

Overall Service Effectiveness on Urban public Transport System in the City of Addis Ababa

Abstract

This paper tries to conduct an in depth analysis on the Overall Service Effectiveness (OSE) of a transport system performance with the perspective of extending the concept of Overall Equipment Effectiveness (OEE) which has been practiced on the manufacturing system in to urban public transport system. To this effect, the OEE model of a manufacturing system was extensively studied and analogously an OSE model that can be used for urban public transport system was developed the first time. The OSE model was fitted and tested with two years monthly secondary data collected from the urban public transport service enterprise in the city of Addis Ababa. The findings of the study show that, the OSE of the Addis Ababa urban public transport system is found to be 44%. It also shows the enterprise has exhibited low availability, poor performances and quality in its service provision.

15 **1. Introduction**

16 Overall Equipment Effectiveness (OEE) is a measure of the performance of a manufacturing
17 unity by considering the Availability, Performance, and Quality (Örjan, 1998; Nakajima, 1989).
18 Within this context OEE can be considered to combine the operation, maintenance and
19 management of manufacturing equipment and resources (Dal, 1999). Further a considerable
20 effort has been made in the literature in relation to the definition of OEE and its applications in
21 various areas. In this regard various authors dealt on OEE as a a tool for decision making, for
22 profit improvement, and measure of performance (Dal et al.,2000; Hansen, 2001 and
23 Bamberet al.,2003). Though OEE has been developed as a method to measure performance
24 effectiveness by Nakajima (1988), it has been improved and modified to practice in different
25 approach and environment other than a manufacturing system industry. The leads the
26 formulation of new metric for OEE measurement by giving different weight for the factors by
27 Raouf (1994), the OEE is also extended to overall process effectiveness (OPE) that can
28 encompass the overall process rather than a unit (Al-Najjar, 1996; Al-Najjar, 1999) and Peters
29 (2003) has identified a measure for overall craft effectiveness (OCE) on focus of productivity
30 labour resources.

31 Like any manufacturing or process industries, it is in fact that, effective maintenance system is
32 also the backbone of public transportation service that uses bus as a means of transport to
33 achieve its goal. However, there has not been a study so far that used OEE to measure the
34 performance of an urban public transport system. The study considered Anbess City Bus
35 Service Enterprise (ACBSE) as a case company and try to extend analogously the OEE
36 measurement mechanism to develop an Overall Bus Effectiveness (OBE) for the enterprise.

37 **2. Literature Review**

38 Maintenance is combination of all technical and administrative actions, including supervision
39 actions, intended to retain an item in, or restore it to, a state in which it can perform a required
40 function (British Glossary Standard institution, 1974). And Like any processing/manufacturing
41 industries, maintenance is the most imperative and significant elements in transportation
42 enterprise. Moreover, maintenance cost is the second highest expense category of running
43 cost of transportation enterprises (Andrle, 1986; Bladikas & Papadimitrou, 1986, Eshetie et.al.
44 2014)

Most maintenance research works were being focused in the manufacturing and continuous processing industries. The scientific method of maintenance approaches date back to 1950s and 1960s (JJ, 1965; Barlow & Proschan, 1965), various maintenance optimization models were presented. In the models, both expenses and welfares maintenance was calculated and optimum negotiations among the two were required. More recently, a very successful systematic method for establishing maintenance programs are reliability centered maintenance and Total Productive Maintenance (Borris, 2006).

TPM implementations truly reduce manufacturing complex problem with a key objectives of maximizing overall equipment effectiveness through the elimination or reduction of all these six losses. (Almeanazel, 2010; Maran, & Thiagarajan, 2012; Kumar, & Thyagarajan, 2012). Overall equipment effectiveness (OEE) measurement is modern key performance indicator of machine or an integrated machines commonly used in the manufacturing /process industries. Especially in those that are implementing total productive maintenance is prevalent measurement since improving OEE is one of the pillars of TPM. It includes availability, performance rate and quality rate (Borris, 2006). Mathematically the OEE is formulated as follow:

$$\text{OEE} = \text{Availability (\%)} \times \text{Performance (\%)} \times \text{Quality (\%)} \quad \text{Eq.(1)}$$

Where:

$$\text{Availability (\%)} = \frac{\text{Total Time Available} - \text{Down Time}}{\text{Total Time Available}} \times 100 \quad \text{Eq.(2)}$$

$$\text{Performance (\%)} = \frac{\text{Number of Units Manufactured}}{\text{Possible Number of Units to Be Manufactured}} \times 100 \quad \text{Eq.(3)}$$

$$\text{Quality (\%)} = \frac{\text{Total Number of units Produced} - \text{Number of Defects}}{\text{Total Number of units Produced}} \times 100 \quad \text{Eq.(4)}$$

Moreover, various authors proposed different models. For example (Mehdi, & Mohammadreza, 2011) proposed mathematical models on finding either the optimal balance between costs and benefits of maintenance , Borgonovo, M. Marseguerra, E. Zio (1999) have proposed Monte Carlo simulation model provides a flexible tool which enables one to describe many of the relevant aspects for plant management and operation,(Thomas, & Jorn, 2006) reliability model which can be used for scheduling and optimization of maintenance, (Ahad, Xiaohui,

72 Ziming, Jay, & Jun, 2008) an optimal system design and maintenance scheduling schemes
73 that can evaluates their effects on the overall system performance, which the optimal
74 preventive maintenance interval can be determined from an interval availability point of view,
75 rather than from a limiting availability perspective by (Dijkhuizen & Heijden, 1999).

76 Overall Service Effectiveness (OSE) is not common to measure the performance of service
77 industries due to the fact that they are not observed in implementing TPM and RCM. Except
78 airlines companies are being originators and exercising RCM. Therefore, the objective of this
79 paper to introduce a new approach in the service sector to measure OSE.

80 **3. Overall Service Effectiveness Model**

81 OEE is commonly a measure of three major losses. Similarly, the OSE is analogously
82 developed and measured from the three major losses. The first loss is down time losses which
83 is a measure of all down times that are related to corrective or preventive maintenance and
84 their setup time to maintenance work. In the case of service it includes all administrative down
85 time and logistic down time losses.

86 The second loss is operational losses. It considers all losses that are beyond or just after
87 maintenance work finished. For instance in the case of transport service, buses may be idle in
88 waiting for drivers and his/her assistance, improper management of operators, extended
89 waiting time of passengers. Buses may not provide service in all roads and in full working
90 hour. This is because of discrepancy of design and actual performance of buses or speed loss
91 of buses. Similarly, it is represented by performance measurement which is the difference of
92 operational and technical availability in this case.

93 The third type of loss is maintenance rework or quality loss. This is used to take into
94 consideration of time and material loss because of rework. It is to figure out how many
95 maintenance rework are being performed in a considered time period and caused to down
96 time loss and material loss. . In the same analogy as OEE, OSE is measured the
97 effectiveness of maintenance quality and policies, managers of maintainers and operators and
98 the buses itself as well as the level of service quality. The overall analogous model is shown
99 in Figure1.

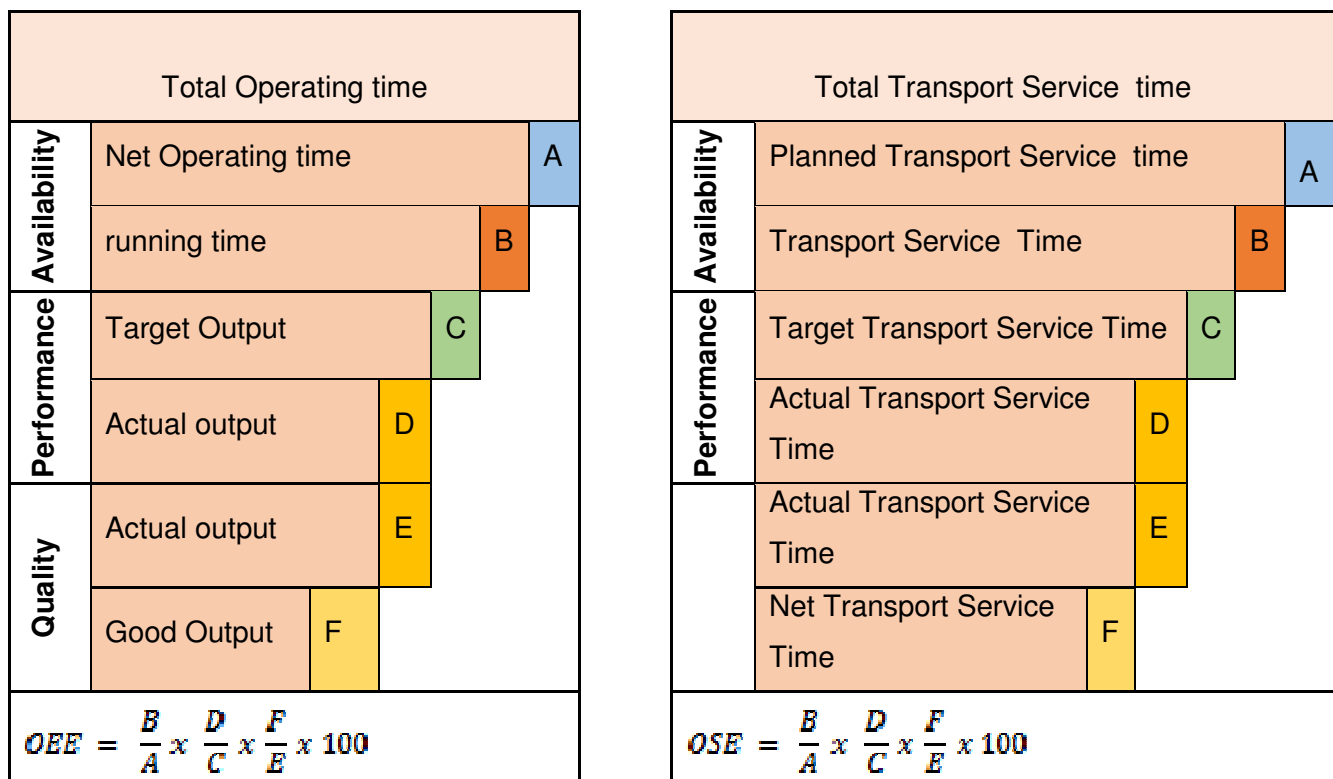


Figure 1. The analogy model of OSE Developed from OEE

4. Results and Discussion

Secondary data related to the number of passengers, number of buses and different expenses to operate the transportation services were collected. With this regards, the distance coverage of each route, the tariff charged the number of working days, the planned transport service, the actual transport service time and the total daily trips made by each bus were also collected from the secondary data in monthly bases from the year 2010/11 to 2011/12 for about 19 month. Based on the data collected from ACBSE, the average values for those parameters to measure the OSE is analyzed and presented in Table1.

In order to validate this model, the service operational time of the enterprise was taken as a basis for measuring its performance. The enterprise is planning to operate 17hrs in a day with 1hrs lunch break. It is planned to operate from 6:00AM up to 23:00PM.

113 Table 1. Analogous explanation of OEE and OSE

			Urban public Bus transport Case
Total Operating time			Total Transport Service time (17hrs/per day= 1020minutes)
Availability	Net Operating time	uptime (Availability Loss) = $\frac{780}{930} \times 100 =$	Planned Transport Service time (930minutes)
	running time	83.87	Transport Service Time (780 minutes)
Performance	Target Output	speed and/or utilization	Target passengers transported (1050.41passengers/day)
	Actual output	(Performance/speed Loss) = $= \frac{786.63}{1050.41} \times 100 = 74.83$	Actual Passengers transported (786.63pass/day)
Quality	Good Output	Yield (quality Loss) = $= \frac{554.38}{786.63} \times 100 =$	Actual Passengers transported (775.27pass/day)
		70.48	Net Passengers transported (554.38pass/day)
OSE = (0.8387 X 0.7483 X 0.7048)X100= 44.23%			

114 The transport service time planned to be available is 930minutes out the total 101minutes.
 115 This implies that an availability of 83.87% of its total operational time. Based on its target and
 116 actual output, the transport system performance of the enterprise is found to be 74.83%.
 117 Moreover, the level of quality in its service operation is about 70.84%. As shown in Table1,
 118 taking all these inputs into account the overall Service Effectiveness of the enterprise is found
 119 to be 44.23%. This implies that though the individual values of its availability, performance and
 120 quality are relatively above 70%, but its OSE is very low. This subsequently affects the overall
 121 service performances of the Enterprise.

122 5. Conclusion

123 Overall Service Effectiveness (OSE) is a new concept in the service industries and attempted
 124 the first time in this paper. Based on the analogy from the Overall Equipment Effectiveness

(OEE) model, the OSE model is developed and tested on urban public bus transport system in Anbessa City Bus Service Enterprise (ACBSE). With in-depth analysis of each of the parameters, the OSE of the ACBSE is evaluated using the model. The findings of the study show that the OSE of the enterprise is found to be 44.23%. However, with close investigation on the individual parameters, such as the availability, performance and quality all exhibited more than 70%. Based on this finding, it is recommended that the enterprise should improve its availability, performance and quality so as to improve its OSE.

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