

**H-4 Evaluation of prevention measures and the current situation regarding increasing environmental impacts from inappropriate reuse and recycling of end-of-life vehicles and auto-parts from Japan in East Asian countries  
(Abstract of the Final Report)**

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#### 1. Introduction

In recent years, about 5 million vehicles are discharged as waste in Japan every year. According to best estimate, about half of these vehicles are reused and recycled as a vehicle and parts or resources mainly in East Asian countries. However, in the importing countries, the quality of fuel is different from Japan, and the quality control of a catalytic converter is rarely performed due to the change of the engine control method. As a result, a reuse as a vehicle and parts is not only generating significantly more greenhouse gases than usual, but also emitting automobile exhaust gas problems such as NO<sub>x</sub>, SPM, and HC. Furthermore, recycling resources such as engine oil and chlorofluorocarbon-replacing material used as a coolant of an air-conditioner, are not appropriately performed due to lack of information or skills. Consequently, global warming and the soil pollution problems are accelerated.

Vehicle producing nations have the responsibility to mitigate this situation and to establish the wide spread of recycling. Moreover, through fulfilling this responsibility, the environmental improvement effects are large. However, at present, Japanese automakers do not have a policy to deal with the global environmental problems in East Asian countries caused by end-of-life vehicles from Japan. This is common not only of Japanese automakers but the whole world. However, a change in clarifying a producer's responsibility is seen in the present condition with the enactment of Automobile Recycling Laws globally.

Considering the rapid increase in fossil energy consumption and the appearance of end-of-life vehicles in East Asian countries, it is quite important to grasp the current situation regarding increasing environmental impacts from inappropriate reuse and recycling of end-of-life vehicles and auto-parts from Japan in East Asian countries and to evaluate prevention measures.

## 2. Research Objective

The purpose of this research is to build a system which uses and recycles appropriately end-of-life vehicles from Japan which causes two or more environmental problems including global warming. We clarify the following three points:

- (1) Estimation of the amount of flows, use, and recycling of end-of-life vehicle from Japan in East Asia.
- (2) Providing current situation of use and recycling in East Asia by classification East Asia into three types: a country (i.e. Thailand) that predominantly uses the vehicle and parts, a country (i.e. China) that predominantly recycles resources, and a country (i.e. Indonesia) which is performing both use and recycling. The countries for investigation is chosen from each type, and a system, technology, and information for reducing environmental impact at the use and recycle stage are clarified by grasping the current situation of use and the recycling that occurs.
- (3) Proposal of the policy alternatives (for example; introduction of a simple vehicles inspection method, an improvement of the vehicle inspection system, offer appropriate recycling technology) relevant to the scrapped vehicle from Japan based on the result of (1) and (2).

## 3. Research Methods and Results

- (1) Generation of end-of-life vehicle from Japan, and the current situation of measures towards appropriate use and recycling

In 2003, we clarified "export" based on the literature documentation by various materials, and the interview to the persons concerned such as dismantlers. Furthermore, the total export volume from Japan was estimated based on volumes in 2000 using the result of Japanese trade statistics and the interview and the questionnaire about export to the customs in Japan and export of a used vehicle and parts using various statistics. Vehicle NOx law in Japan affects the increase in generation of end-of-life vehicles. Moreover, we provided information on the ARN system in the Netherlands, the used car export problem in Germany and possibility of import of automobile press from Japan in future South Korea via overseas investigation.

In 2004, questionnaire survey on quantity and relation information of the portable type export was carried out to the harbor transportation agent in order to accurately estimate export total amount of end-of-life vehicle from Japan. It has grasped from the hearing investigation to the persons concerned about the present condition of import, use, and recycling of the used vehicle from Japan in New Zealand which imports most used vehicles from Japan in the world. Moreover, We grasped the present condition of the automobile recycling in the Republic of Korea and Taiwan, where a possibility of exporting a used vehicle like Japan is high in the future, by spot investigation.

In 2005, we investigated the impacts of a ban to export an end-of-life vehicle as a sailors' baggage in July 2006. In addition, through the survey of Automobile Recycling Act in EU and oversea investigation in New Zealand and South Korea, we clarified the contents of Japanese Automobile Recycling Act executed from January, 2005.

## (2) Current situation of used and recycle of end-of life vehicles from Japan in East Asia

In 2003, we grasped the compilation of each trade statistics in East Asia which are needed in order to grasp flows as a used vehicle and parts, or resources of end-of life vehicle from Japan to East Asia. Next, The discrepancy problem of trade statistics was verified from the trade statistics of Japan and Thailand. Moreover, we proposed the method of visualizing the final flow. Lastly, The current situation and the concrete problem of recycling by field survey in China were clarified.

In 2004, we proposed the method of creating a database for the grasping and evaluation the international cycle and the related environmental load of the end-of-life vehicle from Japan in East Asian countries, and tried the establishment of database. Specifically, the Asia International Automobile Recycling Input-Output Table that combined the detailed material flow of the end-of-life vehicle estimated from the foreign trade statistics, transportation statistics, a related investigation, environmental load inventory data, etc in East Asia countries with Asian International Input-Output Table was devised, and the creation was performed to for Japan and Thailand in 1995.

In 2005, we added China into the database considering the reliability. We believe Asian International Input-Output Table play an important role of the platform for further studies.

## (3) Impact analysis of earth environment load of use as a vehicle and parts

In 2003, we selected Thailand as a candidate country where end-of-life vehicles from Japan are used a used vehicle and parts in East Asia. In cooperation with researchers in Thailand, the maintenance situation and character were grasped about the statistics relevant to ownership and usage of a used car and parts from the interview to the staffs of a government organization and the collection of the reference and material in Thailand. Furthermore, vehicle ownership and usage in Thailand were modeled using the statistics obtained.

In 2004, we improved a vehicle ownership and usage model for the evaluation of transportation policies in Thailand, and based on this improved model, various simulations were performed such as increase in gasoline tax, subsidy for transit etc. Moreover, in order to develop the method estimating the recycling volume and the environmental loads of end-of-life vehicle from Japan in Thailand, the Input-output model was built from the Asia International Automobile Recycling Input-output Table for Japan and Thailand, which was developed on the sub theme (2). Furthermore, scenario evaluation of individual , domestic recycling system and international recycling system was performed using this Input-Output model.

In 2005, impact analysis of Inspection and maintenance system and deregulation of a ban to import used vehicles are examined using an improved model built in 2004. In addition, we added the case which end-of life vehicles in Thailand are recycled appropriately as resources not in Japan but in Thailand. Scenario evaluation was performed using the Input-Output model.

## (4) Current situation and the technical problem of recycling and the creation of prevention measures

In 2003, we selected China as a candidate country where end-of-life vehicles from Japan are recycled as resources in East Asia. Focused on Shanghai, China, the global image of vehicle ownership, usage and

disposal in Shanghai was grasped by interviews to a used car dealer and a dismantler in cooperation with the local researchers. Furthermore, we estimated the volume, organization, and the contents of vehicle maintenance too.

In 2004, in order to evaluate the feature of the international flow of resources, the material flow of metal scrap of East Asia has been grasped. Next, it has grasped about the present condition of Automobile press imported from Japan in China.

In 2005, we continued to grasp the material flow of end-of-life vehicles in China using a material flow of metal scraps in East Asia and the database built in sub theme (2) to understand the characteristics of international flow of resources. Moreover, we surveyed the updates of policies on an automobile press importing from Japan and analyzed the impact of Automobile press import policy using the Input-output model developed in sub-theme (3).

#### (5) Current situation of use and recycling and the creation of prevention measures at the usage stage

In 2003, Indonesia was selected as a candidate country where end-of-life vehicles from Japan are used as not only a used vehicle and parts but also resources in East Asia. In cooperation with the research partner in Indonesia, an import policy, the actual situation of imports, and vehicle registration and inspection system in Indonesia were grasped via interviews to the persons concerned. Furthermore, we prepare construction of the database relevant to a used vehicle and parts.

In 2004, in order to grasp the import volume of the used vehicle and parts from Japan to Indonesia, the export volume of the used vehicle and parts from Japan to Indonesia have been first grasped from foreign trade statistics of Japan. Next, we grasped the import volume of the used vehicle exporting to Indonesia using the statistics obtained from the Ministry of International Trade and Industry of Indonesia. In Singapore where exports many used vehicle to Indonesia, the existence of the route from Japan to Indonesia via Singapore was checked from hearing from the local researchers. The inspection and maintenance system is observed as measure to appropriate use of the end-of-life vehicle from Japan. In addition, we surveyed the contents and impacts of a green bus program for the preparation to evaluate the validity of the inspection and maintenance system. Furthermore, we collected inspection and maintenance system cost including equipment and management data in Japan for the future cost - effectiveness analysis.

In 2005, we surveyed the inappropriate recycling process of batteries as a typical issues regarding recycling in Indonesia and estimated the environmental loads caused by inappropriate recycling processes. In addition, emission reduction effects of inspection and maintenance system and strengthening the emission standard were estimated.

#### (6) Design of appropriate use and recycling system of end-of-life vehicles from Japan in East Asia using LCA

In 2003, this research extended the existing automobile LCA technique in order to evaluate the second and third life cycle of the end-of-life vehicle from Japan in East Asia. Specifically, the increase factor in an environmental impact of the vehicle in developing country was extracted for the second life cycle of

the gasoline vehicle and a diesel vehicle from Japan in Indonesia, and quantifies using life cycle inventory analysis (LCI), furthermore, evaluates an environmental impact by estimating social external cost using the Life Cycle Impact Assessment Method based on Endpoint Modeling (LIME) which the National Institute of Advanced Industrial Science and Technology developed.

In 2004, Improvement and extension of LCA model were performed, the wide area recycling system was compared with the individual recycling system, and the effect of environmental measure was evaluated from external cost.

In 2005, we improved the LCA model. Applying this model to Indonesia and Thailand, we compared international recycling system with import/export of end-of-life vehicles and domestic recycling system.

#### (7) Examination of the policy for appropriate reuse and recycling of end-of-life vehicle from Japan in East Asia

In 2003, we went to the countries in East Asia which import an end-of-life vehicle from Japan. We explained to the local researchers and established the network with joint research organizations for future research cooperation. Furthermore, we invited Asian researchers to Japan and discussed the joint research proposal which could be cooperated and complemented mutually. We recognized the importance for our proposal to work effectively. Moreover, the import policy relevant to the used vehicle and parts in East Asia was arranged from both sides of regulation without a customs duty and a customs duty from literature documentation centering on the countries in East Asia.

In 2004, each policy subject about usage and recycling and its individual improvement policy of the end-of-life vehicle from Japan arranged for Thailand, China, and Indonesia were summarized in the meeting of a total of 3 times. The meeting aiming at acquisition of the information for examining a more suitable improvement policy and the method development for evaluation of an individual improvement policy in Thailand and China. The researcher at Chiangmai university who is one of the expert of automobile fuel consumption in Thailand, gave us the suggestions on the validity of automobile ownership and usage model of a sub theme (3) and detailed automobile mpg data required for the improvement in the accuracy of a model. In China, through the discussion with the researcher at the Dalian science-and-engineering university, it became clear that differs from the present condition of usage and recycling of vehicle greatly among the regions. The joint research organization for grasping the present condition of usage and recycling of vehicle was built in Dalian.

In 2005, through the comprehensive discussion with overseas researchers on the results of each sub themes, appropriate prevention measures against the environmental issues caused by end-of -life vehicles from Japan in East Asia. We proposed the international recycling system which imports all the ex-Japanese end-of-life vehicles generated in East Asian countries to Japan and installation of optimal counter measures in each country. As the more inappropriate vehicle usage and recycling in importing countries, the more effective this international recycling system becomes, it is quite important to grasp the exact and all-inclusive study on current and future situation of each country and to establish a collaborative international system including Japan for executing our proposal.

#### 4. Discussions

(FY2003)

- (1) it is important to count the quantity which cannot be caught like sailors' belonging export in the present trade statistics for the total export volume of the used vehicle and the parts, or resources of end-of-life vehicles from Japan.
- (2) The environmental policies in Japan, the import policy in East Asia and the social economy situation of other advanced nations may affect the flows of end-of-life vehicles from Japan to East Asia. Moreover, it is also required to grasp the current situation of Germany which has the same problem.
- (3) We should take care of trade statistics which are basic statistics for grasping flows of end-of-life vehicle from Japan, since they have the uncounted portions and the different values between export and import countries.
- (4) Environmental impacts assessment models in importing country should make the best use of the statistical materials of each country.
- (5) In China, almost imported end-of-life goods from Japan are recycled as resources by manual labor. However, it is difficult to continue the method in the long run. Moreover, unsuitable processing is performed in the present condition. As mentioned above, if no measure is taken, this unsuitable processing will cause a big environmental problem in the near future.
- (6) In order to evaluate the environmental impacts generated at the usage stage, the statistics relevant to vehicle ownership and use are needed. However, since the countries in East Asia are not enough as an automobile registration system, statistical accuracy is not necessarily satisfied. Therefore, it is important to examine the accuracy of such statistics in advanced studies from now on.
- (7) It is important to clarify the import policy, an automobile registration system, the automobile inspection system, environmental regulation, and an automobile related taxation system, etc in East Asia for the proposal through this research.
- (8) It is necessary to extend the developed LCA method in consideration of the second and third life cycle so that we can evaluate the impacts between international recycling system and individual domestic recycling system.
- (9) The network with overseas researchers, especially the researcher of a field with large relation is indispensable when advancing research quickly. Making use this network, sufficient argument is important for the further study.

(FY2004)

- (1) In order to estimate the sailors' belonging export which was the subject at the time of grasping from Japan the total export volume of end-of-life vehicle with sufficient accuracy, we should grasp the movements of the Russian ships which occupy the major parts of the sailors' belonging export.
- (2) It is important to grasp the present condition of New Zealand that import a lot of used cars after abolition of a customs duty, in order to catch what the flow of the used car from Japan

becomes when a ban policy of importing used vehicles in ASEAN in the near future.

- (3) It is important to adopt the approach which utilizes effectively the existing statistics, investigation result, and the spot investigation result of this research as much as possible for estimating an international cycle of the end-of-life vehicle from Japan in East Asia.
- (4) In order to improve the method developed for estimation the environmental loads from use and recycling of the end-of-life vehicle from Japan in East Asia, it is important to collect the opinions of the researchers in Asia too.
- (5) Since proper treatment of chlorofluorocarbon and liquid is not fundamentally performed when end-of-life vehicles from Japan are recycled in East Asian countries, a possibility that ozone layer depletion and the environmental problem of soil contamination will become more serious in the near future.
- (6) This research has taken up the import policy, the registration system, the inspection system, and the environmental regulation automobile related taxation system, etc. as a vehicle related policy simulation. In order to evaluate validity of the simulation results, it is useful to collect the previous researches regarding these policies.
- (7) It is necessary to extend the developed LCA method in consideration of the second and third life cycle so that we can evaluate the impacts between international recycling system and individual domestic recycling system.
- (8) In order to carry out our policy proposal concretely, it is important to build the network with the governmental officers in addition to overseas researchers, and to discuss continuously about the result of this research.

(FY2005)

- ( 1 ) End-of-life vehicles exported as sailors belongings, which are a crucial issue for estimation of total amount of exports from Japan, has been banned since July, 2005. However, the difficulty of estimation does not change because they are exported as an used parts. We have to keep taking care of sailors belongings.
- ( 2 ) In the near future, when used vehicle imports will be permitted in ASEAN countries, many Japanese and South Korean end-of-life vehicle imports may increase dramatically, according to our investigation in New Zealand and South Korea. To deal with this end-if-life vehicle issues, we should establish collaborative relationship among related countries for minimizing negative environmental impacts.
- ( 3 ) In this research, though we built a database on generation and recycling of end-of-life vehicles, evaluation models for vehicle usage and recycling, they are applied to some countries such as Thailand and China. Applying to other East Asian countries is strongly required together with the cooperation with governmental officers and researchers in related countries.
- ( 4 ) In recycling of end-of-life vehicles from Japan as materials in East Asian countries, especially, batteries are not recycled appropriately regardless of the law asking for appropriate recycling. Not only enactment of law, but also counter measure for operation is urgent business for us.

- ( 5 ) Inadequate importing policy, vehicle registration system, inspection and maintenance system and environmental regulations are major causes that accelerate the environmental problems on usage and recycling of end-of-life vehicles from Japan. Counter measures should be built considering correlations among these policies.
- ( 6 ) We developed an LCA model which can evaluate the measures on usage and recycling comprehensively, and showed the effectiveness of international vehicle usage and recycling system. However, the results are limited only in Thailand and Indonesia and gasoline-powered vehicles. For more realistic system, the enhanced LCA model should be applied to many other cases and generalized the outcomes.
- ( 7 ) Networks with not only overseas researchers but also governmental officers are quite important to execute our proposal of international vehicle use and recycling system via extensive discussions on our research results.