



RESEARCH ARTICLE

TRIPLE ROLE CONCEPT AWARENESS IN PUC CERTIFICATION LEVERAGES CONTROL ON VEHICULAR POLLUTION TO ATTAIN SDGS

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ABSTRACT

Vehicular pollution has been identified as one of the major contributors to air pollution affecting the **environment** and **society** at large for human health issues due to air quality degradation particularly in the metro cities of India. Following CMVRs (Central Motor Vehicles Rules) 1989, Ministry of Roads Transport & Highways (MoRTH); Govt. of India established PUC (Pollution Under Control) centers in all states (under STAs/RTAs) of the country, under their I&M (Inspection & Maintenance) program to test on-road vehicles to control vehicular pollution. Triple role concept, a universal, simple, yet unaware but most befitting role for PUC operator & its management. Roles, under the enlarged concept of quality at the workplace, are the tasks to be performed. In triple role all jobs encompass three roles viz the **customer**, the **processor**, and the **supplier** for the job holder.

Purpose: PUC centre to test on-road vehicles emissions and issue PUC certificate to those which meets specifications. But that did not happen. Vehicular air pollution continues to rise. To overcome the problem, the PUC owner and organizers need to be made aware of the concepts of **triple role** to do right PUC certification to control vehicular pollution and thus help resolve ESG issues.

Objectives: The objectives of the study are to develop awareness and implement (i) triple role concept so that PUC performs efficiently putting control on vehicular pollution. (ii) Feedback loop, another universal, as it is fundamental to maintain control of every process.

Design/Methodology/approach: For investigating the failure, the scientific method proposed by biophysicist John R platt's *strong inference* is used. The causes i.e the absence of elements of triple role results in wrong certification of vehicular pollution. The integration of scientific method into RCA by using cycles of PDCA, Deming approach, will resolve the cause (hypothesis) into root cause of the problem. Analyzing this way, the root causes are reached leading to problem resolution.

Findings: Most of the elements (above 80%) of triple role, related to PUC performance feedback, quality of output etc, are missing in the functioning of PUC, as it is operating on regulations etc. Lack of managing is evidenced.

Originality or uniqueness of this study: Although the study brings out the necessity of awareness of the concept but it evolved the requirement of management for PUC. Regulations and laws seem not adequate.

Implications: For the employees in PUC to operate in a state of triple role require management, capable process & feedback loop including their responsibility etc.

Significance: Triple role is applicable to processes/activities in all functions, workplaces and individuals at all levels from general manager down to worker. It is only management that can provide it in the organization through development programs.

PUC's role and ESG Issues: For PUC, Vehicular Air pollution affects **Environment** in terms of global warming, **Society** for their health concerns and **Governance** for how PUC is lead and managed to keep air pollution in control. These are the ESG issues. To achieve breakthrough in PUC performance, awareness of triple role is necessary to resolve ESG issues and attain SDGs.

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INTRODUCTION

Pollution under control (PUC) test for emissions from on-road vehicles have assumed significant importance in the wake of

PUC Centre were established under Central Motor Vehicle Rules (CMVRs) 1989, in all the states of the country. PUC testing is the only existing mechanism to monitor and control the on-road vehicles' emissions. The growth in population of freight vehicles, buses, cars, two/ three wheelers and

agriculture machinery, airplanes, trains etc. plus the corresponding surge in fuel use have increased the air pollution to levels more than what they should have been. A study by the Forum of International Respiratory Societies bring out that air pollution particularly vehicular air pollution is the cause of number of diseases such as diabetes, childhood leukemia, cough, headache bronchial and cardio vascular disorders leading to human deaths. On the environments, the problems of global warming, acid rain and ozone depletion are well known and have become very perceptible from the daily life in our cities. The impacts of air pollution caused by vehicles are daunting. The Air pollution has become a major concern in most of Indian cities.(WHO 2016), If we quote - As brought out by recent study for Delhi (Delhi city alone), approximately 10,000 to 30,000 deaths annually in the city occur due to air pollution from PM 2.5 and fumes. Leading researchers of the study are Joshua Apte from University of Texas, Julian Marshall from University of Minnesota and others, That indicates that the vehicles which come to the PUC center need to be tested for their tailpipe emissions and PUC (pollution under control) certificate to be issued to those vehicles whose emissions are in compliance to the standards currently in vogue like BSIV or **BSVI**. The PUC certificate as of today is thought as a formality required for escaping penalty from traffic police and obtain a compulsory vehicle document required under CMVRs 1989.

LITERATURE REVIEW

The problem of air pollution is continuously increasing rather compounding as time goes on. From intense literature review, some of the points are described herein under:

Anumita Roy chowdhur Centre for Science and Environment.” Are our cities Bharat Stage-VI ready? An Orientation Workshop on Advancing On-road veh Emissions”. Mumbai, Feb 3, 2020. Lessons from other cities: Observations from field in Delhi and NCR, PUC has very poor compliance. Only 23% of vehicles in Delhi turn up for tests. Similar data regarding NCR towns not available. Poor failure rate i.e. nearly all vehicle pass. Observed malpractices in Haryana NCR: Broken non functioning testing equipment was a common sight across Rohtak. Smoke Meter not connected to computer. Even then issued a pass certificate. So on Observed malpractices UP-NCR: Bulandshahr, Centre code- 687: The PUC centre issued a fake PUC certificate.

The Supreme Court directed the Environment Pollution (Prevention and Control) Authority (EPCA) Delhi, on January 17, 2017 and February 6, 2017, to inspect PUC centres in the National Capital Territories of Delhi and also those in the districts of National Capital Region (NCR). In response, the Centre for Science and Environment (CSE) on behalf of EPCA carried out a physical inspection of PUC centres to chart a roadmap to improve the program.

The overall assessment revealed serious quality concerns regarding the way PUC tests are conducted and equipment maintenance carried out in numerous PUC centers across the NCR region. Some of the points are covered in CSE’s workshop given above. PUC certificate is a mandatory requirement for vehicle owner as per CMVRs 1989. Rising air pollution indicates that vehicle emissions are not tested according to the prescribed methods and procedures.

Rising vehicular air pollution points out to the poor performance of PUC. Rarely any journal, paper, institute and study or Audit etc have marked their performance satisfactory. The poor performance indicates that the PUC centre and its organizers have not fulfilled their **roles**.

Factors affecting PUC Performance

1. Role of PUC Centre Operator & its management and ESG issues: As stated above, PUC operator could not perform according to his role and responsibilities. May be there are number of reasons like no reviews of his performance, internal audits missing, inadequate equipment, no real time feedback loop and there is no monitoring & measuring of PUC activities etc, etc. This indicates person in PUC not performing as per PUC Operator roles. The PUC centers are established as private entity following CMVRs 1989 of MoRTH in every state and under those state legal formalities. May be in those regulations the objectives for the activities of PUC are not provisioned, managerial tasks, stated above, are not inbuilt. Such like situations may provide free hand for PUC process to work carefree in regard to PUC certification for vehicular emissions resulting in uncontrollable rise in vehicular air pollution. This all clearly indicates deficiency of Managerial roles.

For PUC, in regard to ESG issues, the vehicular pollution control is essential as it affects Environment in terms of global warming, Society for their health concerns and Governance for how effectively PUC is lead and managed for keeping vehicular pollution in control. We can say that it has become an ESG issue. ESG is a framework which includes key elements around Environmental and Social impact, as well as how Governance structures help maximizes stakeholders’ well-being. Stake holders well being is affected by vehicular air pollution explained as above. Therefore to achieve SDGs (Sustainability Development Goals), the ESG issues required to be resolved. In the light of above, PUC’s role and its management have become crucial. Had PUC operator and his management the knowledge of triple role, vehicular air pollution might have been in control. The triple role is presently a knowledge gap in PUC centre activities

2. Lack of Feedback loop and Control in PUC: PUC has very poor compliance so its certification of vehicular emissions results in uncollectible harm to people and environment. Control is a universal managerial process. It ensures that planned performance targets are met and objectives achieved. Joseph M Juran while on Quality Control: Assuring Repeatable and compliant processes, argues that Control includes product control; quality control ...etc. Quality control is another universal managerial process which takes place by the use of feedback loop, also a universal. In our case of PUC, both these universals are essential but completely missing in PUC. Feedback loop is fundamental to maintain control of every process. In the present system of PUC functioning, there exists no feedback loop from PUC to transport department and vice versa.

Need & significance of triple role concept and feedback loop:

To bring breakthrough in current performance of PUC, awareness of triple role concept (a knowledge gap) and establishing feedback loop for control between PUC and transport department, are essential.

Triple Role concept: In the organization, the repetitive patterns of activities at the work place are the tasks, procedures and processes carried out by organizational functions. Open system theorists call these patterns of activities roles. A role is a task, consists of one or more recurrent activities out of a total pattern of activities, which in combination produce output. The management of PUC is carried out through regulations and the operation functions are handled by the PUC owner only. An employee in a process plays three roles: supplier, processor and customer. Juran (1988) defines this interchanging role as the "triple role" concept. He maintained that each stage of a process or activity was a Three Role Model - supplier, processor and customer.

Every Process stakeholder is a supplier, processor and a customer; carrying out these roles and responsibilities appropriately. This is essential for achieving Operational Excellence. This all applies well to PUC operator to do right PUC certification of vehicular emissions.

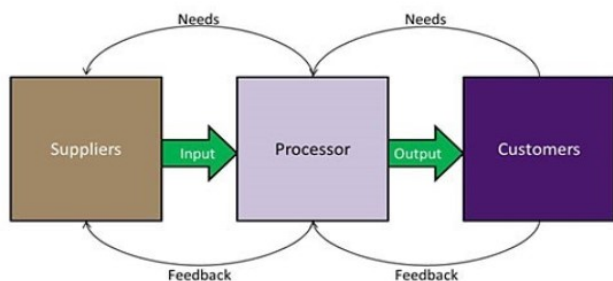


Figure 1 Juran's triple role Model

Figure 1 above shows a triple role Juran's model that applies to an organization as a whole, to individual departments or functions e.g workstations etc. It applies also to individual organizational members performing their roles/tasks in any function or level. All these functions or entities perform three simultaneous roles of supplier, processor or customer. The control is embedded in it through feedback. We all participate in one or more processes every day, carrying out the roles of a process stakeholder. Process stakeholders are those who are involved in the process, who have invested in the process, and have an impact on the performance of the process. And that is what our PUC is.

Feedback Loop

Compliance or quality control process is a universal managerial process. Control takes place by the use of feedback loop. It is fundamental to maintain control of every process. It applies to all types of operations and processes anywhere & everywhere. The activity or process outcome is compared to the established standards or targets of performance (product goals or process goals) and then taking action on the difference between desired standards of performance and actual performance of a process. This is what the control is which enables to remove defects, drawbacks and variations, This helps to take product or process conformance decisions such as that the outcome or result meets customer needs, protects human safety and protects the environments. Feedback loop Fig.2 is critical tool to improve performance of the organization. In the case of PUC activity there is a little mention of a feedback in Standard and Test Procedure for Idling MoRTH/CMVR/TAP-115/116 (Issue 4). It states that "PUC Operator shall submit the monthly report of all tested in-

use vehicles along with print out in original to the Transport Department.

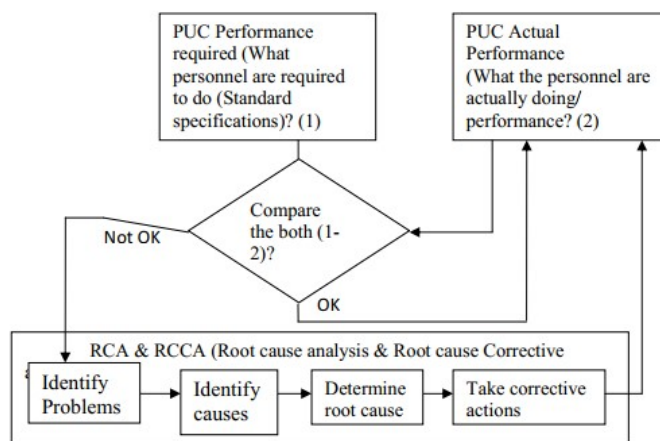


Fig. 2. Feedback loop

Thus feedback loop is essential component of universal quality management methods, which is not there.

Objectives of the study

Purpose: PUC certification of vehicular emissions is a service provided to vehicle owners in the country. Service or product is fit for its purpose if it is able to protect human safety and the environments. (Juran on what leaders need to know about quality) that is- issue PUC certificate to those vehicles which comply with the standard specifications like BS-IV or BS-VI. So the question arises 'why air pollution from vehicles is rising when PUC centre certify vehicles which meet the prescribed standard emissions limits. Therefore to find answer to the question and reach the purpose, the objectives of the study are to develop awareness and implement

- (i) Triple role concept so that PUC performs efficiently putting control on vehicular pollution. In triple role, a universal, all Jobs encompass three roles viz Customer, Processor and the Supplier.
- (ii) Feedback loop, another universal, as it is fundamental to maintain control of every process so that PUC is enabled to remove defects, drawbacks and variations in PUC certification activities. Feedback of data from PUC to Transport department and vice versa is essential to meet the purpose.

On PUC roles of supplier, processor & customer and the feedback loop, we draw inferences and develop hypotheses for resolution. It is described in the following sections.

METHODOLOGY

Key Variables: Roles are the work tasks, procedures and activities carried out by organizational function. In our case of PUC, (a organizational function), follows pattern of activities in combination to produce PUC certificate (a organizational output or performance). Had PUC operator the knowledge of triple role, vehicular air pollution might have been in control. The triple role is presently a knowledge gap in PUC centre activities. So the roles in triple role viz customer, processor

and supplier are the key variables and are the causes responsible for under performance of PUC.

Key relationship between the variables: These roles viz customer, processor and supplier are the causes of output that is PUC certificate. The relationship between the variables can be best explained by cause and effect diagram or Ishikawa diagram (named after its inventor).

Fishbone diagram is a quality tool used to identify problems in a system. It shows how causes and effects are linked and helps analyze failures in systems, processes, and products. See figure Fig-4 for Ishikawa diagram.

PUC Centre context: For PUC operator, his purpose has three levels namely (a) ROI, (b) meet Needs & Expectations of Interested parties/stakeholders and (c) provide Service through testing & measuring vehicular emissions & certification.

The Framework: The framework evolved from study of various research studies on vehicular air pollution, papers, the present position of vehicular pollution problems and the Paradyne Corporation model identifying the actions to be taken in each role. When we think of the process stakeholder (PUC operator in our case), we think of the processor in the process who transforms inputs (vehicle for pollution parameter measurements) into outputs (PUC certificate). The other roles in the process are of Suppliers & Customers. These roles are depicted below in Fig-3.

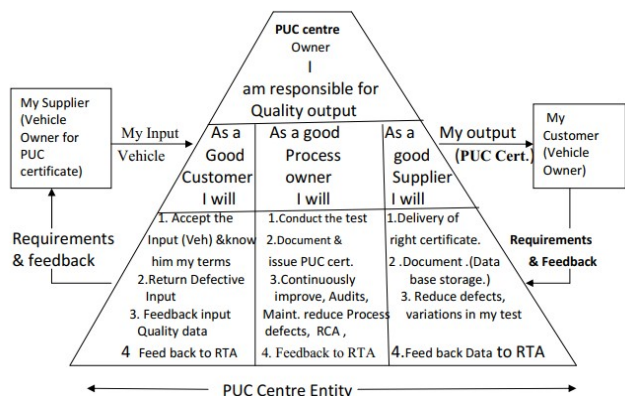


Fig. 3. Triple Role concept framework to achieve continuous improvement

Each of these roles are linked by mutually understood expectations i.e specifications, work orders and procedures, and feedback as to how well the expectations are met i.e complaints quality reports, performance reviews, observations and praise etc.,

Scope of Study: In this study paper, we are dealing with causes of failures of PUC. Causes of failures are many in each role of triple role which give rise to multiple hypotheses, so we have taken one cause/ hypothesis in each role for resolution. Other causes can be dealt in the similar way. The scientific method proposed by John R Platt’s “strong Inference” (1964), an approach to resolve multiple hypotheses, is at the roots of this study.

Data and data Sources: Data is derived from the reports of audits (PUC Audits in Delhi & NCR) and study (one study for PUC system in India in Delhi, Mumbai, Bangalore & Pune) carried out on PUC on its performance. These reports

contained non compliances and observations in regard to the methods; procedures, code of practice etc. used by PUC activities of certification. Here all data is secondary in nature.

Analysis

The observations & non conformances from audit and study report are:

(i) First analysed to know the cause and also to know that these non conformances pertain to which role of PUC operator. In this connection, (a) an audit conducted by CSE New Delhi in PUC centres across Delhi, NCT & NCR and (b) study carried out by John Rogers, Grupo Trafalgar, Maxico city under World Bank, of PUC system across India, have been taken. The above stated analysis is presented in work sheets in the following sections.

(a) Audit: January 17, 2017 and February 6, 2017, <https://www.downtoearth.org.in/news/air/vehicle-inspection-programme-needs-an-overhaul-62052>, or *PUC%20Challenge s%20 CSE%200. 32057800_1580730430_anumita-mumbai-bsvi-readiness.pdf*: And (ii) Vehicle inspection programme needs an overhaul: Centre for Science & Environments, DTE. PUC centre across Delhi, NCT & NCR (National Capital Region) Delhi. See work sheet-1

(b) Study: John Rogers, GrupoTrafalgar, Maxico city, Oct.2002, Assessment of the pollution under control program in India and recommendations for improvement. The World Bank, See work sheet-2

(ii) Secondly to resolve the causes, an Ishikawa diagram is created and those causes of failure are listed onto it so as to investigate the failures. It is best to look for a cause closest to the problem that is getting to the root cause using the 5 whys (RCA-a technique developed in 1930 by Sakichi Toyoda).

The process begins with listing the causes on the Ishikawa (cause & effect) diagram. The causes obtained in worksheet 1 and worksheets 2 are put in the bones of Ishikawa in all the roles as given in Fig. -4, below:

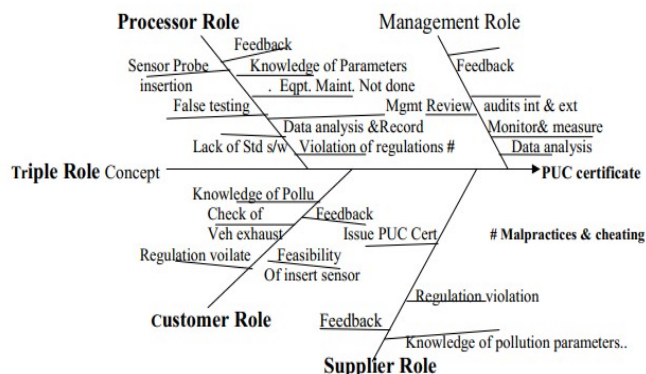


Fig. 4. Ishikawa diagram of causes

The diagram should be viewed as a graphical depiction of hypotheses that explains the failure under investigation. The scientific method (developed by biophysicist John R Platt) is used to investigate the failures. This study is a case of multiple hypotheses as there are three main hypotheses for each role of Supplier, Processor and customer. Further there are number of causes of failure in each role. Each role has hypotheses and there is experimental work on each and every hypothesis.

Work sheet-1

Sr. No	Non Conformity/ Observation	Cause (s)	Failures in Customer Role	Failures in Processor Role	Failures in Supplier Role	Failures in Management role
1	Flawed implementation a) Serious quality concerns in the way PUC tests are conducted and equipment maintained in centres across NCR	1. Veh. Exhaust not checked for leakage, wear & tear 2. Sensor prove not inserted 3. Eqpt: periodical maint. not done, AMC not executed & cal not done.	Accepting the Veh having faulty exhaust. Input inspection not done.	Conducting of (i) PUC tests (ii) Maintenance of equipment	Providing a PUC certificate even when doing no measurements of PUC parameters	1. Monitoring and measuring PUC process. 2. Not Getting closure report of NCs from PUC. 3. lack of real time feedback between PUC & Transport Deptt.
2	Rampant cheating and malpractices, which includes fake software, false passes and inappropriate tests.	1. Regulations violations at extreme level. 2. Serious mistakes of PUC operator.	Input testing (Not conducting tests on vehicle exhaust Sheer violation of procedure & regulations...	1. Inappropriate tests 2. Use of fake software, conducting no tests, for processing of PUC certificate & false passes. Violation of regulations	Rampant cheating and malpractices in terms of false passes. Procedure not followed. Violation of regulations.	1. Monitoring and measuring PUC. 2. Management reviews, int. audits not done 3. Feedback loop not provided. 4. Institute Strict penalty for regulations.
3#.	3. Manual recording and non-uniformity in the format of PUC data makes data retrieval and analysis difficult	1. Format of recording data not standardized 2. Data recording & analysis in Procedure missing	Manual recording of data is cumbersome-	Manual recording of data not done	Missing initiatives for standardizing the formats	1. Management role to provide standardized formats. 2. Feedback loop not there. 3. Monitoring & measuring
4#	Lax PUC norms, which rarely Fail the vehicles.	1. PUC Criteria to test only 2 pollutants for petrol & I for Diesel vehicles	-	-	-	Management Decision. (Only Test of HC & CO for Petrol Vehicle & Smoke density for Diesel vehicles).
5#	PUC must have the system of transmission of PUC data and daily feedback	Feedback loop in PUC & transport deptt.	Feedback not provided .-	Feedback not provided .	-Feedback not provided	F B Missing. Feedback loop is fundamental to control. Not devised/established..
6	Nearly 20 per cent of tests recorded zero values, which is not possible even the new tech. vehicles minimal carbon monoxide CO & HC	1. No Knowledge of pollution parameters. 2. Seems veh parameters not tested.	Lack of knowledge in this role.	1. Lack of knowledge 2. Wrong PUC certification	Lack of knowledge. Issue of PUC certificate which is wrong,	1. Feedback loop missing 2. Monitoring & measuring missing. 3. Int audits & mgmt reviews missing.
7.	CSE's investigation found that emissions testing probes are not even inserted in the exhaust pipe, or it remains unconnected with the computers at the time of testing to show false passes.	1. Bad intensions of PUC operator and malpractices. 2. Violations of regulations.	1. Emissions testing probes are not even inserted in the exhaust pipe. 2. Violations of regulations	1. Probes remain unconnected with the computer. 2. Operator negligent. 3. Violations of regulations	Manipulating for issue of PUC certificate 2. Violations of regulations	1. Monitoring & measuring of PUC process. 2. No check at the time of PUC process equipment installations 3. Absence of feedback 4. Stern action for violations.
8	Ill-maintained equipment, lack of documentation on calibration of equipment, poorly done tests, lack of standardized software in testing equipment	1. Maintenance of eqpt., periodicity & AMC. 2. Cal. not done 3. Test procedure not followed. 4. No Management decision for Standardized software	1. Test of exhaust not done for choking, leaking & loose. 2. Irresponsible for his roles.	1. Maintenance of equipment, 2. Cal periodicity cal agencies documentation not done, 3. Procedure for tests not followed, 4. lack of standardized software in testing equipment	1. Documentation on cal needs to be done. 2. Poor testing but issuing PUC certificate. 3. Not responsible for his role	1. lack of standardized software in testing equipment 2. Provide Feedback loop between PUC and Transport deptt. 3. Internal audit & reviews of PUC not done.
9#	PUC must have the system of transmission of PUC data and daily feedback to PUC required (It will help curve malpractices).	. Feedback loop not provided	No system of feedback	1. Processor to get feedback from supplier as well as customer	Feedback system of transmission of PUC data and daily feedback to PUC required	1. To provide feedback loop. (It will help curve malpractices). 2. Mngement missing.

Non Conformances pertain to Management role (Srl 3,4,5,&9)

Work sheet-2

Sr. No.	Non Conformity/Observation	Cause (s)	Failures in Customer Role	Failures in Processor Role	Failures in Supplier Role	Management Role
1#	Quality Assurance & Audits not done	Management Function	1.Not Aware 2. PUC needs to incorporate these.	1.Not Aware 2. PUC needs to incorporate these.	1.Not Aware 2. PUC needs to incorporate these.	(i)To institute Internal audits of PUC at defined intervals and (ii)QA/QC in PUC activities
2#	No analysis of data collected is done	Lack in Awareness of data analysis	Not Aware of data analysis	Not aware of data analysis	Not aware of data analysis	Training to Operator (Management role deficiency)
3	During testing the probe fell out of the exhaust pipe but the operator took the reading Of Smoke density	(i)Wrong intentions (ii)Skill deficiency of PUC operator	Manipulating the check on exhaust and sensor insertion.	Role & responsibility not done Procedure not followed.	Not testing but issuing PUC cert. is violations of regulations	(i) No monitoring & measuring of PUC by management (ii)(Strict action for rules ;violations.
4#.	None of the regional programs attach any importance to controlling the issued certificates & their supervising.	Management not doing its activity	Not Aware	Not Aware-	-Not Aware	Management to institute control on PUC certifications & Its supervision.
5#	Independent body to analyse the results of emission limits to determine and or recommend changes or to analyse systematic problems.	Management	-	-	-	Management Role to institute a body for actions on the observation.
6#	Training	Knowledge gap in PUC activity as 2 to 3 days training inadequate	Affecting to implement procedure for roles on PUC certification	Affecting to implement procedure for roles on PUC certification	Affecting to implement procedure for roles on PUC certification	Management to organize training & development programs.
7	In study overall remark is PUC ineffectual (i) Technician determines the length of each test. Taking the reading of instrument at any time (ii) Free acceleration smoke check on Diesel vehicle, Neither rpm nor engine temp. registered (iii) Calibration of equipment	(i) a)Wrong intentions b)Knowledge of procedure very low c) Technical knack (ii) Same as in (i) above (iii) a)Calibration periodicity not determined b) While taking up tests cal of machine is not checked.	This role cannot be carried out correctly due to the mentioned causes Same as above Same as above	This role cannot be carried out correctly due to the mentioned causes. Same as above Same as above	This role cannot be carried out correctly due to the mentioned causes. Same as above Same as above	To institute (i)monitoring & measuring (ii) Internal Audits (iii) Management review of PUC (ii) Training & dev. Programs for (skill development) PUC operator.
8.	Measurement of residual and Amb Values not recorded	Procedure not followed	Procedure not followed . The Value of PUC certification not understood	Procedure not followed . The Value of PUC certification not understood	Procedure not followed . Value of PUC certification not understood	1.Management to do training & development programs for PUC. 2. Monitoring & Meas. Not done.

Non Conformances pertain to Management role.(Srl. 1,2,4,5 & 6)

That is the reason John R Platt’s Strong Inference method is used. The scientific method is integrated into RCA, because it emphasizes alternative hypotheses which help to bring out root cause of failure for which we look for. The causes in Ishikawa may not be the ones (actual cause close to the problem that is the root cause) which are the actual cause of failures. So these need to be drilled down to root cause by using 5 whys-a method in RCA (Root Cause Analysis-Saki chi Toyoda).

Then the scientific method (Devising alternative hypothesis-conducting crucial experiments- evaluating the result – iterating the process till we get the clean result as stated in biophysicist John R Platt’s *strong Inference*) is used in the form of Deming’s well known plan-do-check-act (PDCA) cycles to empirically investigate the failures as the concept of PDCA is based on scientific method. Thus integrating the scientific method into RCA by using Deming’s PDCA will help resolve the causes to the cause near to the problem solution.

Table-1: Integrating scientific method with RCA (5Whys analysis as given in Table-2) and Deming’s technique of PDCA. Mind that every cause in the Ishikawa is a hypothesis. Also progression of why’s analysis is similar to resolution of hypotheses as per scientific method modeled by **biophysicist John R Platt’s ‘Strong Inference’**.

Table 1

	Plan			Do			Check	Act
	Role	Hypothesis (Cause)	Priority	Action	Due date	Responsibility	Result	Action
1	Customer	Sensor probe fell out but Operator still issued a PUC certificate	Top	1. Resolve hypotheses as given in table -2 for customer role. (RCA)	Immediately	Management	Correct insertion of probe into exhaust and thus obtain correct measurements	1.Control this operation 2. Strengthen monitoring & measuring. 3. Establish Feedback loop
2.	Processor	Malpractices & cheating prevalent in PUC (Violations of Regulations)	Top	1. Resolve hypotheses as given in table -2 for Processor Role (RCA) 2. Provide trg to operator	Immediately	Management	Consistent monitoring (management activity) of PUC curves such activities	1. Organizers to institute management of PUC and not solely depend on regulations. 2. Establish Feedback loop between PUC & RTA
3	Supplier	Check of Pollution parameters before Issue of PUC certificate	Top	1. Resolve hypotheses as given in table -2 for Supplier Role (RCA) Provide training.		Management	After training, the operator has the knowledge of limits etc. Correct PUC certificate is issued.	1.Establish Feedback loop 2. Strengthen management 3. To institute Training & dev programs for PUC

So resolving the causes by 5Why technique (integration of scientific method with RCA), as explained in Analysis, para (b) point (ii) above, is shown below in Table-2

Table-2

Sr No	Role	Cause	Why1	Why2	Why3	Why 4	Why 5	#
1	Processor	Malpractices & cheating of (Violations regulations)	Why PUC indulge in malpractices? -There is no monitoring of PUC .	Why monitoring is not there. -Not covered in regulations.	Why not covered in regulation -There is a procedure called std method	Does the method tells about the malpractices? -No	Is there any other provision to curve these in PUC? - Yes@	@1.Absence of management’s monitoring of PUC results in free hand for malpractices. So establish Management 2.Absence of feedback loop
2.	Customer	Sensor probe fell out but operator still issued a PUC certificate	Why probe fell out -It was not inserted in the exhaust properly (300 mm) into exhaust	Why it was not inserted -May be exhaust choked	Why operator did not checked the exhaust before test -He did not know	Why operator did not know. -He is unaware of standard procedure/meth od	Why operator is unaware of procedure - in adequate training	1.Absence of monitoring by management 2. Management to institute trg & dev programs for operator 3 Provide feedback loop
3	Supplier Role	Check of Pollution parameters before Issue of PUC certificate as nearly 20 per cent of tests recorded zero values, which is not possible even in new tech. vehicles	Why check pollutants levels before issue of PUC Certificate - parameter values should be given as measured	Why proper value of Parameters ? - It is the Procedure requirement -Purpose of PUC Certificate	Why operator does not follow procedure? Operator is not knowing the parameter values	Why the operator not knowing the values? Inadequate training	-	Absence of feedback give rise to such mistakes so 1. Provide training on pollution parameters. 2.Establish Feedback loop

5Whys of RCA is similar in operation to the iteration process applied in resolving Hypotheses explained in Scientific method
Summarizing the findings, refer table-3 below:

Table 3.

Sr No.	Audit or Study Report	No. of NCs analyzed	PUC Operator			RTA/STA (Transport Department)	Remarks
			Failures In customer Role	Failures In Processor Role	Failures In Supplier Role	Failures in Management Role	
1	Audit Report	09#	05	05	05	1. # Out of 09 No. NCs, 04 No. NCS Exclusively pertain to Management. 2. Other 05 Nos. pertain to Operator	# See & refer worksheet -1
2	Study report	08#	03	03	03	1. # Out of 08 No. NCs, 05 No. NCS Exclusively pertain to Management. 2. Other 03 Nos. pertain to Operator	# See & refer worksheet -2
	Total	17	08	08	08	17	
	Percentage		100	100	100	100	

The analysis depicts that the problems that appear in PUC process have their origin upstream (Management that is transport department). Therefore PUC suffering from performance problems cannot necessarily solve it by themselves.

1. The failures in each role of triple role in PUC are 100% that means the implementation of Standard procedure for PUC certification process (already provided under rules) is the first need for PUC operator to implement in its certification process which shows the complete failure.

2. Management failures in their role towards PUC are 100% that means the management is altogether missing. This indicates that organizers of PUC need to get awake and establish managing activities (management) in the PUC without further delay.

3. Management failures also indicate that to have control over PUC activities, Feedback loop (Between PUC & Transport Department) may be the significant reason.

4. Lax PUC norms, although put on PUC, is really an issue of organizers. .

DISCUSSIONS AND RECOMMENDATIONS

DISCUSSION

Triple role concept is such a topic of quality management that it in itself contains control elements. The problems of PUC are that its performance is not improving. Its ailments have become chronic in nature. It all requires breakthroughs in its activities so as to come on track and initiate actions for right certification showing improvements. Awareness of triple role and its application in PUC activities will rejuvenate PUC to take up its role in the right direction of performance in controlling vehicular air pollution. Lack of managing is evidenced.

RECOMMENDATION

The failures emanated from the analysis needs to be taken up for actions to resolve them. The Required actions are brought out here in under as Recommendations.

1. Establish Feedback loop between PUC and RTA/STA (Transport Department) supported with by a software having features of non-manipulability and real time applicability, on top priority.

2. RTA/STA (Transport Department) needs to establish management activities in PUC so as to exercise control over the operations of PUC. The management activities to include consistent monitoring and measuring of PUC, hold internal audits, management reviews, establish training & development programs for PUC and closures of Observations/NCs from internal as well as external audits. 3. Formulate & execute training programs on techniques such as of Triple Role concept and QA/QC in PUC periodically.

CONCLUSION

Presently PUC is overwhelmed with tags of under-performance in vehicular pollution, contributing towards societal deaths and harms to environments affecting Sustainability and thereupon Sustainability Developmental Goals (SDGs). PUC affects the entire society in the country and environments raising questions on its governance. Costs of poorly performing processes, entities and organizations are too high. To come out of such situations, techniques like Triple Role Concept, a universal, but very basic in nature and almost costless, simple to know and easy to apply, everywhere existing (amongst organizations, Departments of the organizations, sections of the departments, between individuals and within the individual and applicable to General manager down to worker- inbuilt in all aspects) can certainly bring us out of underperformance, if implemented. This glaring fact is the theme of this study.

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