Accelerated product quality verification through real-world high-mileage driving in a short period of time

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Summary

The model cycle of JATCO's transmissions has been shortened in recent years in order to cope with rapid changes in customers' vehicle requirements and in the environment surrounding vehicles. Consequently, it has been necessary to shorten the period for verifying the real-world quality of our new products and ones that incorporate new technologies. We have so been investigating high-mileage transmissions recovered from customers. However, that method alone requires considerable time to verify the real-world quality of our products in the field. Consequently, it has become necessary to recover high-mileage products more quickly in order to cope with the need for a shorter model cycle.

To ensure that we supply products that satisfy customers, it is absolutely essential to eliminate any dissatisfaction with the transmission perceived by customers while driving. Toward that end, we initiated an activity to install our new products and ones featuring new technologies in vehicles that undergo high-mileage driving in a short period of time in real-world environments. This approach enables quicker verification of product quality in the field than the previous method. Data are constantly collected during driving in a wide range of environments and situations for subsequent analysis, enabling confirmation of the degree of customer satisfaction with the transmission and the occurrence of high input loads that might lead to transmission failure. This article describes the market fleet activity that enables high-mileage driving in the real world in a short period of time and presents typical results obtained with this method.

1. Introduction

JATCO has been manufacturing automatic transmissions for over 50 years. In order to continue to provide products satisfactory to customers, we have been recovering used transmissions that accumulated high mileage during customer use and investigating them for the purpose of improving the quality of our products in the field.

The model cycle of our transmissions has been shortened in recent years in order to respond to rapid changes in customers' vehicle requirements and in the environment surrounding vehicles. In this connection, we are continuing to verify the quality of our transmissions in the field in relation to product deterioration revealed by investigations of high-mileage transmissions recovered from customers as has been done to date. In addition, in
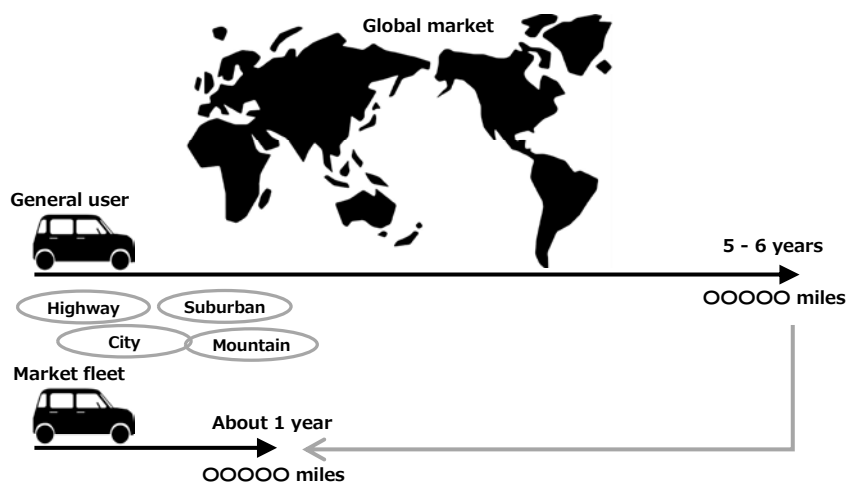

Fig. 1 Market fleet overview

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order to cope with the shorter model cycle, it has become necessary to recover high-mileage products in a shorter period of time and to provide immediate feedback.

Moreover, what drivers demand of transmissions while driving has also become more rigorous owing to diversification of driving environments and the ways vehicles are being driven nowadays. To solve these issues, we decided to initiate a market fleet activity in order to recover and investigate high-mileage transmissions quicker than with the previous method and thereby accelerate verification of product quality in the field.

2. Overview of market fleet activity and driving conditions

This section gives an overview of the market fleet activity and the driving conditions. Market fleet refers to a method of shortening the period for recovering high-mileage transmissions by having a staff of local professionals drive fleet cars approximately 500-1,000 km a day. In this way, the high mileage that ordinary users would accumulate in 5-6 years can be reached in approximately one year.

The routes driven include city roads, suburban roads, highways, mountain roads and others so as to reproduce the driving environments and ways of driving vehicles actually experienced by customers. This approach achieves highly accurate verification of product quality in the field (Fig. 1 and Table 1).

In addition, data on the vehicle and transmission are constantly collected during driving for subsequent analysis. This enables verification of the accuracy of the input loads that were assumed in the product development process.

The transmissions of market fleet vehicles that have reached the mileage target are then recovered from the field, disassembled and analyzed. If the results show that the component parts have deteriorated more than was expected or reveal deterioration suggestive of a potential cause of a failure, the input loads inducing such deterioration are analyzed based on the driving data recorded for the vehicle and transmission. This makes it possible to verify the progression of such deterioration and to make improvements so as to prevent potential problems.

Fleet vehicle drivers are also asked to comment on vehicle behavior from a customer's perspective. Vehicle operating conditions relevant to their comments are

Table 1 Driving conditions

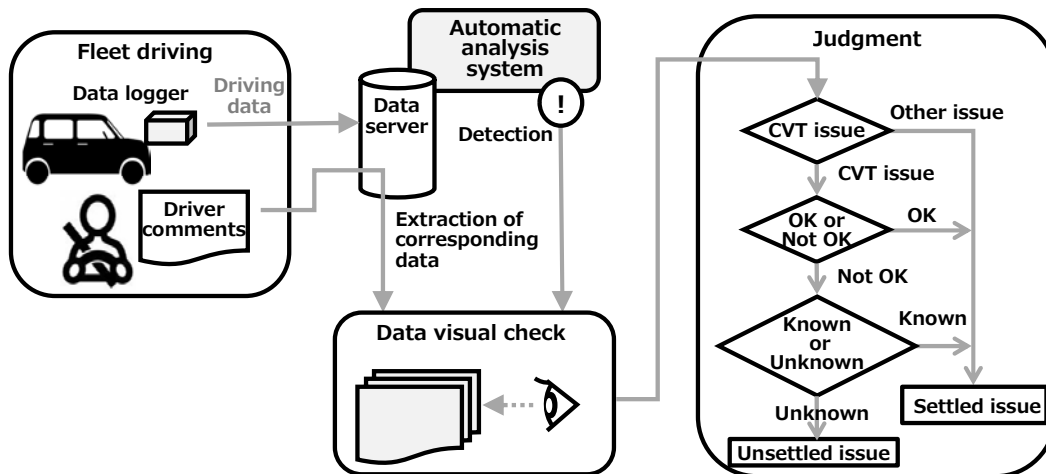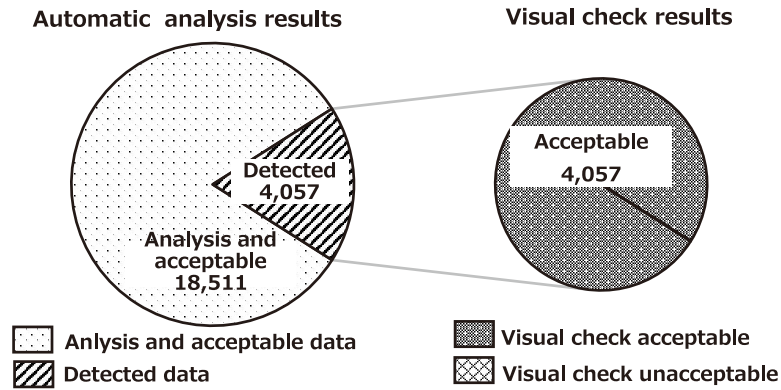| Vehicle	Mini-vehicles ~ Ordinary passenger cars
Regions	US & JPN
Routes	City roads, Suburban roads, Highways, Mountain roads, etc.
Mileage / time	High mileage that a customer accumulates in 5 or 6 years is reached in about 1 year.
Procedure	Vehicles are driven by professional staff to focus on the ways of driving in the test area

Fig. 2 Driving information analysis method

Automatic analysis results

Visual check results

Detected
4,057

Acceptable
4,057

Analysis and
acceptable
18,511

▦ Anlysis and acceptable data
▦ Detected data

▦ Visual check acceptable
▦ Visual check unacceptable

Fig. 3 Automatic analysis results (example for one vehicle)

Analysis results for driver's comments

Visual check results

Other issues
39

CVT issues
28

Settled issues
28

▦ Other issue
▦ CVT issue

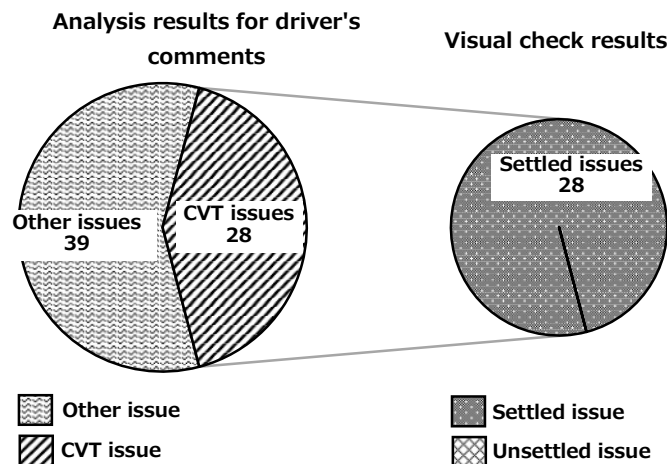▦ Settled issue
▦ Unsettled issue

Fig. 4 Analysis results for drivers' comments (example for one vehicle)

analyzed based on vehicle and transmission data. This enables comments concerning the transmission to be separated from others pertaining to the vehicle itself. Comments can thus be divided into those at a level that customers might perceive as unsatisfactory vehicle behavior, already known phenomena that are not a problem, and unknown phenomena for which improvement is necessary, among others. This leads to the development and manufacturing of products satisfactory to customers (Fig. 2).

3. Results of market fleet implementation

3.1 Results of automatic analysis of driving data

Data on the vehicle and transmission collected during driving are analyzed by an automatic analysis system. This enhances detection sensitivity for extracting data without omitting or overlooking anything with respect to high input loads that might cause a transmission to fail during customer use. The staff then analyze the extracted data in detail in order to judge whether or not high input loads were actually applied.

All the data collected during driving pertaining to the vehicle, location and mileage target were automatically analyzed and also analyzed in detail. The results showed that there were no high input loads to the transmission as described in the following example. The automatic analysis system detected approximately 4,000 cases of data suspected of indicating high input loads that might lead to acceleration failure or inability to drive. However, the results of the detailed analysis revealed that there was no problem with regard to any of the data (Fig. 3).

3.2 Analysis results for drivers' comments

Concerns expressed by the fleet vehicle drivers about vehicle behavior from a customer's perspective were analyzed and the results revealed that there were no unknown phenomena requiring improvement. As one example, there were 28 cases of concern about the shifting of the transmission and other aspects. However, as a result of comparing the drivers' comments with the phenomena in question, it was found that all cases involved known phenomena that did not require any improvement (Fig. 4).

3.3 Results of disassembly and inspection

Transmissions were recovered from vehicles that reached the mileage target in each region and the degree of deterioration was confirmed quantitatively by disassembling the units for a visual inspection and precision measurements. The results of the visual inspection of the appearance of disassembled parts confirmed that the gears, clutches and other components were not broken or damaged. No deterioration was found that would lead to transmission failure (Fig. 5).

Precision measurements were made of wear and other conditions. The data were compared with the results of previous investigations of high-mileage transmissions recovered from the field. It was confirmed that there was no abnormal deterioration (Fig. 6).

As described here, for transmissions that completed the mileage target without any problem, the level of deterioration of the component parts was within the expected range. There were no signs of anything that might become the cause of transmission failure. The results thus verified that the investigated transmissions possessed sufficiently high quality for high-mileage driving in the real world.

4. Conclusion

The implementation of the market fleet activity has markedly shortened the time needed to investigate used transmissions compared with the previous method of recovering transmissions from customers. This has made it possible to verify the real-world quality of our products much quicker than before.

Data on the vehicles and transmissions recorded during driving were comprehensively analyzed automatically and drivers' comments about vehicle behavior were analyzed in detail. This method provides highly reliable and accurate verification of real-world product quality as well as enabling valuable feedback to the quality assurance standards used in product development and manufacturing.

Accordingly, the market fleet activity described here is an extremely effective method of assuring product quality in the real world.
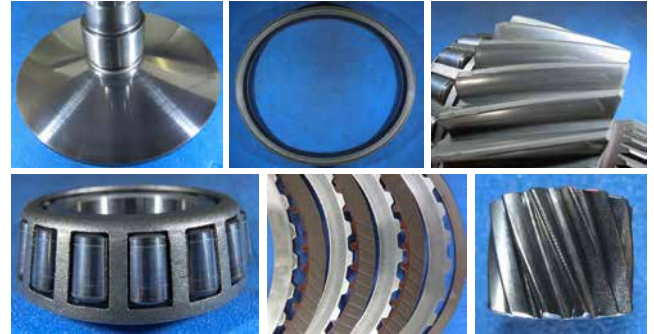

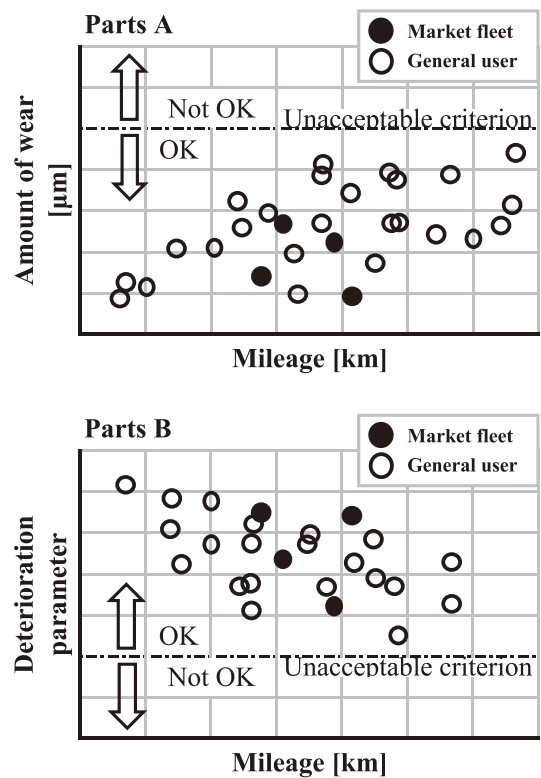Fig. 5 Disassembly and visual confirmation

Fig. 6 Precision measurement result

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