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END OF LINE DIAGNOSTICS SYSTEM ANALYSIS ENRICHMENT OF ELECTRIC VEHICLES

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Abstract— One of the most crucial considerations for electric vehicles is functional safety. The complexity of electrical and connecting parts increases along with the increase in the number of electric cars on the road. To allow quick corrective action to be taken in the event that a component fault is discovered and thereby prevent system breakdowns, develop dependable and strong On-Board Diagnostics (OBD). This is one way to increase the practical safety of EVs. In this research, we develop a systematic diagnostic strategy based on various faults observed on the assembly line. On an assembly line, a number of issues, such as pin bends, improper wiring harness routing, incomplete connections, and loose connections, can arise when making cars. Electrical circuit errors at the end of the line are one of the greatest problems with the parato chart. One of the most crucial aspects of functional issues is end-of-line diagnosis of electrical circuitry. As a result, in this paper, we go over the On Board Diagnostics, Working of On Board Diagnosis, action plan for different flaws, CAN bus, ARAI requirements for functional safety, etc.

Keywords—Fault diagnosis, Electrical Connections, Functional Safety, Electrified Vehicles

I. INTRODUCTION

A. Introduction to On Board Diagnostics (OBD)

Fig.1. OBD Scanner [22]

On-Board Diagnostics, or OBD, is a computer device inside a car that monitors and controls performance. [6] In the automotive sector, having access to diagnostic information from Electronic Control Units (ECU) is crucial for both product development and life cycle support. [2] This vehicle's on-board computer system gathers data from a network of sensors, which it then uses to control various auto systems or notify the driver of potential issues. [6] To gather vehicle data and identify the issue, a technician need only plug into the OBD system.[6] Users can now more easily comprehend vehicle diagnostics thanks to OBD systems.[6]

The 1980s mark the beginning of OBD's existence. [6] Modern electric vehicles are powered by Li-ion battery packs. They must be closely supervised because of how perishable they are. [3] Understanding the battery's degradation is also becoming more and more crucial, not just for car makers but also for vehicle users, in addition to on-board monitoring of safety and range. [3] Following suit, the European Union passed laws requiring OBD systems to be installed in all new cars.[1] Vehicle monitoring systems were created during this period in response to a number of factors, such as:[6]

The majority of automobiles on the road nowadays are fitted with the Controller Area Network (CAN) bus, and a modern car may have up to 70 electronics control units. [4] Control of emissions: OBD's development was primarily motivated by the desire to aid in the reduction of car emissions. [6] In order to detect any system failures that might lead to higher emissions, OBD systems monitor the operation of key engine components. [6] OBD is included in EPA literature on the implementation of the Clean Air Act because it is so useful in this field.[6]

Electronic fuel injection: Automobile manufacturers started mass-producing cars with electronic fuel injection in the 1980s. [6] Electronic fuel injection, in contrast to mechanical fuel injection systems, is controlled by a computer system, which keeps track of and regulates the fuel intake into the engine.[6] In the majority of American states, OBD emission testing for light motor vehicles (LMV) are not only available but are taking the place of traditional tailpipe tests, and recommendations are made for heavier vehicles. [5]

Electronic components: As electronic fuel injection became more popular, more electronics started to appear in vehicles, which increased the demand for more complex monitoring systems to aid in more precise problem identification.[6]

Vehicle monitoring systems have experienced numerous iterations since their conception. Today, OBD acts as a standardized system that specifies the connectors and error codes to be used, making it simple for technicians to swiftly and accurately service a variety of vehicles.[6] OBD inspections have been implemented in the European Union by the Netherlands, and on the Asian continent by Korea's I/M programmes. [5]

B. Working of On Board Diagnostics

In order to create a comprehensive monitoring system with standardized access and readability, a fundamental OBD system comprises of a central system, a network of sensors, a connection point, and indicators. [6] The main elements make up the OBD system:[6]

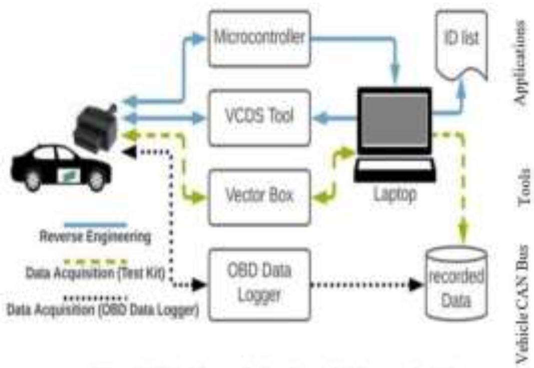

Fig. 2. Working of On Board Diagnosis [3]

The OBD system's beating heart is the Electronic Control Unit, or ECU. Numerous sensors dispersed throughout the vehicle provide data to the ECU. [6] This data is used by the ECU to control various parts of the car, such as the fuel injectors, or to monitor potential issues.[6] The OBD protocol used in modern automobiles is based on the Controller Area Network (CAN bus) architecture, a vehicle communication bus standard designed to let controllers, sensors, and actuators interact with one another without a host computer. [7]

Sensors are present in every component of a car, including the engine, chassis, and electronic system. [6] Each of these components sends codes to the ECU that contain information about the signal's source and other specifics. [6]

After that, the ECU "reads" and decodes this information.[6]

DTC: When a sensor provides data that is outside of the intended range, the ECU records the information as a code known as a Diagnostic Trouble Code, or DTC. [6] The DTC code is essentially a collection of letters and numbers that specify the cause and type of the issue.[6] DTC codes are normally uniform but may vary by manufacturer.[6] When a DTC is saved, the ECU alerts your indicator light that a problem has been found. [6] By connecting a sensor to the OBD system connector, the DTC can also be extracted.[6] Disconnect the component connector (causing an open circuit) if there is a short circuit DTC in the ECU to determine whether the issue is in the wire harness or the sensor, and then re-read the fault code status to check whether the status changes (where applicable). [8] If the fault code changes, such as when an open circuit DTC occurs, the problem is with the component's internal circuit. [8] If the fault code stays the same, the problem is with the wiring harness.[8]

MIL: The electronic equipment also assisted in recognizing and diagnosing the engine breakdown modes. [8] When a malfunction was discovered, the system recorded the pertinent information for a technician to review and activated the Malfunction Indicator Light (MIL) on the dashboard of the car.[8] In general, a minor issue exists if the light comes on and remains on. [6] If the light flashes, a pressing issue exists.[6]

Fig. 3.Illustration of using vehicle CAN bus [21]

DLC: All of the data and DTC codes gathered by the ECU are accessible through the Diagnostic Link Connector, or DLC. [6] The point of entry for automobiles with OBD systems is the DLC port, which is often positioned underneath the dashboard on the driver's side of the vehicle but may also be found elsewhere in commercial vehicles. Any scan tool with a type 2 cable can attach to the type 2 connector because the OBD II system in contemporary cars is made to be universal.[6]

C. Working of vehicle can bus

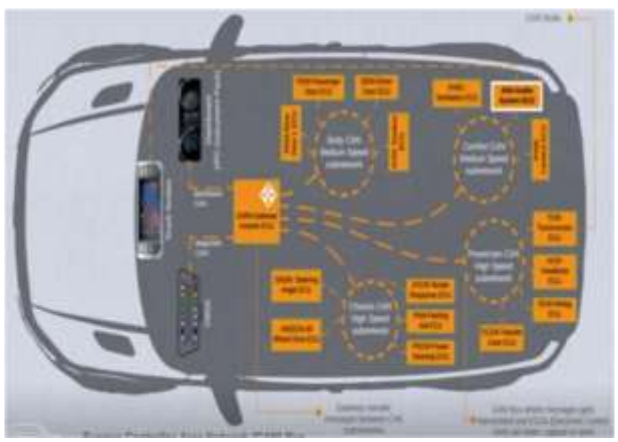

Fig. 4. Working of CAN bus [8]

Since Robert Bosch GmbH initially launched the Controller Area Network (CAN-Bus) protocol in 1983, a wide range of industries, including the home appliance, healthcare, and entertainment, have adopted it. [7] Electronic control units, or ECUs, are a class of electronic components included in modern automobiles. [8] The 20 to 100 ECUs found in a typical car each govern one or more unique vehicle characteristics. [8] The Controller Area Network (CAN) is one in-vehicle communication network that connects these ECUs, which are spread throughout the vehicle. [9]

One ECU that monitors and keeps track of numerous accessories in the car door is the DCU (Door Control Unit). [8] Driver DCU has features such as close-open doors, mirror folding, child lock safety, automated window movement, and mirror adjustment. [8] We employ a deep learning technique in areas like voice recognition, weather forecasting, market research, etc.

since artificial intelligence (AI) is the current leading technology with recognized usage in many different fields. [10]

The CAN bus, which is a network of two electrical lines (CAN_Low & CAN_High) in automobiles, allows data to be transmitted to and from ECUs. [8]

The CAN is the name of the internal automotive network that enables communication between ECUs. Network for controllers. [8]

The smaller networks that make up the vehicle's CAN network are connected via a Gateway Module ECU. [8] A node is an individual ECU with a CAN driver and CAN Transceiver.[8] The arbitration identification (ID) field of each transmitted CAN frame identifies the priority of the packets.[11] The ID bit value decreases as the packet's priority increases.[11] This protocol seeks to avoid CAN bus traffic collisions.[11]

To share information and decide how to respond, ECUs need to be in communication with one another. [8] If the door of your automobile were to open, for instance, a message indicating that the door is open would be broadcast on the comfort CAN. [8] The AHU-Audio System ECU would then pick it up and display it on the touch screen.[8] CAN's durability is a result of the security features that are currently in place. [12] In order to cut down on noise, the CAN protocol uses two voltage levels: dominant logic "0" and recessive logic "1".[12]

Another illustration, presuming rearward gear was chosen: [8]

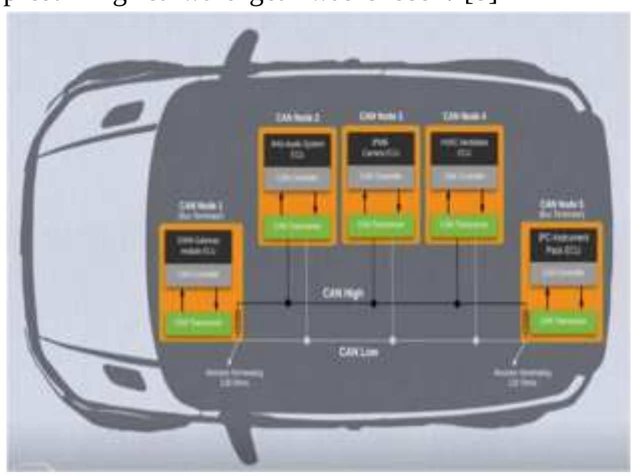

Fig. 5. CAN Subnetwork working [8]

A message delivered over the CAN network would inform any interested ECUs of the choice of reverse gear. The AHU-Audio ECU would recognize the signal and show the rear view camera in place of the information that is now displayed on the touch screen. [8] The signal would also be detected and turned on by the ECU of the reverse light. [8] Some ECUs interact with both the car's internal network and the outside world. [8] The greatest security threat comes from these ECUs.[8] Using an error frame, the special purpose CAN controller overwrites bogus messages in real time. [11] The only new hardware required for the suggested security monitoring system is the monitoring node on the CAN bus, which could be seen as a benefit. [13]

CAN bus advantages include:

Data move really quickly.

Low cost, light weight, and toughness.

Smart sensors lower the quantity of sensors and wiring on automobiles, which lessens the processing load on ECUs.

II. LITERATURE REVIEW

A. ARAI requirements for functional safety

□ Details of ISO 26262

The first edition was published in November 2011, and the second, which has experienced a number of changes, was released in December 2018. [14] Vehicles that carry less than 3,500kg, such as trucks, buses, and motorcycles, are included in the second edition.[14]

□ Addition of trucks and buses (T&B)

Buses and trucks seems to have been planned to be included when the first edition was implemented, but this needed time to evaluate, and there was precedent for restricting vehicles to under 3,500 kg. [14] Trucks are typically made by automakers utilizing base models (such as the cabin, engine, and chassis), with installers (body builders) adding specialist body pieces.[14]

This makes it possible for a base vehicle that was created and produced in conformity with ISO 26262 to have body pieces created and produced in violation of that standard.[14]

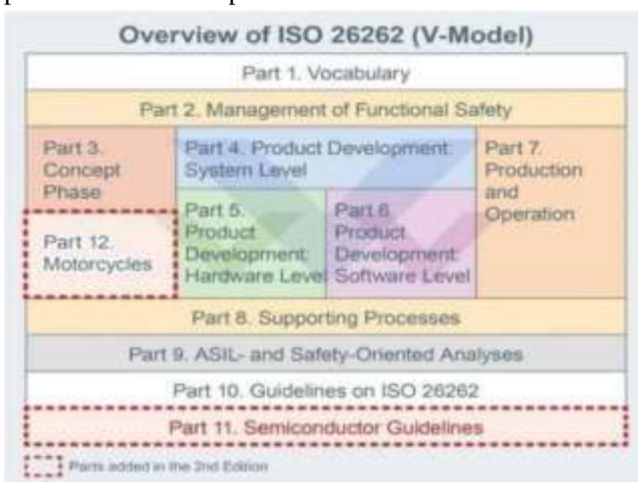

Fig. 6. Overview of ISO 26262 [14]

It appears that substantial effort was spent discussing how to handle such a circumstance.[14]

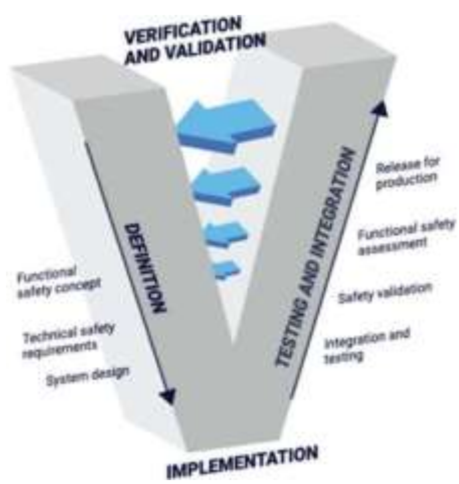

Fig. 7. The V-model from ISO 26262, Road vehicles — Functional safety [16]

Use ISO 26262:2018 to provide functional safety in road vehicles. It presupposes a systematic

V-model development approach in order to standardize the safety life-cycle procedure employed by automakers. [17] According to the standard, "The software development process is based on the concept of a V-model with the specification of the software requirements, the software architectural design, and implementation on the left-hand branch, and the software integration and testing, and the verification of the software requirements on the right-hand branch."[16]

The functional safety standard clearly outlines the suggestions for employing fault injection during various testing phases, but it makes no suggestions regarding the use of mutation testing. [15] This is also consistent with the existing accepted practise in the automotive sector, where mutation testing has not yet gained widespread acceptance. [15]

Fig. 8. Safety conformity levels [23]

- **Motorcycles added**

2 or 3-wheeled drive vehicles that weight no more than 800kg empty are the aim here; mopeds, as defined by ISO 3833, are not included. Mopeds are defined as any engine size under 50cc with a top speed under 50km/h. [14] Because they are built to go up to 60 km/h, motorized bicycles (also known as mopeds) are not classified mopeds even though the legal speed limit in Japan is 30 km/h.[14]

- **Semiconductor guidelines**

As Part 11, establishment of regulations for new semiconductor. [14] It should be noted that Part 11 is merely a guideline and that no requirements or work deliverable are essential. [14] The 2nd Edition contains numerous examples that make it easier to build semiconductors in compliance with ISO 26262 than the 1st Edition, which did not show how to react when employing semiconductors.[14]

- **Detailed objectives**

The description of the target items has significantly increased in the 2nd Edition. [14] That serves to make the goal of each section clear.[14]

The numerous examples make it simple to grasp the recommendations.[14]

- **Automotive Safety (ISO 26262)**

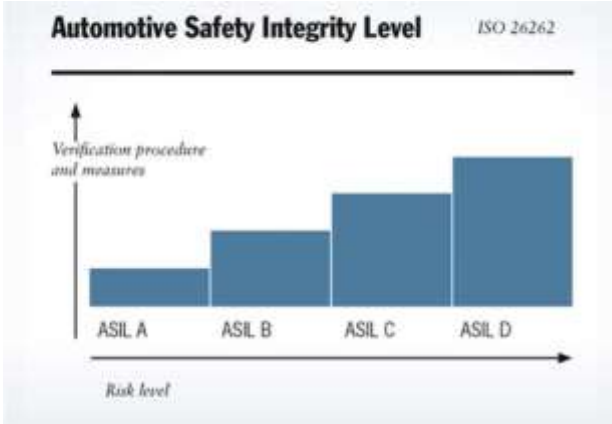

Fig. 9. Automotive Safety Integrity Level [19]

Modern cars have a large number of safety-critical systems that, in the event of failure, put the lives of both the occupants and other road users in grave danger. [19] The technique described in ISO standard ISO 26262 makes it possible to systematically identify and eliminate such weak points early in the vehicle development process, thereby reducing hazards and risks. [19] This improves the goods' dependability and quality.[19] A suitable allocation must be discovered because of the ASILs allocation problem's criticality and how crucially important it is to the safety of any automobile system. [18] Exact solution approaches and optimization strategies are employed to achieve this goal. [18]

□ **Safety design for modern automotive applications**

Fig. 10. Examples of Vehicle Display Device [14]

By providing the driver with a variety of information, these display devices serve a crucial role, therefore if the display malfunctions or the screen goes dark, serious issues may result.[14]

Incorrect information displayed by the instrument cluster and electronic mirrors, however, might make it much more hazardous.[14]

This is because a blank screen alerts the driver to a problem right away, but if the display stops or is delayed, the driver might not notice the failure until it is too late because they are not constantly watching the screen. [14] For instance, if the tachometer shows a lower value.[14]

The driver might exceed the posted speed restriction because they are unaware of their actual speed. [14] Furthermore, if an electronic mirror displays a delayed image that hides a car approaching from the side, the driver might be misled into believing it is safe to change lanes, potentially resulting in an accident. [14]

Fig. 11. Functional safety flow [24]

Instrument clusters and electronic mirrors must have fail-safe mechanisms to guard against issues of this nature, even when using high reliability electronic components. [14] As previously noted, there is always a chance that the system would malfunction as a result of any kind of CAN implementation method.[14]

There is a similar structure shared by all CAN node implementations (M, Nd1–Nd4), consisting of a host micro-controller (MCU), CAN controller, and CAN transceiver. However, there are variations in how the aforementioned parts are integrated.The CAN nodes can connect with MCUs using a CAN controller or an integrated CAN controller that includes an MCU and CAN controller already built in.[14]

MCU and CAN controller ICs (integrated circuits) since the CAN controller needs to be initialized by software. [14] These
applications are kept in the MCU's memory, which enables the CAN. [14] The MCU interface, such as SPI (Serial Peripheral Interface), can be used to access the controller. [14] The CAN controller controls all CAN bus-based message transmission and reception.[14]
Separate CAN controller ICs are used in circuits that are intended to access to various MCUs, enabling the reuse of software created for one system (for instance, in C language) even while the MCU is different in another system. [14]
Software, on the other hand designed for an MCU's integrated CAN peripheral may not be applicable to another MCU's on-chip CAN, especially if the MCUs are provided by different vendors.[14]
As a result, since software can be reused in future designs, the advantages of a distinct CAN controller configuration are more favourable in the CAN control system design. [14] The CAN transceiver IC, which gives the physical bus differential transmit capabilities in both the Stand alone and Integrated setups, connects the CAN node to it.[14]

B. Different tests carried out in On Board Diagnosis

The various tests include the following: Engine Control Unit flash test, Transmission Control Unit test, Airbag module test, ABS module test, Heater glass connection test, Fully Automatic

Temperature Control Unit module test, Start/Stop button test, Power Lift Gate Control Module test, Center Console all button test (Chest mode, Leg mode, Automatic A/C on/off, fog lamp), Headlamp test, Airbag ECU connector test, PDU earthing test.

C. Various component diagram of electric vehicle

Fig. 12. Different component diagram of **Nexon** EV [20]

In this diagram the various components are shown of the electric vehicle. That are the battery pack, battery charging point, DC/DC Converter, On Board Charger(OBC), motor, inverter, 3-phase ac module shown. An the LV/HV cable routing is shown. [20]

III. PROBLEM STATEMENT

Electrical First Time Quality Low- **70%**

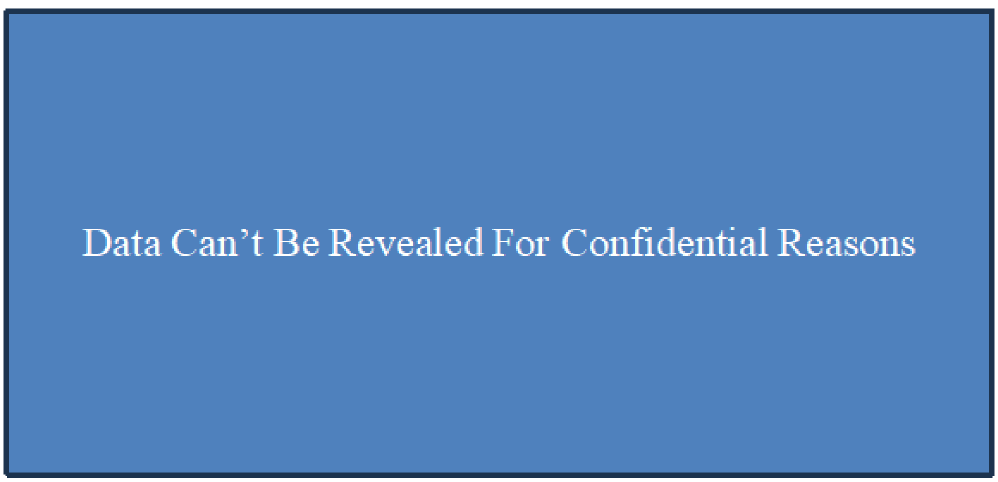

Fig. 13. End of Line DSA Issues

The DSA issue is illustrated in the parato figure above, and the problem is that the First Time Quality is only 70%. DSA Test Pending, HU TEST DSA Not OK, READ DTC DSA Not OK, BCM TEST DSA Not ok, and HVAC TEST DSA Not ok are the major and repeated defects. Therefore, in an attempt to find a fix, we are conducting a 5WTH study of the electric circuit error.

- □ 5WTH Analysis of electric circuit errors

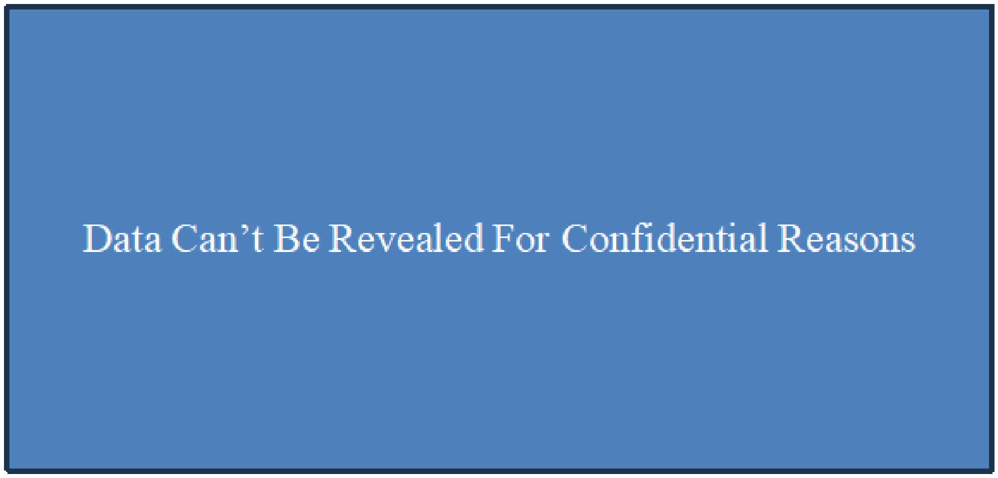

Fig. 14. 5WTH Analysis of electric circuit errors

The problem is that only 70% of the electrical work is done correctly the first time. After performing a why-why analysis, we found that the error began at the end of the line and was caused by a loose connection, a cable cut, a bent pin, etc. The reason for this error is that no visible subsequent checks are available. Due to the low rework efficiency, which is mainly brought on by a lack of labor, a subsequent check is not performed.

IV. OBJECTIVE

Fig. 15. Quality Assurance Testing of Production [25]

The 4Ms—Man, Machine, Method, and Material—were all at work during the assembly line manufacturing of the car. We paid particular attention to errors related to electric circuits in this research. Therefore, the goal of this study is to eliminate complex errors caused by people, machines, methods, and materials. Moreover, electric car first-time quality needs to be improved.

□ First Time Quality Improvement
□ Elimination of rework
□ Reduce the over time
□ Repair area float reduction

V. PROPOSED METHODOLOGY

We went about the process of correcting the error. On behalf of various defects, we use a range of tools to execute interim corrective action (ICA)/permanent corrective action (PCA). The Way to Teach People (TWTTP), One Point Lesson (OPL), On the Job Training (OJT), Standard Operating Procedure (SOP), and Human Error Root Cause Analysis (HERCA)

1. Issue – Dash wiring harness black plastic tape cut and damage near EPB connection

Issue Visual:

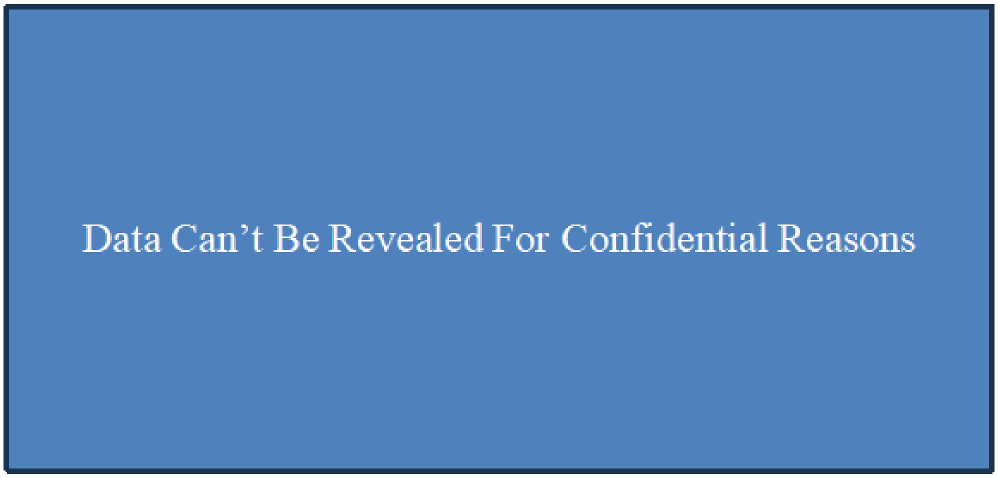

Fig. 16. Dash wiring harness black plastic tape cut and damage near EPB connection

Root Cause /Confirmation of Cause:

- □ Dash wire harness is wrapped around the acc paddle to prevent dash harness from being cut during dashboard fitment.
- □ While routine on the acc paddle, the black plastic wiring harness tape was cut and damaged close to the EPB connection.

- □ Improper harness tapping technique.
- □ Only 250mm of the region is wrapped with plastic tape; all other areas of the various branches are taped with cotton.

Interim / Permanent Action

ICA:

- □ Operator made aware of the problem
- □ Checking began following dashboard fitting.
- □ Application of plastic tape for NOK vehicle rework has begun.

PCA:

- □ Cotton tape is used in place of plastic tape at a specific spot.
- □ Checkpoint at trim delibra installed.

Human Error Root Cause Analysis (HERCA):

Here, we used HERCA analysis to address the problem. We asked the staff members different questions as we were doing this. Along with asking the operator questions as part of the HERCA analysis, we also look for flaws in the processes or protocols, issues with the tools and equipment, issues with the workplace or working atmosphere, and issues with motivation, involvement, initiative, or forgetfulness. On the basis of this understanding, we then try to find answers. The HERCA study revealed that the issue is related to the workplace because the operator's station doesn't have enough lighting.

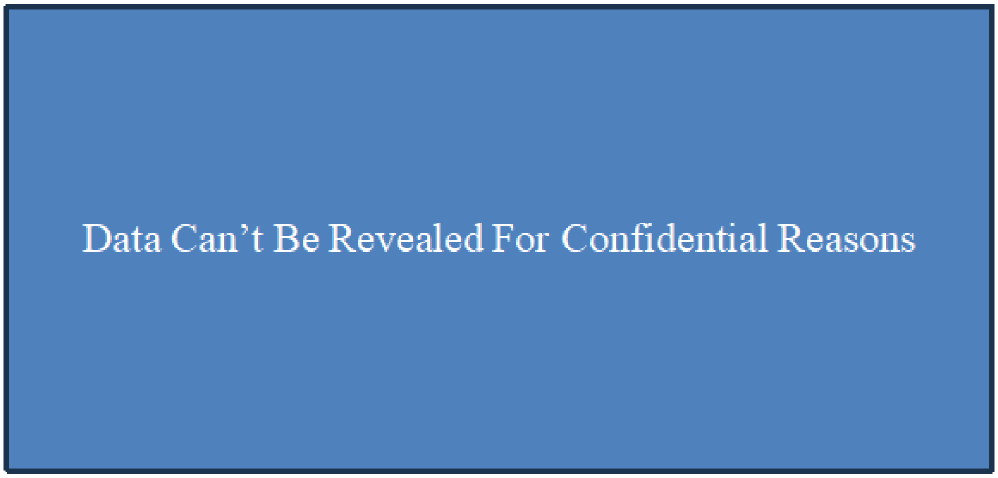

Fig. 17. HERCA analysis of Dash wiring harness black plastic tape cut and damage near EPB connection

There are faults, particularly due to the lighting issue. As part of the answer, we also provide the proper lighting for that particular station.

Robustness of Solution

- Plastic tape replaced with cotton tape on defined location.

High Level Summary

- During routine on the acc paddle, the black plastic wiring harness tape was cut and damaged close to the EPB link.
- Checking began following dashboard fitting.
- Application of plastic tape for NOK car rework has begun.
- Plastic tape replaced with cotton tape on defined location.
- Checkpoint at trim delibra installed.

2. Issue –On Board Diagnostics (OBD) Wiring harness routing wrong

Issue Visual:

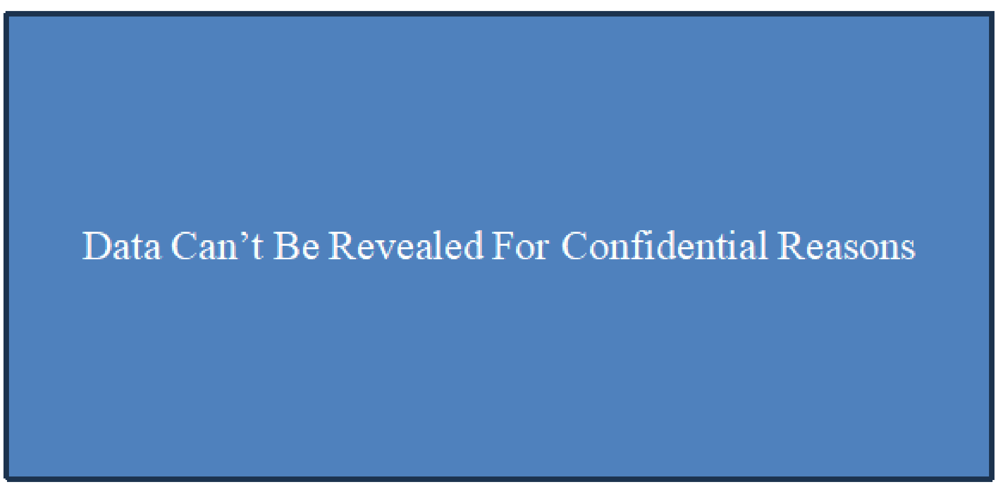

Fig. 18. Issue Visual of On Board Diagnostics (OBD) Wiring harness routing wrong (Actual Vehicle)

Root Cause /Confirmation of Cause

- OBD connection is routed from the RHS side rather than the LHS side.
- Operator ignorance.

Interim / Permanent Action:
ICA:
□ For offering accurate routing, operators receive awareness training.
PCA:
□ OPLs on the assembly line are used to educate operators.
□ On the dashboard line, OPL of the OBD wiring harness routing is set.
□ The operator must verify that line lock has been set in Operator Terminal and that routing has been entered.
Robustness of Solution
□ Through a one-point instruction on the dashboard line, the operator was educated.
□ Line lock OPL configuration in OT. Operator must verify that OBD is being routed correctly in accordance with OPL in OT and must recognize the process.
High Level Summary
□ OBD connector path on the RHS rather than the LHS.
□ By providing OPL on assembly line, the operator is taught.
□ Line lock OPL configuration in OT. Operator must verify that OBD is being routed correctly in accordance with OPL in OT and must recognize the process.
One Point Lesson (OPL):

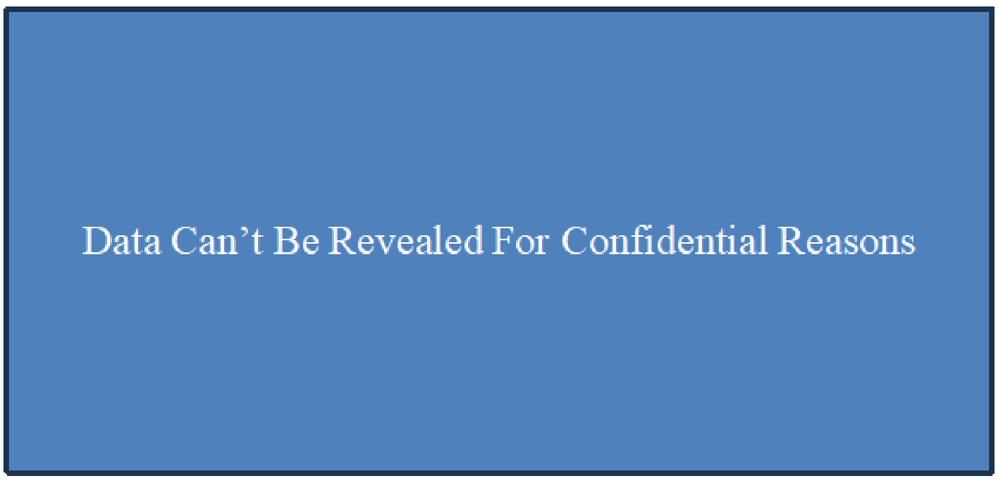

Fig. 19. One Point Lesson of On Board Diagnostics (OBD) Wiring harness routing wrong

3. Issue –Electric Parking Brake Failure switch stuck up
Issue Visual:

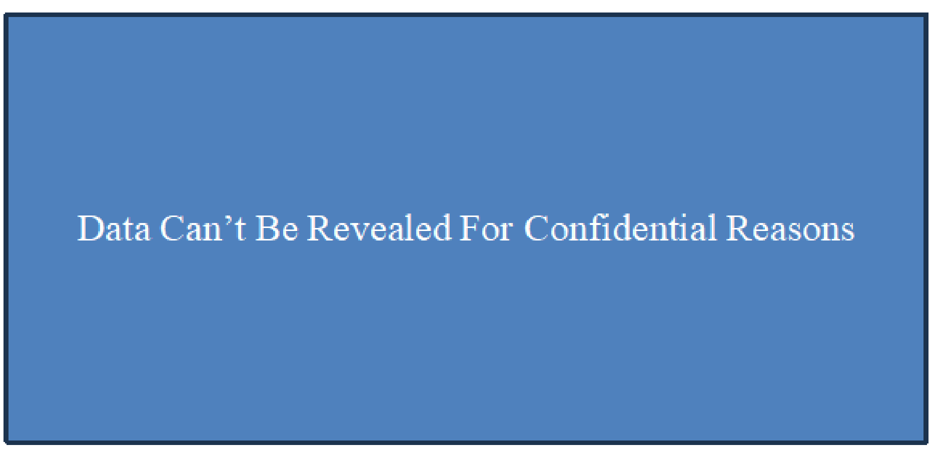

Fig. 20. Issue Visual of EPB Failure switch stuck up

Root Cause / Confirmation of Cause

□ Switch for EPB Failure is locked. The ABS connector branch on the EPB harness has a small cut that may contact the transmission. Poor body bolt locking allowed access to the ABS connector and EPB harness.

ICA:

□ By displaying this defect's visuals to the team leaders and all three shift operators, the defect's gravity was communicated.

PCA:

□ This process failure can occur at POF, according to a trim line process walk.

□ Team members received on-the-job training using a single instruction.

□ After correctly securing the ABS connector branch clip in the body, conformation marking began.

One Point Lesson (OPL):

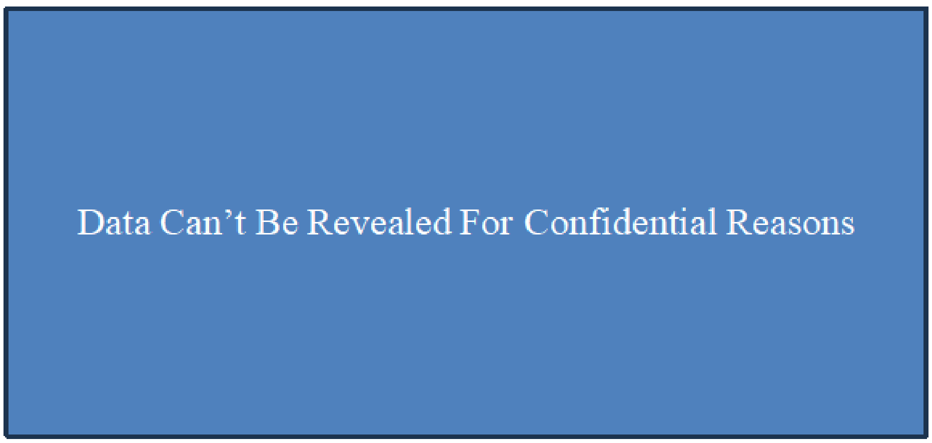

Fig. 21. One Point Lesson of EPB Failure switch stuck upRobustness of Solution

□ One Point Lessons (OPL) are posted on the assembly line, and all three shifts' workers receive on-the-job training (OJT).

□ After correctly locking the ABS connector branch clip into the body, conformation marking began.

□ By displaying this defect's visuals to the team leaders and all three shift operators, the defect's gravity was communicated.

High Level Summary

□ According to the inquiry, the switch sticking up caused the EPB failure, and the ABS socket branch that was the route cause became trapped with the transmission and caused an EPB wire pinch.

□ After correctly locking the ABS connector branch clip into the body, conformation marking began.

4. Issue – Buzz noise comes for incoming / outgoing calls

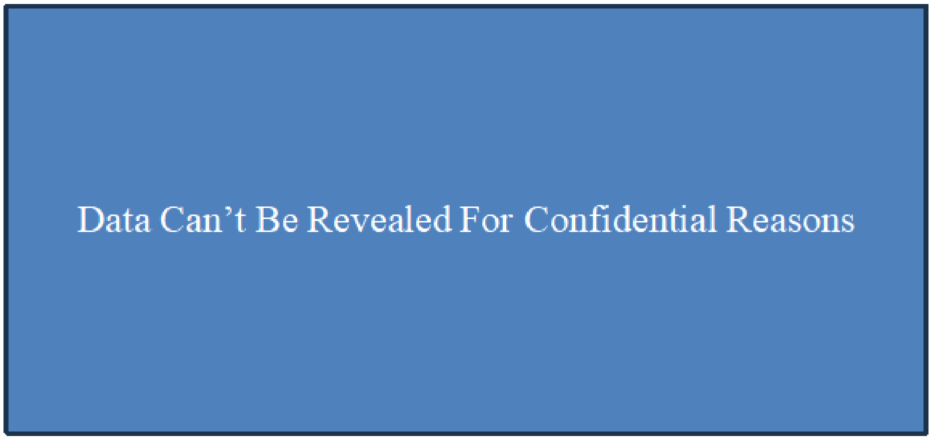

Fig. 22. Issue Visual of Buzz noise comes for incoming / outgoing calls

Root Cause / Confirmation of Cause

□ Incoming and outgoing calls were making a buzzing noise, according to the client.

□ When the wiring harness for one vehicle was examined, pin-3 was discovered to be bent.

□ There are two side guides for coupling, reducing the possibility of pin bending during coupling.

□ During transportation, a pin bends.

□ No available bubble film protection.

ICA:

□ Operator is trained to perform a push pull push test and is made aware of the problem.

□ Check the connection's snap sound.

PCA::

□ At station 44, bubble wrap tape needs to be applied and quickly removed before coupler attachment.

One Point Lesson (OPL):

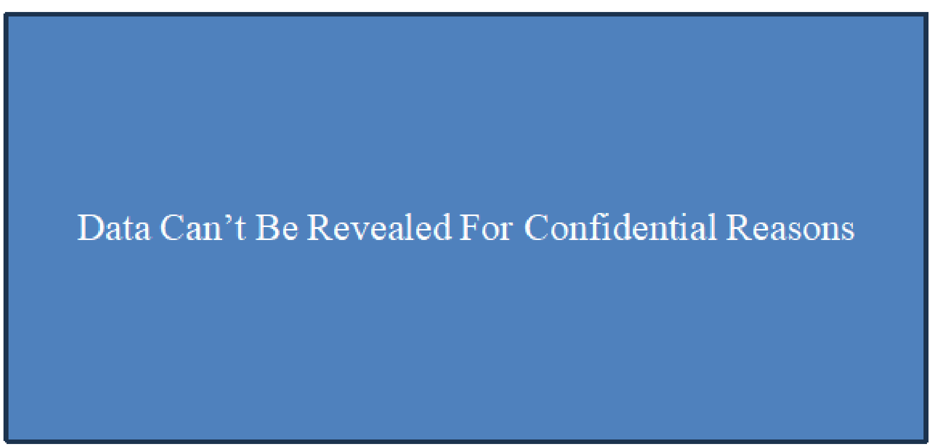

Fig. 23. One Point Lesson of Buzz noise comes for incoming / outgoing calls

Robustness of Solution

□ Through a one-point instruction on the fitment station, the operator is educated.

□ For each connector, the operator must use the push-pull-push method, and prior to fitting, he must examine the state of the pins.

□ To prevent pin bend in the inline connection for the instrument panel, connectors must be bubble-wrapped.

High Level Summary

□ Incoming and outgoing conversations cause a single car buzz noise, which is a customer-reported defect.

□ One vehicle had three pins that were bent, which we discovered and fixed.

□ OPL offers operator training programmes.

□ To prevent pin bend in the inline connection for the instrument panel, connectors must be bubble-wrapped.

5. Issue – AC Blower does not work – Connector was not secured properly

Issue Visual:

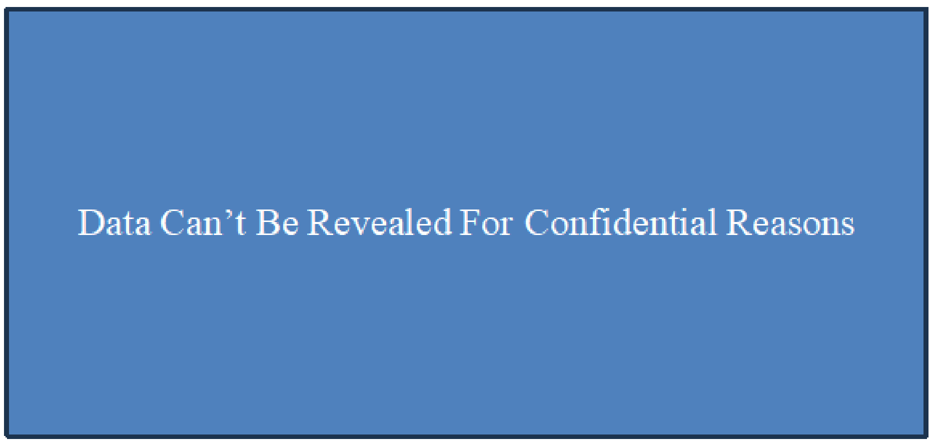

Fig. 24. Issue Visual of AC Blower does not work – Connector was not secured properly

Root Cause / Confirmation of Cause

□ The supplier end of the AC blower connector connection is where it is tracked during the DSA procedure.

ICA:

□ Checking began after the DB's Ventilation installation.

PCA:

□ OPL indicator on station; operator instructed to inspect HVAC connection following HVAC installation on CCB.

One Point Lesson (OPL):

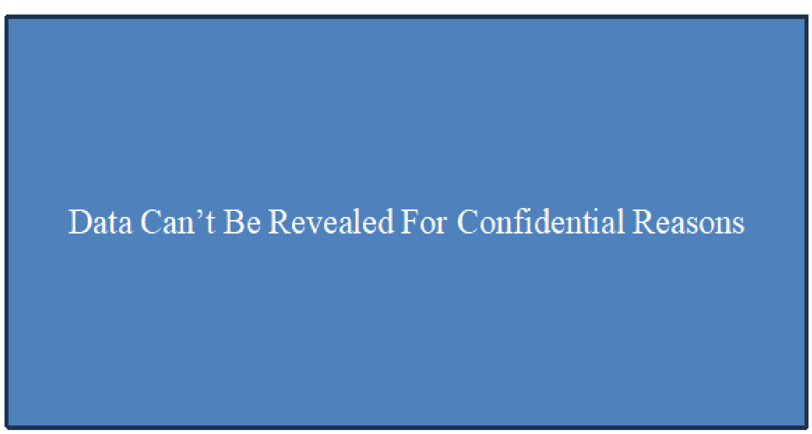

Fig. 25. One Point Lesson of AC Blower does not work – Connector was not secured properly

Robustness of Solution

□ The marking of parts began with the seller.

□ Operator validate HVAC connection after HVAC installation on CCB.

□ If the link is cut off, the dashboard, roller brake test, and diagnostics system analysis test will fail.

High Level Summary

□ Due to an unsecured connector, the AC blower is not working.

□ The supplier end of the AC blower connector connection is where it is tracked during the DSA procedure.

□ The marking of parts began with the seller.

□ After installing HVAC on CCB, operator double-check HVAC link.

VI. RESULTS AND DISCUSSION

We concentrated on the more complex problems that more frequently impacted electrical networks.

The various important and ongoing problems are as follows: 1. The EPB connection was near to a cut and damaged area of black plastic tape on the dash electrical harness-To resolve this problem, cotton tape was added at the trim delibra and the plastic tape was replaced. 2. Improper OBD Wiring Harness Routing – To resolve this problem, we train the operator and offer One Point Lessons (OPL) on the assembly line. The OPL of the OBD wiring harness routing is placed on the dashboard line. The line lock setup and handling in OT must be verified by the operator. 3. EPB failure switch stayed up - In order to solve this issue, a process walk on the trim line showed that the EPB failure switch sticking up can happen at POF. Through a One Point Lesson, the team got On the Job Training. Conformation marking started after the ABS connection branch clip was securely fastened to the body. 4. At station 44, when the bubble wrap tape is about to be introduced and just removed before the coupler connection, a buzzing sound can be heard during incoming/ outgoing calls. 5. The AC blower does not work because the connector was not properly fastened. To fix this issue, the operator was instructed to verify the HVAC connection after the HVAC system was installed on the CCB. An OPL display was placed on the station.

Fig. 26 displays the study's final outcome. This image shows how the First Time Quality has improved.

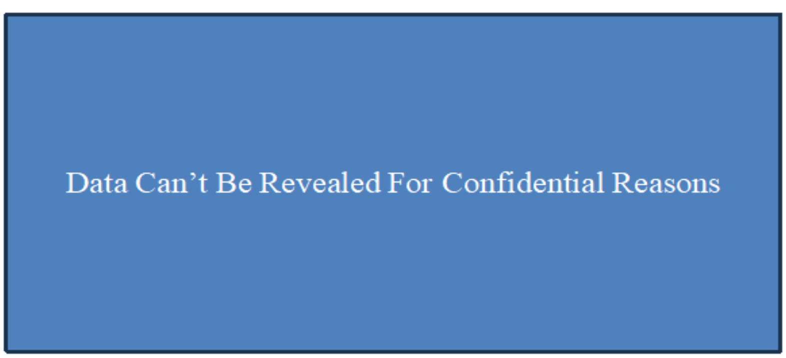

Fig. 26.Enhancement in End of Line DSA First Time Quality

This is accomplished using methods such as The Way to Teach People (TWTTP), One Point Lecture (OPL), On the Job Training (OJT), Standard Operating Procedure (SOP), Human Error Root Cause Analysis (HERCA), and others. Prior to taking any interim corrective action (ICA) or

permanent corrective action (PCA), the underlying cause must first be determined. As a result, the significant and pervasive problems have been resolved. We are able to accomplishthe desired results as a consequence.
This study finds that the use of electric vehicles increases electrical intricacy, making function safety even more important.

VII. CONCLUSION

The systematic method for fault diagnosis of electrical circuit defects is demonstrated in this paper. On-board tests to guarantee the operation's security. We install the Multi Function Tester on the vehicle and examine all of the sensors, modules, and electrical connectors to determine whether or not the function is secure. If a fault was discovered, the Multi Function Tester's screen would display the defect and the defect number. We begin troubleshooting based on that error, and it is only through troubleshooting that we are able to correct the flaw.
In this paper, we have demonstrated a methodical approach to approaching different flaws and identifying their underlying causes. Locate a solution for it as well so that it won't appear on the assembly line once more. One of the most common kinds of flaws is damage to electrical circuits. We then put our action plan into practice to deal with those issues. The Way to Teach People (TWTTP), One Point Lesson (OPL), Standard Operating Procedure (SOP), Human Error Root Cause Analysis (HERCA), and On the Job Training (OJT). The root reason mustbe identified before implementing any Interim Corrective Action (ICA) or Permanent Corrective Action (PCA).
This paper provides a general paradigm for analyzing the fault diagnosability of electrical circuits. This method is very effective for finding errors in any type of electric connection. The results also show that the proposed strategy is workable. The proposed methodology may also be successful in terms of electrical circuit defects as the use of electric vehicles rises over time. And we pinpoint the effective solutions for problems.
The overall procedure aims to increase the First Time Quality (FTQ) of the electric circuit in electric vehicles.

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