Easy and Portable Off Board Diagnosis Service Management System for Vehicle Troubleshoot

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Abstract

Throughout the evolving advanced technology in the Automobile Industry, diagnosing and servicing vehicles have always concerned more for the vehicle users. Highly integrated On-Board Diagnosis (OBD) in the vehicle system helps the technician to quickly understand faults in the Engine and After Treatment System (ATS). Complex vehicle control system interacts with the cluster to trigger the fault information to the drivers to fix issues before they get worse supporting proactive solution by Malfunction Indicator lamp (MIL), Diesel Particulate Filter (DPF) clogging and other important system safety related lamps. These On-board cluster features are useful for drivers, but diagnosing these problems is always accompanied by testing equipment and printed manual procedures.

This paper provides an easy and handy Diagnosis Service Management (DSM) in every user pocket. DSM mobile application would support customers to instantly address any vehicle issues with relevant guidelines and troubleshooting procedures which in turn saves the effort of a service technician. Mobile DSM is highly helpful for conditions of off highway vehicles located away from city service centers. The devised off board methodology of addressing issue has reduced the complexity and confusion to the driver at first place. A precise off board solution to solve a highly complicated vehicle technology is more cost saving and attains greater customer satisfaction.

1.Introduction

1.1On Board Diagnosis (OBD) system and challenges

Any vehicle manufacturers are legally responsible to produce vehicle with low emission technologies. All on-road and off-road vehicles are certified only when the emissions or pollutants are within the limits. So importantly heavy machineries of exhaust gases treatment technologies are to be integrated to lower the emissions from the vehicle to the environment. At the same time in addition to the emission standards, vehicles must be equipped with a diagnosing system called OBD (On Board Diagnosis) for monitoring all the complex integrated system in the vehicle. OBD serves as an important part for environmental protection. Because OBD gathers all the vehicle information from the sensors. OBD system comprises of a central system, links from the sensors, a common connection point and indicators. The engine ECU collects and uses the gathered information from the sensors to monitor the vehicle behavior. The OBD's ECU now interprets all these collected information and stores it as a Diagnostic Trouble Code (DTC). Based on the saved DTC errors the ECU sends signals to the cluster to turn on early warning lamps like Malfunction Indicator Lamps (MIL), NOx lamps etc. Major challenges are trouble shooting these faults by the driver or the service technician in this sophisticated vehicle system to identify the likely area of malfunction by means of error codes.

1.2 Off-highway vehicles OBD legislation

While OEMs have been monitoring emissions and aftertreatment activity throughout the progressing tier regulatory norms, off highway sectors now comes into the zone of tightening in monitoring and detection of emissions and failure of emissions control systems which necessitate the use of new sensor technology. The significant cost jump as newer technologies are to be introduced going from conventional to full scope electronics where after treatment systems has called for OBD monitoring in the off-road vehicles. But compared with on-road applications there is also a significant difference in the levels of cleanliness and other critical actions in the vehicles. OBD legislation and rules require all emissions related diagnostics to be compatible with standardized fault management and driver warnings, ensuring greater common denominator across the on-road and off-road applications in aid of service technicians. OBD system will be much more complex because of the off-highway vehicles operating regions and conditions as an increased possibility of noise, vibrations and harshness with frequent start and stop driving. Emission related systems being diagnosed in these vehicles includes fuel, exhaust gas regeneration, cooling system and ATS which all influence the performance and fuel economy. So, it is always good to have early awareness to the deviations in these systems could improve power and operating costs over the life of a vehicle, as well as emissions.

1.3 OBD trend in Off-highway sectors

In earlier days, CEV3 vehicles were built with conventional clusters that are analog where the engine and after treatment systems are completely mechanical operated and there was no concept of OBD during those days. Evolving to CEV4 engines, that are controlled by electronic control unit, the concept of OBD was emerging to monitor the engine with very few indicator lamps for driver assistance. Advancing to CEV5 emission regulations, as much of complex systems has been integrated to the vehicle, the clusters is becoming for sophisticated which increases the complexity of troubleshooting for the driver and the technician (Figure 1). In addition to the most important warning lamps in the cluster, now with the inclusive of DPF systems in the CEV5 systems requires indication for DPF related warnings. Earlier notification of system issues will allow earlier intervention in simpler repairs and reduce the number of vehicles that reach a more serious secondary failure because an operator was unaware of the initial failure.

Figure 1: Advanced features of OBD clusters for CEV5 Vehicles

2. Customer support-Importance of diagnosis service management

Educating drivers and service technician has always been a concern for any OEMs. In the off-highway vehicles when the system throws a fault, diagnosis of the fault becomes tedious. The operator has to get the vehicle to the service station as soon as conveniently possible because there is a problem that could be causing the vehicle to no longer be emissions compliant. It is important for the technician and driver to clearly understand and communicate when the warning lamps are illuminated. Hence it must be made it easier for technicians to fix detected problems by providing a standardized method for diagnosing and repairing malfunctioning components as the level of understanding the problem will be much higher even at the technician.

Diagnostic Service Management (DSM) is a procedural document helpful for vehicle service technician to investigate and fix vehicle failures. DSM provides Potential root cause for the indication lamps in the OBD clusters. It contains all necessary ideas to troubleshoot the issue like DTC code, fault description, inspection method, electrical threshold of the fault, torque limitation, corrective action, driving cycle detection and healing. A proper guideline must be stipulated which helps the technician to deal and address the faults in the complex vehicle routing system. When a vehicle is reported for a fault, the technician must connect the OBD diagnosis tool and check for the DTC error codes. The number of error codes is increasingly high 300 and 400 respective to the vehicle application. Each error code points out to a different problem in the system. Why has the fault come? How to rectify?. A proper methodology of resolving the issue must be provided to the operator. Initially understanding the vehicle layout and the system integration itself is a challenging role for any service technician to identify the issue, further the right inspection and the corrective action has to be carried out to clear the vehicle.

2.1 Steps involved in Diagnosis Service Management

Step 1: Verify the failure indication in the cluster for OBD vehicles.

Step 2: Analyze the type of scan tools that are used to assess vehicle components.

Step 3: Perform basic vehicle routine test and visual inspection.

Step 4: Retrieve the Diagnostic Trouble Code (DTC) through the scan tool from vehicle cluster.

Step5: Describe the fault, diagnosis procedure and detection method from the DSM.

Step 6: Narrow the fault in the vehicle and identify the root cause of the failure.

Step 7: Follow the inspection and corrective action guidelines through the DSM.

Step 8: Perform the repair and conduct a universal drive cycle.

Step 9: Educate the drivers on system failure and troubleshooting methodology.

Figure 2: Vehicle Troubleshooting Procedure

3. DSM Evolution

3.1 Traditional method

Traditional way of documenting the service manual has been the standard way followed by all the OEMs as seen in figure 2. Access to the documents in the moment of troubleshooting is not an easy practice for any technician. Especially for off highway vehicles like tractors, forklifts, cranes, combine harvesters, and bulldozers driving the vehicle to the service station for any reported issue is laborious. Not all the operators will have the access to the paper document for understanding the issue and even perception of the problem might differ from technician to technician. The diagnosis service manual is unique for each vehicle application variant hence the number of documents increases as the vehicle types increases. Each DSM comprises a list of respective vehicle error codes, fault names and its description. Each fault has its own threshold for fault triggering, inspection, and corrective actions. Some critical faults have to be resolved immediately in a faster and proper way else it influences on the vehicle operating conditions.

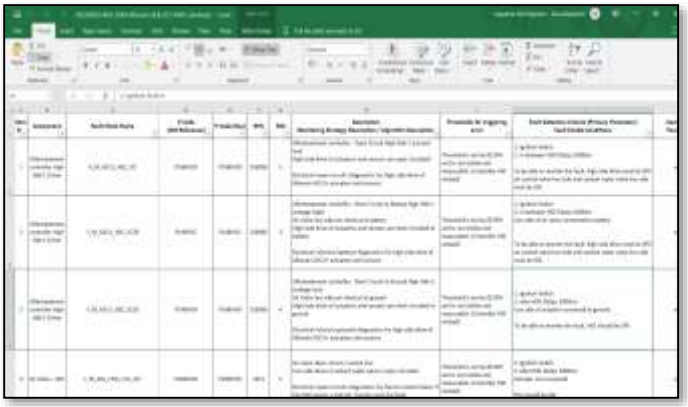

Figure 3: DSM Traditional methodology- paper documentation format

Excel or workbook is used for creating diagnosis service manual as in figure 3, traversing throughout the workbook to locate a particular fault is difficult and puzzled. Wrong diagnosing of fault will lead to vehicle misbehavior and will not solve the issue. Searching the faults across different workbook sheets is a tedious job for any technician and leaves the situation in increased anxiety.

3.2 New Generation DSM- Off Board diagnosis

To overcome the effort of service operators during fault investigation, an easy way of access to the DSM is highly important. The below two are the major evolution of DSM.

3.2.1 DSM for Desktop

DSM desktop application was created to visualize any fault and its details in one single page. We had built our own application software for desktops. This application has preloaded DSM workbook at its back end. When the fault name or error code is typed or searched from the list of available faults for the selected vehicle application, all the necessary details of the faults are emerged. This way the technician can easily investigate the trouble shooting methods and clear the problem in the vehicle. This DSM application provides an advantage of searching fault in the DSM directory using any of these input from the vehicle fault name, p_code, SPN, FMI. But this application displays very limited and necessary information like threshold, inspection method, corrective action and torque limitation.

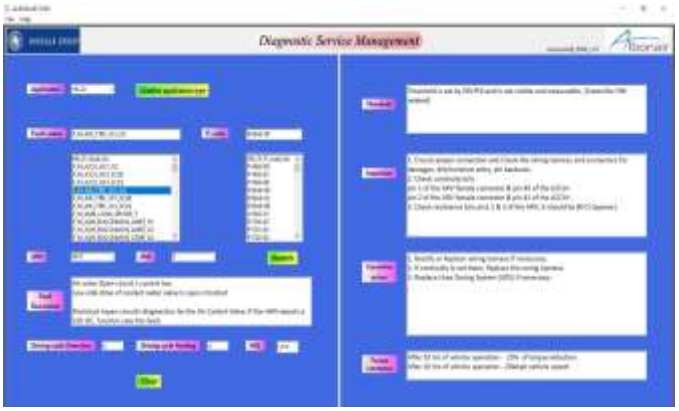

Figure 4: Desktop DSM Application view.

The Figure 4 shows the single page visualization of the detailed information a selected error code. But usage of laptops are limited among the service technicians in the remote locations and again access to the laptop every time is a difficult practice for any technician.

3.2.2 DSM for mobile

Thinking of an easy way to access even at a worst situation put our thoughts to the mobile phones, this mobile application was developed inhouse aims to provide an off-board diagnosis support for the technician. It's a very handy and a portable solution that provides an on-time guidance and assistance to the service operators when the vehicle reported at service center for problems. Mainly this mobile application supports in the conditions of troubleshooting off- highway vehicles located away from the city service centers. This user-friendly application is easy to use from any new technician to lay man.

3.2.2.1 Best features of Albonair Mobile DSM.

Figure 5 DSM Mobile app screen1 and screen 2

Gathering the basic information from the vehicle, the user will logon to the mobile app and fetch the necessary guidance for investigation. As shown in the figure 5 screen 1, the user can first select the vehicle type in the available drop-down list customized for each OEM and can choose the search criteria based on the error information available from the vehicle scan tool. The error information in the vehicle can be in the form of p-code, Fault name or SPN and FMI. This app already has a preloaded list of p-codes and fault type for the selected vehicle application that makes the user to easily select the exact error code as shown in the figure 5 screen 2.

Figure 6: DSM mobile app screen 3

As soon as the selected p-code is searched, a relevant information about the p-code or DTC code will appear. Certain diagnostic data like fault thresholds is available to understand the root cause of the issue.

The major parts or area to inspect and the corrective actions to be undertaken are guided through this application. For some critical faults the vehicle is set for a torque limitation. For any new technician or operators, it would be difficult to locate the exact component of failure. This app provides the picturisation of the component under fault as shown in the figure 6.

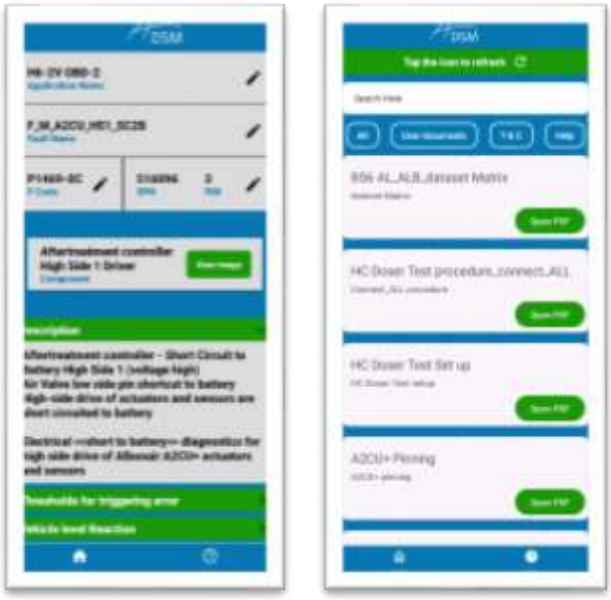

Figure 7: DSM Mobile app screen 4

DSM mobile application not only act as service manual, it also helps with other supporting document required for service engineer in case of immediate reference as listed in figure 7 screen.

Benefits:

- Rather searching for the fault across different excels, this application reduces the effort of the field or service engineers while attempting to address vehicle failures.
- This app is much user friendly to access and it provides ready list of all fault code, fault name, SPN and FMI based on your application type.
- Easy for beginners to understand quickly about DSM and user can have an easy access to the app even in the remote area without internet connectivity.
- DSM mobile application was developed inhouse in aim to integrate DSM of all Albonair applications for easy visualization of detailed information of fault code solutions.
- Downtime of the vehicle is very less as the technician fastly rectifies the issue and clear the vehicle. At the same time servicing cost and effort is also reduced.

Summary

Vehicle trouble shooting methodology differs for each OEMS, the one traditional methodology still in field practice is documentation. Any technician and operators should always have access to a lot of documents to educate himself and address the issue in the vehicle. Apart from the DSM manual there are many other customer assistance documents for understanding the vehicle operation. As the number of documents increases with respect to the vehicle application type, the technician wasting his time to find the right documents increases the vehicle breakdown time for the customer and impacts the reputation of the company service or service center. Moving from paper-based documents to desktop application finds an easy solution for accessing the materials, but still as the off- highway vehicles are mostly operated in remote areas, accessible to the laptop or desktop becomes difficult. This paper devises a cost-effective solution of mobile DSM that benefits the customer and technician to have an easy and handy solution in pockets, with this now troubleshooting the vehicle becomes an easy job and reduces the effort of the service engineers.

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Definitions/Abbreviations

DSM	Diagnosis Service Management
ATS	After Treatment System
MIL	Malfunction Indicator Lamp
ECU	Electronic Control Unit
OBD	On Board Diagnosis
DTC	Diagnosis Trouble Code
OEM	Original Equipment Manufacturer
CEV	Construction Equipment Vehicle
DPF	Diesel Particulate Filter
SPN	Suspect Parameter Number
FMI	Failure Mode Indicator