norhayati Zakuan 2, Salwa Mahmood 1
1Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Johor Bahru, Malaysia
2Faculty of Management and Human Resource Development, Universiti Teknologi Malaysia, 81310 Johor Bahru, Malaysia

Abstract
Normally in Malaysia, vehicles are being used extensively regardless of its age or condition. This situation is not only in rural areas but exists in major cities. Vehicle manufacturers expected their vehicles to last in 15 years, hence vehicles exceeding this limit are considered as End-Of-Life Vehicle (ELV). The extensive usage of ELV may lead to vehicle failure which threatens the safety of its user as well as other road users. ELV usage also contributes to environmental pollution. In order to overcome this, a framework for ELV management needs to be developed. Prior to that, a survey was done to study the current practice being applied in Malaysia. This paper also study the existing framework applied by other countries as adaptation for Malaysian ELV recycling implementation framework. This framework is expected to assist the government in drafting new ELV related policies.

Keywords:
ELV; Framework; Vehicle Recycling; Vehicle Recovery

1 INTRODUCTION
Total number of vehicle in Malaysia had reached a cumulative amount of 21.25 million vehicles at the end of year 2010 with an average of 12% increase of vehicle registration each year over the period of 5 years. If the estimation was to be continued, Malaysia will have as much as 31 million vehicles in the year 2020. As the automotive industry develops, its impact to the environment also increases. Thus, a proper solution of managing waste is needed to sustain the environment and reduce human impact towards nature.

The disposal of End-of-Life Vehicles (ELVs) is of high concern to achieve sustainable development in any country. Maximum recovery and recycling needed to be achieved to reduce waste discharge and to change the image of the automobile industry through environmentally sound management. Lately, ELV management has been launched extensively in developed nations to establish an appropriate recycling system using the best available technologies. For European Union, the End-of-Life Vehicle Directive has passed laws to the member countries to reuse and recover 85% by weight of the average vehicle in year 2006 and this percentage is expected to increase to 95% by year 2015.

After the establishment of National Car Project in 1985, the automotive industry in Malaysia has grown tremendously. However, Malaysia has not dealt with the environmental impact of the automotive industry sustainable development. To date, directive or legislation on End-of-Life Vehicles for the automotive industry has not been established even though an attempt was done in 2009 but later withdrawn due to fierce rejection by public. It was known later that the legislation was introduced without proper research and has too many loose ends. As a result, Malaysia have a very low vehicle scrap rate and relatively high vehicle age. Several countries in Asia have started the effort on reversing the problem of ELV accumulation or overpopulation. This campaign was triggered by the European Union (EU) with an ELV law in September 2000 and had since lead Japan and Korea to follow suit with tailored version of ELV Law. These countries recognized that a distinct ELV law is necessary within the framework of the extended producer responsibility (EPR) system. Japan, Canada and Taiwan had reported success in controlling the number of ELV off the road.

Due to the success of countries implementing ELV law, a SWOT analysis on the respective framework had also been done. The results from this analysis will be used to model a new framework ideal to Malaysian current and future condition.

2 LITERATURE REVIEW AND METHODOLOGY
Waste treatment has become an important issue and a serious concern to the environmental conscious society. Concerns about reducing waste during the generation process have been emphasized as the first priority before further treatment. Waste form ELVs is also one of the recently emerging waste streams. This had led to a need to achieve maximum recovery level with less amount of waste discharge. Among efforts to reduce the amount of ELV waste is by extending the lifetime of a vehicle, lowering exhaust gas emissions, and changing materials for easier recycling or recovery in the industry [1]. Waste treatment is required as environmental management practices and to enhance the image of automobile industries. Malaysian National car maker PROTON in response with recent EU legislations, the Directive 2000/53/EC European Commission had to change approach in designing and manufacturing of its product [2].

After 52 years of independence, the Malaysian government had introduced the National Automotive Policy to boost the countries participation in the automotive industry with aiming to be the hub of regional automotive industry. However, the National Automotive Policy has not dealt with the environmental impact of the automotive industry development. To date, directives or legislation on End-of-Life Vehicles for the automotive industry have not been established exclusively. In the EU countries, the directive is seen as a pushing factor for the establishment of an environmentally conscious automotive industry [3]. It is noted that in National Automotive Policy, ELV related policy will be introduced gradually with first implementation which was a mandatory annual inspection of vehicles with 15 years of age or older for road tax renewal. This policy however is later withdrawn.

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End-of-life vehicle recycling in Malaysia however is being done by 5000 small companies bound under associations such as Malaysia Automotive Recyclers Association (MAARA) and working without a standard working practice [4]. The business was run in similar way as regular car workshops thus a proper regulation should be in place to improve and control the current practice in recycling ELV. Vehicles usually imported from developed nations such as Japan and European countries to be dismantled and sourced for parts which are still usable and in working conditions. Unusable components then are sent to the smelter plants to be melted for recycling purpose or sent to the junkyard. Moreover, recycling resources such as engine oil and coolant of air condition units such as chlorofluorocarbon (CFC) is not appropriately handled due to lack of equipment, information and skills. Consequently global warming and soil pollution problems are accelerated. Currently, there is no exact figure available to describe the number of ELVs that have been recovered in Malaysia.

The ELVs directive is needed to boost the number of reuse and remanufacturing vehicles parts-components, increase the number of recycled materials, regulate the use of hazard or toxic materials, and facilitate OEMs in ELVs-recovery programs. As more vehicle manufacturers starting to flock into Malaysia, a regulation is developing sustainable and environmental conscious local manufacturers is seems fairly justified.

The first step for this study was to gain the current practice of ELV Recycling system in Malaysia. For this step, the author chooses to use Qualitative Data Collection and complemented with Quantitative data collection for framework validation later. Interviews seems to be the best method compared to questionnaire because the current situation is unknown or yet to be documented.

The first round of data collection was done using Qualitative data Collection techniques. The chosen methods are interviews and direct observation. A total of 8 companies had been interviewed. 2 of the interviews were done via structured interview while the rest was using participant interview techniques. Each interview only last between 20 minutes to 1 hour. Participant for this interviews are; 5 ELV Recycling companies, 2 workshops and 1 used tire reseller. The best input was provided by the ELV recycling companies.

For the interview questions, a set of open ended questions are being asked. Such questions includes details of how dismantling activities is being done, how the safety of the activities being monitored, how parts reliability and safety are being tested. Second main criteria being investigate is the shredding process while waste which being transferred to landfill is the third important criteria. The question set also includes the environmental related questions such as the awareness of the company on environmental law and legislation. Later, a questionnaire consists of a Current ELV Recycling System to respondents for validation as shown in Figure 1.

![Figure 1: Current ELV recycling system in Malaysia](image)

**3 CURRENT SITUATION**

**3.1 Legislation Requirement**

The first row of Table 1 addresses the legislation by seven countries; Taiwan, China, Korea, Japan, Canada, Singapore, and Malaysia regarding ELV recycling. All mentioned countries have enacted their own version of regulation to enforce ELV recycling except for Canada and Malaysia. Automotive Recyclers of Canada (ARC) estimates that 600,000 vehicles leave the road annually in Ontario. This is half the total estimation of 1.2 million vehicles for Canada. Approximately 1.2 million vehicles are taken off the road annually in Canada. This creates more than 150,000 tons of vehicle waste which is introduced into landfills in Ontario alone. This volume includes contaminated materials which in time will pollute the soil. Despite his huge numbers, law on ELV is still not being introduced by the Canadian government.

In term of jurisdiction and mandatory ELV recycling (also called vehicle retirement), each province in Canada has their own regulations initiative but not in federal government level.
The closest Canadian Government have is the Canada-Wide Action Plan for Extended Producer Responsibility which was introduced in October 2009 [9]. ELV is indirectly included through products of “automotive products such as used oil, filters, batteries, refrigerants, brakes and transmission fluids”. It can be safe to state that Canada ELV recycling is driven by market demand as well as recycling awareness of Canadian citizen. Moreover, a complete framework of Canada ELV Recycling System is yet available which maybe one of the reasons why Canada still lacks in ELV recycling regulations. Plus there is no agency that tracks the number of ELV related materials and how they are handled except for British Columbia. Reference [9] also states that end-of-life is the least studied phase of vehicle lifecycle.

In Japan, recycling is made mandatory for all citizens and corporate entities by various laws implemented by the parliament. For the record, there are 80 million vehicles in Japan and 5 million is being disposed every year [11]. The Japan End-of-Life Vehicle Recycling law which was enacted in 2002 and came to force in 2005 was designed as a response with the increasing number of landfill due to vehicle waste in the island nation, and hike in vehicle recycling fees. The law systematically improves vehicle recycling through specification of car manufacturers and importers tasks as well as customers and government task.

The Japan Automotive Recycling System is designed to minimize illegal dumping possibilities by adopting a prior fee payment arrangement whereby the purchaser of a new vehicle must pay the recycling fee at the time of purchase, while the owner of an in-use vehicle must pay it at the time of the first periodic inspection. Moreover, the recent surge in industrial material prices has made otherwise abandoned ELVs valuable resources to be properly recycled. As a result, according to the Ministry of the Environment, the number of unlawful ELVs in Japan sharply declined from 126,000 units (92,000 units illegally stored and 34,000 units illegally dumped) in August 2001 to only 35,064 in March 2007.

One important contributor for this decline is the introduction of Licence Validity called Shaken which dictates the tough inspection interval of a vehicle shown in Table 2. The tough inspection was required to ensure public safety and environmental sustainability via multiple point testing. The rapid economic development of Taiwan and demand for improved quality of life had pushed the number of motor vehicles to the highest in the past 30 years. From the end of 1976 until the end of March 2009, the number of small vehicles to the highest in the past 30 years. From the end of 1976 until the end of March 2009, the number of small vehicles increased from 11,000 to 85,000 in 2009. Due to the rapid development of Taiwan economy, the number of motor vehicle increase drastically from 10,000 to 11,000 billion in 2009.

### Table 1: Comparison of ELV management system between countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Government Involvement / Act</th>
<th>Manufacturer Involvement</th>
<th>ELV age</th>
<th>Recycling Fees paid by</th>
<th>Operator Size</th>
<th>Effectiveness</th>
<th>GDP Per Capita (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taiwan</td>
<td>Waste Disposal Act / Statute 307 Law on ELV</td>
<td>None</td>
<td>10 years</td>
<td>Manufacturer &amp; Importer pay when purchased</td>
<td>303 Recycling operators, 5 shredding &amp; Sorting plants</td>
<td>95%</td>
<td>36,604</td>
</tr>
<tr>
<td>China</td>
<td>The Act for Resource Recycling of Electrical/ Electronic Products and Automobiles</td>
<td>None</td>
<td>10 years or 500,000km</td>
<td>Market Driven (Collector pay last owner)</td>
<td>367 Recycling operators, 1 pilot recycling centre</td>
<td>90%</td>
<td>7,536</td>
</tr>
<tr>
<td>Korea</td>
<td>End-of-Life Vehicle Recycling Law</td>
<td>None</td>
<td>Not Specified</td>
<td>Market Driven (Collector pay last owner)</td>
<td>226 Recycling operators, 7 shredding &amp; Sorting plants</td>
<td>85%</td>
<td>29,004</td>
</tr>
<tr>
<td>Japan</td>
<td>None (Voluntary)</td>
<td>Take back CFC, Airbag unit, Shredder Dust</td>
<td>Min 3 years, inspection once in 2 years</td>
<td>First owner, upon purchase</td>
<td>5000 Recycling operators, 140 shredding &amp; Sorting plants</td>
<td>85%</td>
<td>33,994</td>
</tr>
<tr>
<td>Canada</td>
<td>Vehicle Quota System</td>
<td>None</td>
<td>Not specified</td>
<td>Market Driven (Collector pay last owner)</td>
<td>-</td>
<td>-</td>
<td>38,915</td>
</tr>
<tr>
<td>Singapore</td>
<td>Vehicle Quota System</td>
<td>None</td>
<td>10 + 5 or 10 + 10 years</td>
<td>Market Driven (Collector pay last owner)</td>
<td>-</td>
<td>-</td>
<td>57,505</td>
</tr>
<tr>
<td>Malaysia</td>
<td>No Law</td>
<td>Proton (AMP)</td>
<td>Proton (10 years)</td>
<td>Market Driven (Collector pay last owner)</td>
<td>209 Recycling Operators, 0 Shredding &amp; Sorting Plant</td>
<td>-</td>
<td>14,591</td>
</tr>
</tbody>
</table>

The Ministry of Industry and Technology (MIT) of Malaysia was established in 1972. The main objective of the Ministry is to accelerate and maintain the pace of industrialization through the promotion, development and encouragement of local industries. The Ministry also assists in the training and upgrading of local human resources and the development of relevant industrial infrastructure.

The proposed framework for the End-Of-Life vehicle recycling system implementation in Malaysia is as follows:

1. **Proposed framework for End-Of-Life vehicle recycling system implementation in Malaysia**

   - **Recycling System**
     - **Lead Users**: Manufacturers, Importers, Dealers, and Consumers
     - **Key Players**: Recycling Operators, Government Agencies
     - **Regulations**: Implementing ELV Recycling Act
     - **Objectives**: Promote the recycling of End-Of-Life vehicles

2. **Implementation Plan**

   a. **Pre-Implementation Phase**
      - **Research and Development**: Conducting studies on ELV recycling technologies
      - **Legislative Framework**: Drafting amendments to existing laws

   b. **Implementation Phase**
      - **Voluntary Recycling**: Encouraging ELV owners to participate
      - **Compulsory Recycling**: Enforcing mandatory recycling through legislation

3. **Monitoring and Evaluation**

   - **Performance Indicators**: Tracking recycling rates, material recovery, and environmental impact
   - **Feedback Mechanism**: Collecting feedback from stakeholders

The proposed framework aims to establish a comprehensive ELV recycling system in Malaysia, ensuring the proper management and disposal of end-of-life vehicles to promote sustainable development and environmental protection.
passenger vehicles has increased from 170,984 to 5,668,581 and the number of motorcycles has increased from 2,009,698 to 14,382,923 vehicles.

<table>
<thead>
<tr>
<th>Vehicle</th>
<th>Expiry Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck, More than 8 tons</td>
<td>1 year</td>
</tr>
<tr>
<td>Truck, Less than 8 tons</td>
<td>2 years</td>
</tr>
<tr>
<td>Bus</td>
<td>1 year</td>
</tr>
<tr>
<td>Taxi</td>
<td>2 years</td>
</tr>
<tr>
<td>Special Vehicles</td>
<td>2 years</td>
</tr>
<tr>
<td>Private car and Motorcycle</td>
<td>3 years</td>
</tr>
</tbody>
</table>

Table 3: China classification of ELV

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Declared as ELV if:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini-size commercial vehicles</td>
<td>Mileage exceed 300,000 km</td>
</tr>
<tr>
<td>Light commercial vehicles</td>
<td>Mileage exceed 400,000 km</td>
</tr>
<tr>
<td>Heavy, medium commercial vehicles</td>
<td>Mileage exceed 400,000 km</td>
</tr>
<tr>
<td>Passenger vehicles</td>
<td>Mileage exceed 500,000 km</td>
</tr>
<tr>
<td>Other vehicles</td>
<td>Mileage exceed 450,000 km</td>
</tr>
<tr>
<td>Mini-size commercial vehicles, including trailers and taxicabs*</td>
<td>Service period exceed 8 years</td>
</tr>
<tr>
<td>Light commercial vehicles and others</td>
<td>Service period exceed 10 years</td>
</tr>
</tbody>
</table>

* taxicabs for 19 passengers or less, light and mini-size commercial vehicles could prolong their service period up to half of the fixed number of years if they pass inspection for compliance with national vehicle exhaust standards.
3.3 Current ELV Recycling System in Malaysia
Based on the first round of interview, a Current ELV Recycling System (Figure 1) had been engineered. In Malaysia, ELV can come from two sources; Vehicle from local market, and Vehicle imported from overseas. All local vehicles which intended for disposal will be required for Deregistration process. This process was meant to unregister the vehicle and to notify the government through Road Transport Department (also known as Jabatan Pengangkutan Jalan, JPJ) that the vehicle is no longer in use, and to strike out the record from JPJ together with all required tax payments. This process also prevents the vehicle from being used as an accessory for crime.

Malaysia also allows its local ELV Recycling companies to import ELVs from other countries. These vehicles will require clearance from Royal Malaysian Customs office. According to the law, any importation of vehicle will require an Importation Approval Permit (or AP). This also applies to ELV importation. In recent news, the government had announced that Open AP for vehicle importation will be abolished from 31st December 2015. It is still unclear whether this move will benefit ELV Recycler or not. The companies interviewed however are confidence that the government will be more lenient with this policy later. Normally, ELV recycler will choose and import the vehicle using their own means of transportation.

All vehicles are later being sent to the Dismantling facilities. In Johor alone, there are 32 dismantling facilities from the total 209 operators registered with the Malaysian Automotive Recyclers Association (MAARA) while the biggest ELV Recycler for local vehicle are in Perak, Malaysia. Here, the documents required for dismantling will need to be inspected for the purpose of verifying owenrship on the vehicle. Reputable companies will not proceed if deregistration documents procured from JPJ are not present (for local ELV) but small scale dismantler often disregard this rule. Imported vehicles on the other hand are easier and only needed customs validation. Documents required are cross checked with the vehicle engine number and chassis number.

Later, the vehicle will undergo a de-pollution stage. Here, all fluids are being drained and stored for respective recycler. Battery, Mercury and other pollutant agents are removed to storage at this stage.

Finally, the vehicle will be dismantled. Useable parts are harvested and enter used spare parts market. Unusable or heavily damaged will be sorted by their respective material which will be sold to recyclers which meant for other industries. Parts which cannot be sold or recycled will be sent for disposal.

During participant interviews and observation, it is learnt that some recyclers do not adhere to the environmental law or guidelines. For an example, engine coolant are being discharged freely into the drains, and air-conditioning gas being freely released into the air. This will lead to a serious impact on the environment. The proposed framework will be required to address this issue as an incorporated part.

4 PROPOSED FRAMEWORK
European Union had targeted to have only 5% of a vehicle weight being sent to landfill by 2015. One of its objectives is to reduce the area required for landfill. Malaysia should also follow this target. If the framework is implemented successfully, the country will be beneficial in term of less land usage for ELV dumping ground, and a new source of economy for the nation. The Framework for ELV Recycling in Malaysia as shown in Figure 2 may assist Malaysia for this ambition.

Responsibility of ELV recycling should not be burdened on users alone. Manufacturers, retailers, recyclers, users as well as government should also work together to solve this problem. The framework empowers ELV recyclers and users to recycle and promote recycling activities. Apart from that, extended responsibility for manufacturers will also suggest them to improve their product through redesign, or simply adapting the design for recyclability and sustainability.

Important parties or stakeholders are also empowered to regulate the involved process. These stakeholders are the recycling associations, government entities, and user associations. Plus, environmental law currently exist will be integrated and internally enforced by the practitioner themselves. The ELV management board will also need to collect all information regarding ELV recycling within Malaysia. All 6R criteria proposed by reference [15] is integrated within this framework. Table 4 shows responsibilities and explanation for each activity. Manufacturers have the responsibility to reduce and redesign the materials and parts respectively. They also indirectly involves in the parts reuse. Apart from that, recyclers, re-manufacturers, part dealers and incinerator also have their own responsibilities.

4.1 ELV Management Board
The ELV Management Board is a non-governmental body which act as regulator as well as auditors for ELV recycling operators. Their function is being modelled after the Taiwan ELV Recycling Fund Management Board.

The board may also assist the government in ELV policy making by providing information and studies regarding ELV Recycling (ELVR) activities. This body is modelled after Taiwan ELV recycling system which the government, recycling associations, and user associations work together to curb ELV problem. The board also have the responsibility of setting Standard Working Practices (SOP) for dismantling, depollution, parts evaluation, and shredding activities. They also may set the standard for safety of equipment and fixed/non-fixed facilities.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Responsibility</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce</td>
<td>Manufacturer</td>
<td>Reduce material variability</td>
</tr>
<tr>
<td>Reuse</td>
<td>Part dealers/ manufacturer agents</td>
<td>Sale of reusable parts collected from dismantling process</td>
</tr>
<tr>
<td>Recycle</td>
<td>Recyclers</td>
<td>Recycle used materials into raw material for manufacturer/ other use</td>
</tr>
<tr>
<td>Remanufacture</td>
<td>Remanufacturer</td>
<td>Damage but still usable parts will be remanufactured/ recondition by OEM</td>
</tr>
<tr>
<td>Redesign</td>
<td>Manufacturer</td>
<td>Design or parts for easy processing</td>
</tr>
<tr>
<td>Recover</td>
<td>Incinerator</td>
<td>Regain the energy locked in the material</td>
</tr>
</tbody>
</table>
Other responsibility is data collection such as number of local and imported ELVs being processed, ASR composition, economic value, recovery rate, or any data deemed useful for improvement of overall ELV recycling system and future sustainability studies. They also responsible in auditing, and provide training and expertise for ELV processors. This function was modelled by Canadian ELV recycling system which has its own Automobile Recycle Association University (ARAU), but here in Malaysia, it is better to integrate this function within the ELV Management Board. Apart from the functions listed, the board are also responsible for the ELV Fund. Recommended member for this board is:

1. MIROS : Malaysia Institute of Road Safety which represent the safety of road users.
2. JPJ : Road Transport Department to avoid fraud or crime related vehicles from being processed unknowingly.
4. Automobile Association Malaysia: represents the users interest in ELVR activity.
5. Sustainable Institute Malaysia: represents the environmental sustainability part, making sure all parties follow the environmental guidelines throughout the process.

### 4.2 ELV Fund Management
This body is responsible in managing fees related to ELV recycling system. They are required to provide monetary incentive for owners who wish to surrender their vehicle for scrapping. The fund management also model Taiwan system. Previously, the Malaysian government entrusted vehicle manufacturer for this fund (one-off incentive) but it's only limited to new vehicle purchase from that manufacturer only.

### 4.3 Sorting and Shredding Plant
Shredding and sorting plant is the new addition to Malaysian ELV recycling system. Failed parts are being sorted
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7 REFERENCES


