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"A Proposed Model to Maximize Fuel Economy and Develop Good Maintenance Practices Through Global Practices"- With Special Reference to A Government Road Transport Corporation (India)

KEYWORDS

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ABSTRACT *The importance of providing mobility to the Public has long been recognized globally and urban transit is an important issue in both the developed world and the developing world. Buses are the most common form of urban transit, while alternatives like light and heavy rail are significantly more expensive in terms of capital expense. Fuel economy not only reduce costs but it also controls emissions and protests the operating environment. maintenance is a necessary function to increase the availability of buses, reduce costs and ensure safety of passengers. This article discusses the way to increase the fuel economy and develop good maintenance practices*

INTRODUCTION

The importance of providing mobility to the Public has long been recognized globally and urban transit is an important issue in both the developed world and the developing world. In the developed world, transit is an alternative to the private car and a means of reducing congestion, while in the developing world, public transit is a key requirement to provide affordable, low cost mobility to much of the urban population. Buses are the most common form of urban transit, while alternatives like light and heavy rail are significantly more expensive in terms of capital expense. Each additional bus provides large benefits.

If a bus is reasonably full, it replaces any where from 10 to 40 other motorized vehicles (including 2 wheelers as well as cars). The consequent fuel savings,CO2 reductions and pollutant reductions and accident reductions can be large (world bank document). To achieve such great mobility at a economical rate it is must that we should have a effective kpl management and good maintenance practices which leads to availability, reliability and comfort.

STATEMENT OF PROBLEM

At present the government road transport corporation under consideration was suffering from losses. Hence there was a requirement to address the causes of losses. There are various causes as part of losses. However, the authors indentified 02 grey areas contributing to losses, which are KPL management and maintenance practices.

RESEARCH OBJECTIVES

- Identify techniques which can give better kpl(Kilometer per liter of fuel).
- Indentify maintenance activities which can lead to good maintenance practices.

METHODOLOGY

The bus transport corporation identified for study is having a total fleet strength of 130 buses and all are from Ashok Leyland (OEM). It is basically a qualitative study based on review of literature (Text books, magazines ,world bank report, company reports and article …etc),observations and secondary data.

LITERATURE REVIEW

Kpl

Fuel economy not only reduce costs but it also controls emissions and protests the operating environment. In this case the kpl achieved is very low i.e 3.5 kms/liter of fuel against 5.3kms/liter of fuel as given by OEM. The organization must address this issue with most consideration and try to implement suitable remedial measures recommended in this paper. The checks on vehicle recommended by world bank to achieve better KPL as listed out in the appendices 'A' and 'B'.

Maintenance practices

The typical maintenance cycle uses daily checks, weekly or bi-weekly checks and checks at 8000 to 10,000 km intervals, with manufacturers specifying the maintenance intervals and specific checks. All companies interviewed regardless of size or location used this type of schedule but larger companies often analyzed the failure data to develop more tailored policies suitable for their local conditions. Small companies (like Bel Tour andCATA) do not have the resources or data to pursue unique strategies, and simply use manufacturer specified maintenance. Larger fleets have also discovered the virtues of written methods to conduct repairs and standard operating practices (SOP) that specify all aspects of diagnosis and repair. This has enabled uniform and repeatable repair results and facilitates moving staff among depots without having to change practices. Mechanics training on the SOP is also a key part of the strategy to introduce uniformity(ESMAP,World bank document, June 2011).

The maintenance and repair workshop is often **located at a bus depot** together with other operational facilities such as stores or the fuel station. The workshop has to provide maintenance for a large variety of vehicles, from several manufacturers and with a long lifecycle. Workshop size and equipment is determined according to the number, size and type of rolling stock and the maintenance regime. The workshop can be separated into areas according to the service function (e.g. cleaning, preventative maintenance, greasing etc (PROCEED,European commission,2009).

Workshop operation includes , Vehicle checks (preventive maintenance), Cleaning, Regular maintenance / repair,

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Greasing, Materials and components stores, Registering of failures and repairs and providing other documentation (such as drivers' service books), Communication with drivers and management.

Activities for providing an environment-friendly bus service (e.g. cleaning with recycled water, waste management, reduced fuel and energy consumption, improvement of chemical treatment), Data supply and disposal (for ticket machines, on board units, counting units (proceed European commission,2009).

The Dutch company Connexxion transformed its Maintenance department into an independent company (Techno services Netherland BV). This manages and maintains the fleets of public transport companies, large road haulage firms, municipalities, coach and taxi businesses. It has a network of 51workshops including five repair shops, together with a central parts store which supplies all the division's workshops with parts on a daily basis**(Almere -The Netherlands).** The bus station, at street level behind the railway station ,is equipped with an underground maintenance and depot level just under the bus station **(Fribourg- Switzerland)**. Maintenance is offered for other Fleets (e.g. lorries) and positive results are reported from both cities**(Piešt'any -Slovakia / Tabor (Czech Republic)**. Schaffhausen signed a service contract that allows it to test and to implement new products of the supplier. Furthermore, the operator broadened the services to other fleets**(Schaffhausen/Neuhausen -Switzerland)**.

Strategies for vehicles checks can be regarded as an efficient set of procedures for **predictive preventative maintenance**. For bus fleet maintenance two separate procedures can be defined as under :-

- Management of breakdowns of running buses (it depends on the seriousness of the breakdown).
- Workshop operations (time of repair depends on the seriousness of the breakdown, preventative maintenance, providing reports on failures and repair protocols).

From the management point of view, it is possible to identify different methods for on-line team assistance and for workshop operation team assistance, while from an economic point of review, it is possible to evaluate and manage the possible outsourcing of maintenance (Carrese,Ottone 2005).

Systematic vehicle checks with clearly assigned responsibilities result in a reliable service. Checks of the vehicle interior and exterior can be done by the driver, or by authorized personnel from the operator or the public transport authority. Passengers may also report their observations if these have not been picked up by the regular official checks. Obligated periodical checks are fixed by the predictive / preventive maintenance policy of the operator and / or bus manufacturer instructions. Since the 1980s vehicle checks have been upgraded with computer-based maintenance **management systems**, which enable a clearer database structure, automatic decision support systems, diagnostics, etc. The aim of a **cleaning strategy** is to provide a high-level cleanliness of the bus fleet and bus stops. In order to deliver that an operational cleaning plan should be approved. The operational cleaning plan should describe the implementation of cleaning standards, quality assurance, training, communications, equipment and material, health and safety aspects. Cleaning as a high-quality feature can be organized according to the following types of cleaning procedures:

- Integrated periodical (e.g. daily dry cleaning, weekly wash and complete disinfection, and replacement of broken parts every six months.

- Segregated periodical (e.g. floors and stairs washed weekly, windows washed every15 days).

- Extraordinary cleaning (e.g. when reported by driver). In order to meet e**nvironmental goals**, vehicle bodies (exteriors) can be washed with recycling water and detergent without chemicals, etc (European commission).

Coimbra applies a policy on clean buses. Fleet renewal has taken place with an emphasis on clean and accessible vehicle technologies **(Coimbra -Portugal)**. Travel Dundee contracts out bus cleaning, with buses being swept out and mopped, and ledges and the driver's cabin all cleaned each night. Every 4 weeks there is a special clean focusing particularly on seat cushions and windows. There is also a thorough annual inspection, which involves the buses being stripped, roofs cleaned etc. A cleaner is also employed by Travel Dundee to sweep some buses at major terminal points during the day. If a bus gets particularly dirty en-route the cleaner may well go out to it or the bus may be changed for another. Also the night fleet supervisor will check the cleanliness of 10% of the fleet each night**(Dundee-UK)**.

A fast repair of damages and / or removal of other graffiti is usually performed if possible within 48 hours (Dordrecht-The Netherlands). Special group of employees is responsible for the maintenance and cleaning of the bus-stops; this group makes regular inspections(Graz -Austria). Periodical checks and cleaning with a requirement that the Number of journeys lost because of vehicle failures should be less than 1%(Györ -Hungary). Buses are cleaned inside and washed outside every day, as part of the very high quality expectations of the network (Monaco). A special policy on graffiti removal is applied. The removal of any racist graffiti is especially performed as a priority normally within 24 hours (Leuven -Belgium). The buses are washed and cleaned daily (exterior automatic washing, interior vacuuming, and cleaning of seats, and holders). Floors and stairs washed weekly, glasses washed every 15 days, a complete disinfection and replacement of broken seats or parts every six months(Toledo -Spain) (European commission).

DISCUSSION

Buses are the most common form of urban transit but, in the developing world, are often seen as inefficient and polluting. It is well known that buses that are properly tuned and adjusted tend to be cleaner, safer and consumes less fuel than poorly maintained buses. Fuel cost is relatively large fraction of total cost especially when labor and bus costs are low, as in many developing countries. Hence, reducing fuel use through targeted maintenance of fuel inefficient buses can reduce significant expenditures especially in developing countries, freeing up resources for other improved city services. In addition if city buses do not receive periodic maintenance that is adequate in quantity and quality, their emissions both local and global will suffer (ESMAP, World bank document, June 2011). Maintenance is no longer the necessary evil, but is vitally important part of the business (Mustafa Graisa & Amin Al-Habaibeh, 2010). Over time, the role of maintenance activities in manufacturing and service sectors has become increasingly important due to reasons like gaining competitive advantag-

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es, increasing customer satisfaction and decreasing additional costs if machines break down (Fernandez and labib, 2003; Kans,2008; Garg and Deshmukh 2006). Maintenance systemss operate in parallel to the production system to keep them serviceable and safe to operate at minimum cost (Duffuaa and Al-Sultan, 1997).

Fuel economy not only reduce costs but it also controls emissions and protests the operating environment. In this case the kpl achieved is very low i.e 3.5 kms/liter of fuel against 5.3kms/liter of fuel. The organization must address this issue with most consideration and try to implement suitable remedial measures recommended in this paper. The checks on vehicle recommended by world bank could not be tested on vehicles due to constraints of time. However, the test was carried out on APSRTC(Andhra Pradesh state road transport corporation-INDIA and KSRTC (Karnataka state road transport corporation-INDIA) vehicles and predictable improvements in kpl was noticed. Leyland buses are also part of APSRTC and KSRTC.

As discussed maintenance is a necessary function to increase the availability of buses, reduce costs and ensure safety of passengers. In this report a lot of scope for improvement in maintenance practices which are being presently followed in the organization. At present no separate agency with in the organization to carry out maintenance tasks. Also there is no policy documents available on maintenance activities to be carried out by the organization. The present system of spare parts inventory is not based on scientific analysis. Even to that extent computers are not being used in maintenance activities and inventory management. There is no methodical approach is being followed in carrying of repair analysis to calculate, Mean Time Between Failures (MTBF) and Mean Time Taken to Repair (MTTR); because this becomes a sound base for calculating spare parts consumption. In the absence of systematic failure analysis it becomes very difficult to predict spare parts consumption pattern.

CONCLUSION

Maintenance is a necessary function to increase the availability of buses, reduce costs and ensure safety of passengers. Maintenance is no longer the necessary evil, but is vitally important part of the business (Mustafa Graisa & Amin Al-Habaibeh, 2010). Over time, the role of maintenance activities in manufacturing and service sectors has become increasingly important due to reasons like gaining competitive advantages, increasing customer satisfaction and decreasing additional costs if machines break down (Fernandez and labib, 2003; Kans,2008; Garg and Deshmukh 2006). Buses are the most common form of urban transit but, in the developing world, are often seen as inefficient and polluting. It is well known that buses that are properly tuned and adjusted tend to be cleaner, safer and consumes less fuel than poorly maintained buses.

Appendix "A"

Tier I Checks for Implementation at the Local Bus Depot to Improve Fuel Economy

COMPONENT	CHECK	PASS/FAILCRITERION AND REPAIR
Tires/ Wheels	1. Check Tire Inflation	1. Pressure meets specification or add air
	2. Check for free rolling of wheels	2. Wheels rotated easily by hand or check brakes (see below)
	3. Wheel bearing lubrication	3. No grinding noise in bearing or lubricate as required.
Brakes	4. Check for free play of brake pedals	4. Excessive free play requires brake pedal linkage adjustment
	5. Check gap between brake liners and drum/disc	5. Gap must be visible or liners reinstalled.
	6. Check caliper boot and wear adjuster cap	6. Wear adjuster should not be at setting limit or replace liner.
	7. Check for break retraction after pedal release	7. Liners move away from rotor on brake release, or else check for break hydraulic/air line defects
Driveshaft/Axles	8. Check lubrication of driveshaft joints, axle bearings and differential.	8. Lack of visible lubricant and/or noise in joints and bearings signify need for lubrication.
	9. Examine tightness of driveline and gearbox mounts.	9. Visible driveline and gearbox vibration indicates need to tighten mounts.
Accelerator/ Clutch pedal	10. Check clutch pedal linkages.	10. Excessive play requires linkage adjustment.
	11. Check Accelerator linkages.	11. Excessive play requires linkage adjustment.
	12. Check accelerator return spring	12. Accelerator snaps back on release or else replace spring.
Engine-related	13. Check air cleaner for clogging.	13. Visible dirt on air cleaner, replace.
	14. Check exhaust pipe for blockage.	14. Check for any foreign objects or broken catalyst in pipe.
	15. Check on-board diagnostics if applicable.	15. Electronics check for diagnostic codes indicating any failure.
	16. Check for visible smoke on snap acceleration.	16. Smoke opacity over 20 percent indicates engine problem, send to central maintenance facility.
Air conditioner-related	17. Check tension in compressor belt drive.	17. Tighten belts as required or replace if worn significantly.
	18. Check for refrigerant pressure.	18. Low pressure indicates refrigerant leaks and leaks should be identified and fixed.
	19. Check for compressor damage.	19. Replace or repair as required.

Sources : World Bank Report.

Appendix "B"

Tier II Checks for Implementation at the Central Bus Maintenance Facility to Improve Fuel Economy

COMPONENT	CHECK	PASS/FAILCRITERION AND REPAIR

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Wheels	1. Check wheel alignment. 2. Check tire camber	1. Set manufacture specification. 2. Set to manufacture specification.
Clutch	3. Check condition of clutch facings. 4. Check clutch release bearing	3. Replace clutch facing if worn. 4. Replace bearing if worn/failed.
Fuel system (Diesel/ CNG)	5. Check fuel lines and tanks for leakage	5. Check for fuel drops on floor under bus (Diesel) or use gas detector (CNG). Replace lines or tank as required.
Engine (Diesel)	6. Check Fuel Injection pump timing and maximum fuel stop. 7. Check Fl pump pressure. 8. Pull and check fuel injectors for leakage or clogged spray holes. 9. Check turbocharger bearings (if turbocharged). 10. Check cylinder compression. 11. Inspect cylinder head for cracks, bolt tightness. 12. Check piston rings if oil consumption is high. 13. Check for engine coolant loss/ overheating	6. Set timing and stop to manufacturer specifications. 7. Low pressure indicates pump rebuild. 8. Asymmetric spray indicates need for injector cleaning or replacement. 9. Turbo rotor must rotate freely or else replace bearings. 10. Low compression requires head gasket, ring check or engine rebuild. 11. Torque head bolts to manufacturer specification, replace cracked head. 12. Replace worn rings. 13. Radiator or hose leaks should be patched
Engine (CNG)	6A. Check air-fuel mixer settings. 7A. Check gas pressure regulator. 8A. Check ignition system wires and spark plugs for misfire. 9A. Check turbocharger bearings (if turbocharged) 10A. Check cylinder compression. 11A. Inspect cylinder head for cracks, bolt tightness. 12A. Check piston rings if oil consumption is high. 13A. Check for engine coolant loss/ overheating.	6A. Set to manufacturer specifications. 7A. Output pressure must be within specifications or replace. 8A. Replace broken wires and fouled spark plugs. 9A. Turbo rotor must rotate freely or else replace bearings. 10A. Low compression requires head gasket, ring check or engine rebuild. 11A. Torque head bolts to manufacturer specification, replace cracked head. 12A. Replace worn rings. 13A. Radiator or hose leaks should be patched.
Exhaust System	14. Inspect exhaust brake valve if used.	14. Valve not opening freely should be cleaned or replaced.

Sources : World Bank Report.

REFERENCES

1. National Center for Transit Research. "*Florida Bus Maintenance Staffing Practices, Technical Memorandum #1,*" Center for Urban Transportation Research, University of South Florida, June, 2011
2. National Center for Transit Research. "*Florida Bus Maintenance Staffing Practices, Technical Memorandum #2,*" Center for Urban Transportation Research, University of South Florida, June, 2011
3. National Center for Transit Research. "*Mechanic Manpower Analysis for Miami-Dade Transit,*" Center for Urban Transportation Research, University of South Florida, June, 2003.
4. Transportation Research Board. "*Public Transit Bus Maintenance Manpower Planning,*" Drake, R.W. and Carter, D.W., Report 10, National Cooperative Transit Research and Development Program, December, 1984.
5. Transportation Research Board. "*Evaluation of Maintenance Manpower Utilization,*" Drake, R.W. and Carter, D.W., Transportation Research Record Issue No. 1019, pages 49-62, 1985.
6. Transportation Research Board. "*Evaluation of Bus Maintenance Operations,*" Drake, R.W. and Carter, D.W., Transportation Research Record Issue No. 1019, pages 77-84, 1985.
7. NAFA Fleet Maintenance Association. "*Fleet Maintenance Operations Guide,*" Chapter 7 – Maintenance Staffing, pages 409-424, June 2009.
8. Federal Transit Administration. "*Characteristics of Urban Transportation Systems,*" Cambridge Systematics, Inc. et al, Revised Edition, September 1992. ……6/-
9. Town of Chapel Hill, North Carolina. "*Town of Chapel Hill Transit Maintenance Staff Analysis,*" Parsons Brinkerhoff, Inc. 2003.(147)
10. Fulton, L. (2001). *Sustainable Transport: New Insights from the IEA's Worldwide Transit Study.* Paper presented for COP7 at Marrakesh: 29 Oct-9 Nov, 2001. International Energy Agency, Paris.
11. Research Results Digest, International Transit Studies Program, Transit Cooperative Research Program, US Transportation Research Board, September 2003.
12. Budget Work Session, Fiscal Year 2010 Operating Budget, Presentation to the WMATA Board,January 2010.
13. Research Results Digest, op cit.
14. Sudhakararao, U. *City Bus Operations- Fuel Management*, Presentation provided to World Bank, September 2010
15. For more information about the EECI or about ESMAP's work with cities, visit http://www.esmap.org
16. Prindle, W. R., From Shop Floor to Top Floor- Best Business Practices on Energy Efficiency, Prepared for the Pew Center on Global Climate Change
17. US Department of Transportation, *Maintenance Management Systems Fact Sheet: Transit Overview*, available at www.pcb.its.dot.gov/factsheets.
18. Ang, B. W. and Deng, C. C., The effects of Maintenance on the Fuel Efficiency of Public Buses, Journal of Energy, March 1990.
19. Ang.B.W. and Deng, C.C., op cit.
20. UNEP, *Cleaning Up Urban Bus Fleets*, UNEP Publication, September 2009.
21. Sudhakararao, U. *City Bus Operations- Fuel Management*, Presentation provided to World Bank, September 2010
22. Prindle, W. R., From Shop Floor to Top Floor- Best Business Practices on Energy Efficiency, repared for the Pew Center on Global Climate Change
23. Global Business Network, Energy Strategy for the Road Ahead, funded by the US Environmental Protection Agency, 2007
24. U.S. DOT Federal Transit Administration. (2008). *Transit State of Good Repair: Beginning the Dialogue.* Washington, D.C.: Department of Transportation
25. Schiavone, J. (2005). *A Guidebook for Developing and Sharing Transit Bus Maintenance Practices.* Washington, D.C.: Transportation Research Board. ..7/-
26. Venezia, F. W. (2004). *Maintenance Productivity Practices: A Synthesis of Transit Practice.*Washington, D.C.: Transportation Research Board
27. Schiavone, J. (1997). *Monitoring Bus Maintenance Performance.* Washington, D.C.: National Academy Press.
28. Ang, B. W. and Deng, C. C., The effects of Maintenance on the Fuel Efficiency of Public Buses, Journal of Energy, March 1990
29. US Federal Transit Administration, *Advanced Public Transportation Systems, Update 2006*,FTA-NJ-26-7062-06.1, 2006 Transit Bus Operational and Maintenance Practices to Maximize Fuel Economy .

Volume : 6 | Issue : 8 | August 2016 | ISSN - 2249-555X | IF : 3.919 | IC Value : 74.50

30. TCRP, *Implementing New Technologies in Maintenance Systems and Departments in Europe*,Research Results Digest 71, November 2005
31. Urban Transportation Showcase Program, *Fuel Sense: Making Fleet and Transit Operations More Efficient,* Transport Canada Case Study No.24, July 2004
32. Natural Resources Canada, *Smart Driver Training Program descriptions*, www. Fleetsmart.nrcan.gc.ca
33. UK Department of Transport, *The Fuel Efficient Truck Driver's Handbook*, Transport Operators Pack available on line
34. State of Oregon, *Head Start of Oregon's Driver Handbook*, www. HeadStart.lane.or.us
35. Symmons, M.A. and Rose, G. *Ecodrive Training Delivers Substantial Savings for Heavy Vehicle Drivers,* Proceedings of the Fifth International Symposium on Human Factors in Driving,2008.
36. Akbarov, A., & Wang, W. (2008). *Problem identification in maintenance modelling: a case study*. International Journal of Production Research , 103 -1046.
37. Ang, B. W., & Deng, C. C. (1990). *The effects of maintenance on the fuel efficiency of public buses*. Journal of Energy , 1099-1105.
38. Barbera, F., Schneider, H., & Kelle, P. (1996). *A Condition Based Maintenance Model with Exponential Failures and Fixed Inspection Intervals*. The Journal of the Operational Research Society , 1037-1045.
39. Bardi, E. J., & Tracey, M. (1993). *Transportation Maintenance Outsourcing: A Survey of US Practices*. Journal of Physical Distribution & Logistics Management , .
40. Beruvides, M. G., Simonton, J. L., Waters, N. M., Ng, E., Chaivichitmalakul, S., Chiu-Wei, C.-C., et al. (2009). *The Concept of a Regional Maintenance Center*. Journal of Public Transportation , 105-118.
41. Bivona, E., & Montemaggiore, G. B. (2010). *Understanding short- and long-term implications of "myopic" fleet maintenance policies: a system dynamics application to a city bus company.* System Dynamics Review , 195-215.
42. Chamberlain, E. S., & Di Bello, L. A. (1997). *Iterative Design and Implementation: AModel of Successful Scheduled Maintenance Technology Deployment*. Transportation Research Record: Journal of the Transportation Research Board , 42-49.
43. Clark, N. N., Zhen, F., Wayne, W. S., & Lyons, D. W. (2007). *Transit Bus Life Cycle Cost and 2007 Emissions Estimation*. Washington, D.C.: Federal Transit Administration.
44. Desa, M. I., & Christer, A. H. (2001). Modelling in the Absence of Data: A Case Study of Fleet Maintenance in a Developing Country. *The Journal of the Operational Research Society* , 247-260.
45. Dutta, H., Maze, T. H., & Cook, A. R. (1986). *Performance of Bus Transit Maintenance (Discussion and Closure*). Transportation Research Record , 46-59.
46. Finegold, D., Robbins, M., & Galway, L. (1998). *Closing the Knowledge Gap for Transit Maintenance Employees: A Systems Approach*. Washington, D.C.: National Academy Press.
47. Finley, Bruce, A *Three Year Comparison of Natural Gas and Diesel Transit Buses,*SAE paper no. 1999-01-3738, November 1999
48. Goyal, S. K., & Gunasekaran, A. (1992). *Determining economic maintenance frequency of a transport fleet*. International Journal of Systems Science , 655-659.
49. Haghani, A., & Shafahi, Y. (2002). *Bus maintenance systems and maintenance.*
50. Huang, J.-Y., & Yao, M.-J. (2008). *On the coordination of maintenance scheduling for transportation fleets of many branches of a logistic service provider.* Computers & Mathematics with Applications , 1303-1313.
51. G. Ivanovic, et al., *The Fix-it Subsytem of Motor Vehicle Maintenance Information .Systems,* SAE paper 2001-01-3196, October 2001.
52. Kiernan, V. (1998). *Internet Information Sharing for Transit Maintenance*. Washington, D.C.: Transportation Research Board.
53. Márquez, A. C., & Herguedas, A. S. (2004). *Learning about failure root causes through maintenance records analysis*. Journal of Quality in aintenance Engineering .
54. Schiavone, J. (2005). *A Guidebook for Developing and Sharing Transit Bus Maintenance Practices*. Washington, D.C.: Transportation Research Board.
55. Schiavone, J. (1997). *Monitoring Bus Maintenance Performance*. Washington, D.C.: National Academy Press.
56. Shum, Y.-S., & Gong, D.-C. (2006). *The application of genetic algorithm in the development of preventive maintenance analytic model*. The International Journal of Advanced Manufacturing Technology , 169-183.
57. Simoes, A., Farinha, T., Fonseca, I., Barbosa, F. M., & Marques, V. (2009). *Buses Degradation Based on Exploration Conditions*. Proceedings of the 3rd WSEAS Int. Conf. on Energy Planning, Energy Saving, Environmental Education , 141-149.
58. U.S. DOT Federal Transit Administration. (2008). *Transit State of Good Repair:Beginning the Dialogue*. Washington, D.C.: Department of Transportation.
59. Venezia, F. W. (2004). *Maintenance Productivity Practices: A Synthesis of Transit Practice*. Washington, D.C.: Transportation Research Board.
60. Zanini, M., et al., *Mobile Assets Monitoring for Fleet Maintenance*, SAE Paper no 2005-01-1436,Apr 2005.