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## OPERATIONAL PERFORMANCE ANALYSIS OF PUBLIC BUS TRANSPORT SERVICES IN ADDIS ABABA, ETHIOPIA

**Summary.** In emerging countries, improving performance in the transportation industry is a critical concern. Bus transport companies like Anbessa, Sheger and the Public Service Employees' Transport Service play a pivotal role in Addis Ababa's transit system. Subsequently, this study analyzes the operators' operational performance, comparing it to industry norms. The collected data is analyzed using the ratio analysis approach. The findings indicate that the Anbessa City Bus outperforms the other buses in several aspects, such as fleet strength, service utilization, and vehicle utilization, but there is a disparity in staff productivity and operational safety. Sheger City Bus, on the other hand, outperforms the market in terms of vehicle utilization, workforce productivity, and operational safety. However, on most of the indicators, the Public Employees Bus performs the worst. Finally, comparing the operators' performance to industry standards, most indications show that they fail to meet. Consequently, even if bus transit operators are subsidized by the government in the operation of their services for residents, the study suggests that they must make significant improvements in how they use their resources to improve their financial and operational performance and deliver better services compared to those provided by other operators in the city. In addition, government incentives such as subsidies should be allocated based on actual operational performance.

**Keywords:** bus transit, operational performance, ratio analysis, Addis Ababa

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## 1. INTRODUCTION

### 1.1. Background

The transport sector plays an important role in a country's overall progress [1]. Transport is a major factor in the movement of people and goods and a key element in maintaining a robust national economy [2].

Public transport comprises bus transit systems, rail systems, light rail systems, monorails, and water transportation. The conventional bus is the most common means of public transportation in most developing countries due to its inexpensive operating and startup costs, route flexibility, and permeability into towns and city centers [2, 3]. Besides, buses are considered to be the most common choice for most commuters as it is the cheapest mode of travel [4]. Thus, one of the essential components of the well-being of increasing and expanding metropolitan regions is the provision of adequate, acceptable public bus transportation services [5].

However, rapid population growth and a high reliance on private vehicles are major challenges facing many cities in the developing world. The rapid growth of private cars increases pressure on the city's urban transit system. This is because, as mentioned in [6], the increased use of private vehicles impacts the quality of life in the community. It causes problems such as congestion, traffic noise, and air pollution. In addition, it affects the operation of public transportation in the city as well as the efficiency of transportation companies.

Therefore, promoting public transport is the most important option to minimize problems related to urban transport in most cities in developing countries. In addition, it contributes significantly to alleviating traffic congestion problems and air pollution, thus providing an alternative means of transportation and contributing appreciably to the value of urban living [7].

Presently, Addis Ababa is experiencing rapid population growth and rapid urbanization. In addition, the existing public transportation system in the city has various problems, such as congestion, overcrowding of buses, and shortage of buses. However, to minimize traffic problems in the city, the government is placing more emphasis on local transport, regularly increasing the number of company buses.

However, the author of this study believes that to make urban public transport attractive and efficient, city services must not only be properly planned, operated and marketed but also be continuously measured and monitored. From an operator's point of view, effective performance measurement of services is a way to promote the operational efficiency of a city's transportation system. Thus, the purpose of this study is to evaluate the operating performance of the public bus transportation system in Addis Ababa from the perspective of the operator.

### 1.2. Scope of study

The scope of this study is seen from a geographical and thematic point of view. Geographically, the study is focused on Addis Ababa city. The thematic area of the study goes to analyse the operational performance of public bus transport in the city (that is, Anbessa City Bus, Sheger Express bus, and PSETSE service). In terms of time frame, the study covers 2013/14 to 2018/19, which adds up to six years of assessment. The span of more than five years is enough to produce a trend of the performance of each transit agency.

## **2. LITERATURE REVIEW**

### **2.1. Performance measurement and its importance**

The term performance refers to a measure of evaluation or comparison. This can be viewed as a quantitative or qualitative characterization of performance [8]. It can also be defined as the purpose of successfully carrying out one or more activities of an organization [9].

Performance has many dimensions, including efficiency and effectiveness. The efficiency of an enterprise represents how the physical inputs of labor, energy, maintenance materials, capital, and overheads are used to produce the physical (intermediate) services defined by vehicle kilometers of service. Effectiveness has two essential components: (i) cost-effectiveness – the relationship between inputs and consumed services (that is, patronage levels) and (ii) service effectiveness – the relationship between produced services (that is, vehicle kilometers) and consumed services (that is, patronage levels). All of these global measures are relative measures of different dimensions of performance [10].

Similarly, performance measurement can be defined as the evaluation of an organization's output as a product of the management of its internal resources (money, people, vehicles, facilities) and the environment in which it operates [11]. Further, it is described as the technique to evaluate how good or bad the performance of transit service is under a prevailing operating condition [12].

In addition, performance measurement involves collecting, evaluating and reporting data related to how well an organization performs its functions and achieves its goals and objectives. The measurements used in the process ideally relate to the results achieved by the organization. However, descriptive measures can also be used to provide context and identify underlying reasons for changes in performance [13, 11].

### **2.2. Transit performance measurement**

Performance measures are a navigation tool that assists in determining where an organization wants to go and how to get there. Trend analysis, comparisons, target setting, system improvement, and incentives for managers and employees are just a few of its practical applications. It also aids in the identification of possible issues and the most appropriate solutions [14, 15].

Measurement of transportation performance is a dynamic method for ensuring that the quality of offered transit services continues to improve and for allocating resources among competing transportation agencies [8]. Performance appraisals are also an objective way to assess performance. They are usually classified into one of two categories:

- i. Efficiency measurements describe the relationship between completed work and the resources required to complete it.
- ii. Effectiveness measurements are commonly thought of as a reflection of how well a transportation system accomplishes its objectives. Typically, this is associated with the number of passengers carried and is assessed for passengers per vehicle hour or mile, as well as the proportion of expenditures recovered from operating revenues (recovery ratio) [16, 17].

Further, the performance of transit agencies should be assessed using standard evaluation criteria. This includes operational performance, which could be evaluated using measures such as fleet utilization rate, passenger volumes, staff-bus ratio, vehicle kilometers, accident rates,

and breakdowns in service. The standard of services could also be assessed by employing such measures as passenger waiting time, passenger journey times, service affordability, and walking distance to the bus stop. Similarly, variables such as the revenue-cost ratio and cost-per-passenger-kilometers could be used in assessing financial performance [4]. Similarly, these are indicated as key indicators to measure the operational performance of the public transit system [18].

Tab. 1

Bus transport performance measures

Measures	Description
Fleet availability	Number of vehicles ousted as a proportion of total fleet stock
Vehicle utilization	Vehicles covered km (Km/bus)
Schedule outrun	The proportion of schedules operated
Staff productivity	Number of staff per schedule for bus
EPK	Earning per km
CPK	Cost per km
Passengers carried	Either absolute or per bus or km
Load factor	Total passenger km / total seat/km
Breakdown rate	Per million vehicle km
Accident rate	Per million vehicle km

Summarily, this study attempts to analyze the operational performance of public bus transportation in the city using the following indicators: fleet strength, fleet utilization, vehicle utilization, service utilization, staff-bus ratio, and staff productivity, as well as the quality of service in terms of operational safety, based on existing literature and studies. In addition, financial indicators such as cost per kilometer (CPKM), earning per kilometer (EPKM), are used to assess the enterprise's financial performance.

### 3. MATERIALS AND METHOD

#### 3.1. Data collection

Secondary data were collected from the annual reports of Anbessa City Bus, Sheger City Bus and PSETSE. Reports, journals, and books were also used as data sources for the research analysis.

#### 3.2. Data analysis

This study also uses ratio analysis to measure operator operational performance based on selected performance indicators.

## 4. RESULTS AND DISCUSSION

### 4.1. Operational performance

The availability and utilization of buses have a significant impact on transit operators' productivity and efficiency. Furthermore, vehicles must be well utilized throughout their operational life to maintain their financial sustainability. Thus, operational performance analysis is critical as it might reveal a significant contribution to productivity. As a whole, the following are the results for each selected performance indicator.

#### 4.1.1. Fleet strength

Fleet strength refers to the number of buses held by each transit service provider to deliver services for users of the service in the city. Thus, as shown in Figure 1, ACBSE has the highest number of buses in the provision of service. The new transit operator, that is, PSETSE, also has a better fleet strength compared to the Sheger bus, but the main objective of the PSETSE bus is to provide transport service for civil servants in the city and provide taxi service with a limited number of buses for residents of the city for a fare.

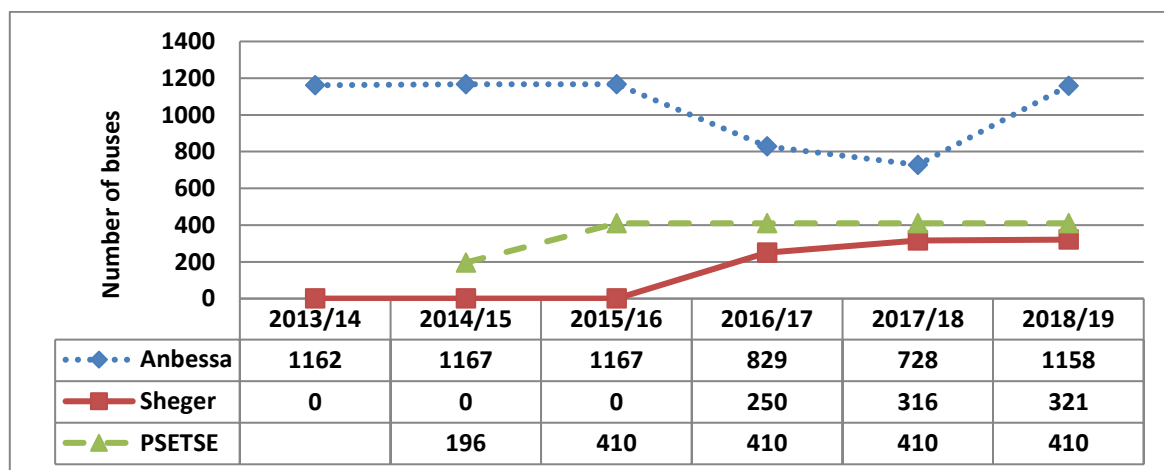


Fig. 1. Number of buses held

#### 4.1.2. Fleet utilization

The percentage of a carrier's fleet of vehicles in operation in a year is called fleet utilization. It serves as an efficiency indicator as it represents the quality of bus service, maintenance and delivery. However, not all agency buses are on the road all the time, as some buses are expected to remain in the workshop for maintenance and repair work, among other things. Therefore, higher fleet utilization means a higher percentage of buses on the road and a lower rate of service breakdowns and failures.

Thus, as portrayed in Figure 2 above, Anbessa City Bus fleet utilization was highest in 2017/18 (60%) but lowest in 2018/19 (37.2%). Also, in the last two years (2017/18 and 2018/19), the Sheger City Bus has had a high vehicle utilization rate, with the company reaching the highest utilization rate (79.4%) compared to the Anbessa City Bus. This means that Sheger city buses have a high fleet utilization rate compared to other buses in the city.

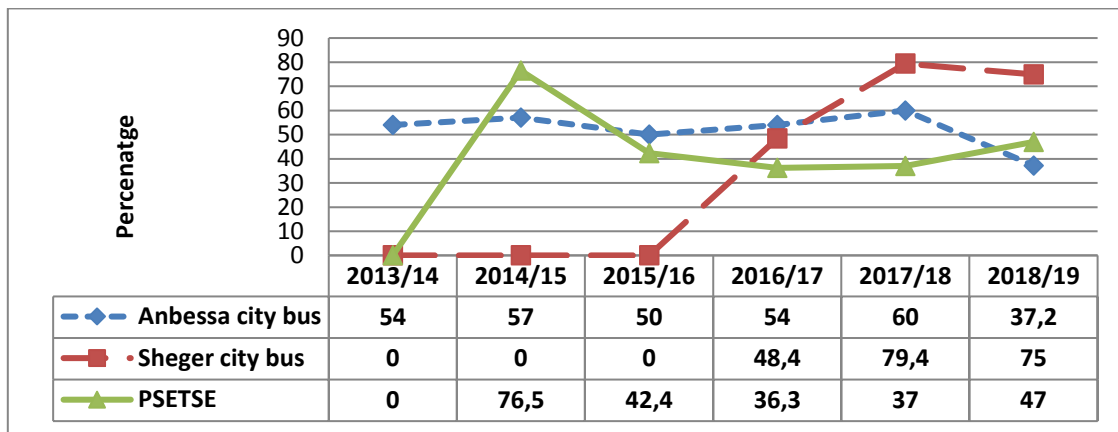


Fig. 2. Fleet utilization (%)

PSETSE's primary purpose is to provide morning and evening services for Federal and AACA personnel work purposes; however, it also provides regular taxi services on a limited number of buses for urban residents. With this fleet utilization, the company only considers the number of buses operating in the city's public transport system.

As the fleet utilization results show, Anbessa City Bus has a high fleet utilization rate compared to other bus companies in the city. However, as with Urban Bus Toolkit 2011, 80-90% fleet utilization is considered reasonable. Apart from the Sheger Municipal Bus result in 2017/18, the other results show that both companies meet the criteria. This demonstrates the need to maintain fleet utilization rates for both companies to improve operational efficiency.

#### 4.1.3. Vehicle utilization

Commonly referred to as 'bus productivity', is a key metric for operating public transport networks and indicates efficient use of working capital. This is the number of kilometers a vehicle has traveled on that route in one day. It also shows vehicle operational efficiency in terms of the effective utilization of vehicles in the system.

As a result, vehicles are better used when they cover more useful kilometers on the road. The chart below shows the fleet productivity of transit companies in each city (Figure 3a).

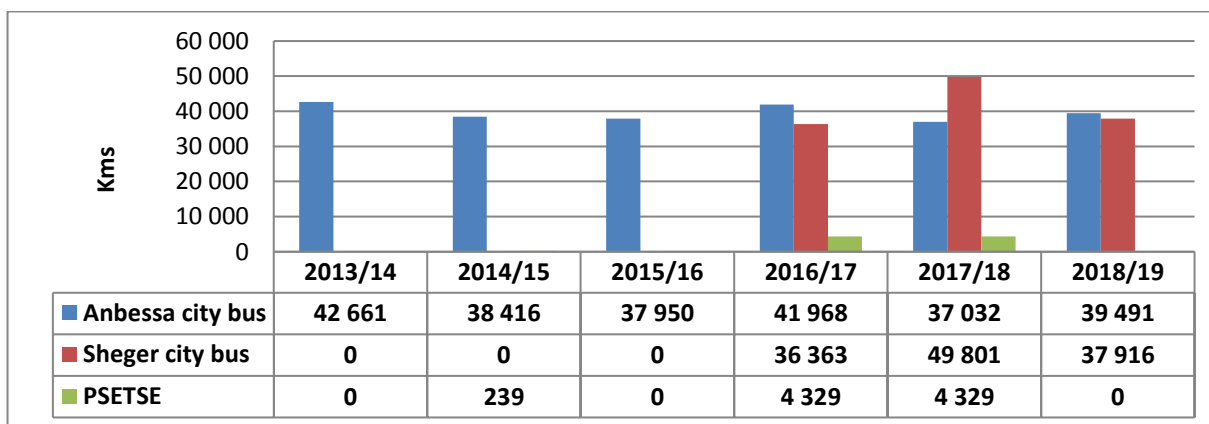


Fig. 3a. Vehicle productivity: km/bus/year

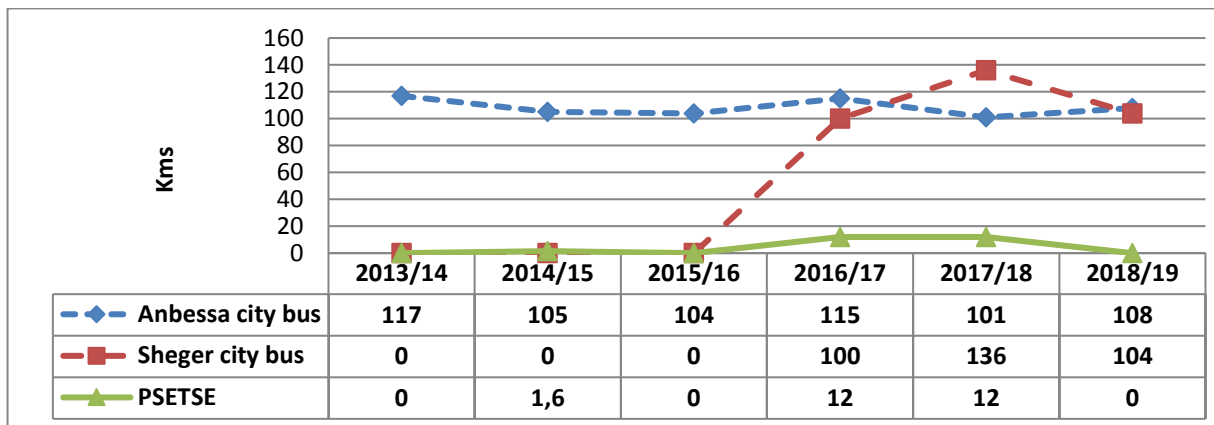


Fig. 3b. Vehicle productivity: km/bus/day

Thus as Figure 3b shows, vehicle productivity for Sheger and Anbessa buses is almost similar; for instance, vehicle productivity for the Anbessa bus was high (117 km/bus/day) in 2013/14 but the lowest in 2017/18. For the Sheger City Bus, the result was high (136 km/bus/day) in 2017/18.

However, compared to all operators, PSETSE's vehicle productivity is the lowest in all years. Because as mentioned above, the company offers a taxi service with a limited number of buses to support other regular public transportation in the city. Thus, the vehicle productivity results show that PSETSE makes a big difference in providing transportation services to urban users. Also, compared to the WB standard, all operators offer their services based on the standard.

#### 4.1.4. Service utilization

This shows how much of the provided capacity is being used by regular users. Hence, it mainly depends on the number of passengers transported and the effective kilometers generated by each city's mass transit system. The graphs below show data for each operator's traffic and items, such as the average number of passengers per bus per year per day (Figure 4a).

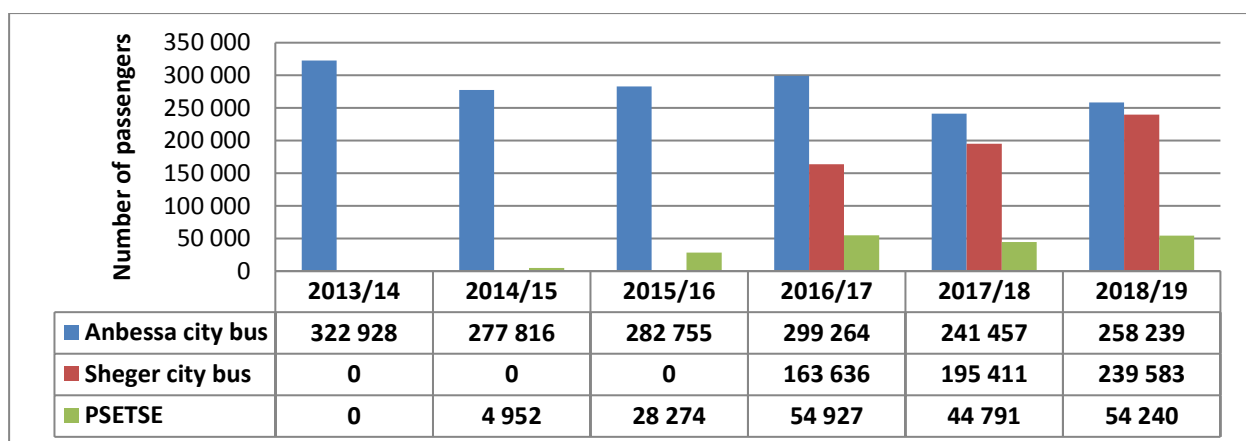


Fig. 4a. Service utilization (total passengers/bus/year)

As mentioned above, Anbessa City Bus has the highest number of passengers during the given period compared to other public bus companies. PSETSE has the least number of passengers. This means that the services provided by PSETSE are not as well utilized as other operators in the city, affecting the company's effectiveness.

In addition, Figure 4b shows the number of passengers per day on the bus, indicating that the ratio of the number of passengers per day on the bus during this period was the highest for Anbessa City Bus and the lowest for PSETSE. This means that the Anbessa City Bus service is very well used compared to other buses. On the other hand, the PSETSE service is least used by urban users. Details of the results are shown below.

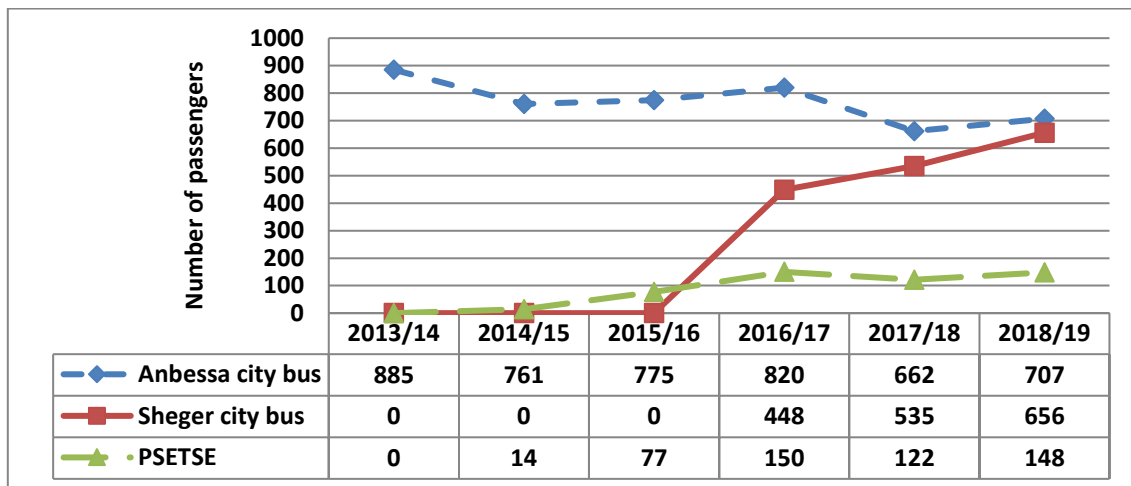


Fig. 4b. Service utilization (passengers/bus/day)

#### 4.1.5. Staff-bus ratio and staff productivity

Although a larger ratio signifies more job creation, it also indicates lower employee productivity and higher establishment costs. Hence, a smaller ratio is always required, as it signals excellent employee efficiency.

The term "staff" refers to the total number of people employed by the company, which includes the operational crew, mechanical staff, and administrative personnel. In light of this, the following graphs depict the result of the staff-bus ratio and manpower productivity for bus transit operators in the city over time.

##### 4.1.5.1. Bus-staff ratio (BSR)

As shown below, BSR for both transit service agencies is nearly similar for all providers in the city. But, to some extent, it is the highest for Anbessa City Bus and reached 8.8 in 2018/19 and lowest for PSETSE; because BSR for PSETSE is different from others, and it is calculated based on only the number of buses operated as a taxi in the city for the years considered (Figure 5).



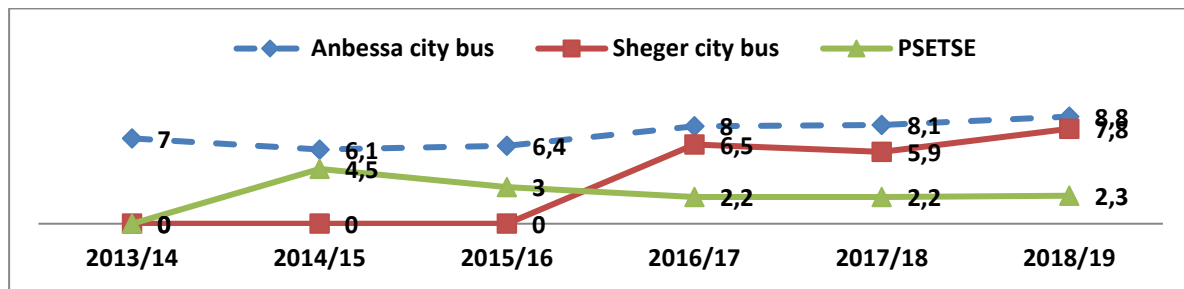


Fig. 5. Bus-staff ratio

#### 4.1.5.2. Manpower productivity

Employee productivity is the ratio of input to output. The number of people employed by the institution is the input, and the services provided are measured in effective kilometers (km/staff/day). Figure 6 presents the employee productivity in km/staff/day for each operator in the city over time.

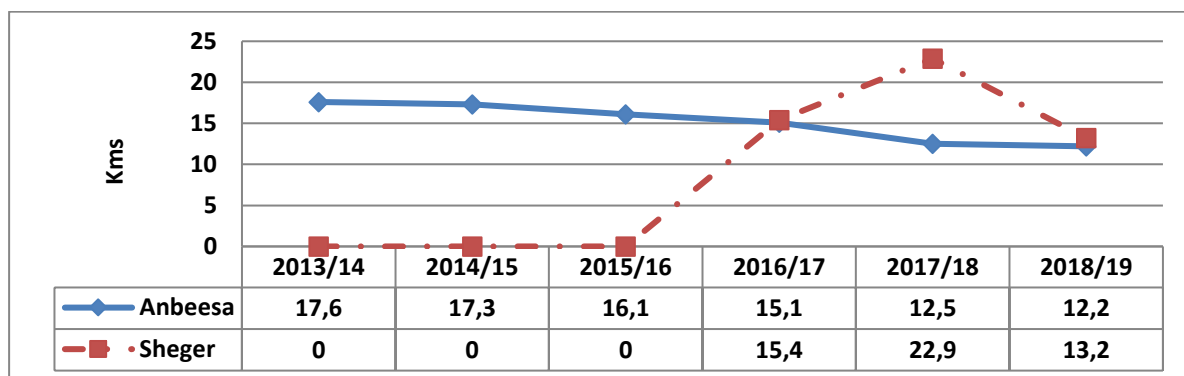


Fig. 6. Manpower productivity: km/staff/day

As shown, Sheger City Bus staff productivity peaked in 2017/18 (22.9 km/staff/day) and declined to 13.2 km/staff/day in 2018/19. Moreover, the productivity of Anbessa City Bus employees has been about the same for many years, reaching a peak (17.6) in 2013/14. However, the productivity of Sheger Municipal Bus employees is better than the Anbessa Municipal Bus in the city.

#### 4.1.6. Operational safety

This study also attempts to measure the operational safety of bus companies through the number of accidents (accidents/100,000 km).

As seen in Figure 7, accidents/100,000 km for Anbessa City Bus is the lowest at 9.76 in 2015/16 but the highest in 2018/19 (that is, 12.7). Similarly, it is the lowest for the Sheger City Bus. This implies that the occurrence of an accident is high for Anbessa city buses.

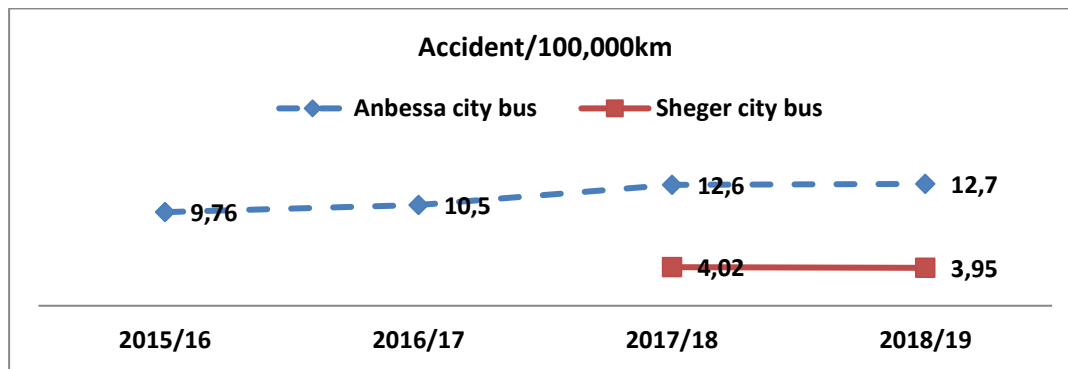


Fig. 7. Operational safety (accidents/100,000 km)

## 4.2. Financial performance

Financial performance is a specific measure of how well an organization can utilize resources from its core operations and generate revenue [19]. It is also used as an overall measure of a company's general financial health over time and can be used to compare similar companies in the same industry [20]. Therefore, this section will be devoted to analyzing the financial performance of the city's public bus companies based on the costs, revenues and profits of each company from 2013/14 to 2018/19.

### 4.2.1. Earning per kilometer (EPKM)

Figures 8 and 9 show traffic revenue per kilometer (revenue from ticket sales) and total revenue per kilometer for each operator in the city. Thus as highlighted in Figure 8, traffic revenue is high for Anbessa City Bus in 2016/17 (that is, 14.7 birr/km), for the Sheger City Bus, 17.4 birr/km in 2018/19 and 59.2 birr/km for PSETSE.

The result showed that PSETSE earned the highest amount of birr compared to others, particularly in 2014/15 (that is, 59.2 birr/km). But the main reason for this result was the fleet utilization for PSETSE during the given year, which was 76.5%, the highest for the enterprise. However, the result shows the others earned fewer amounts of birr from traffic revenue as they aim to provide urban transport services for the residents at reasonable fares.

Similarly, Figure 9 shows the total revenue/km for all transit service providers in the city. Here also, PSETSE revenue/km is the highest compared to others and growing from year to year. This is because the enterprise obtained a huge amount of revenue from the city and the Federal Government for regular transport services that were delivered to civil servants in the city.

Besides, Anbessa and Sheger city buses also obtained revenue from the City Administration as a subsidy to run their operation effectively in the city.

### 4.2.2. Cost per kilometer (CPKM)

The result for the cost/km of transit service providers in the city is shown in the next figures. Thus, as Figures 10 and 11 depict, operating cost per km was highest for Sheger City Bus in 2015/16 and 2018/19, that is, 38.2 birr/km and 42.6 birr/km, respectively. For Anbessa City Bus, the operating cost per km increased year to year and reached its maximum in 2018/19, which is 36 birr/km.

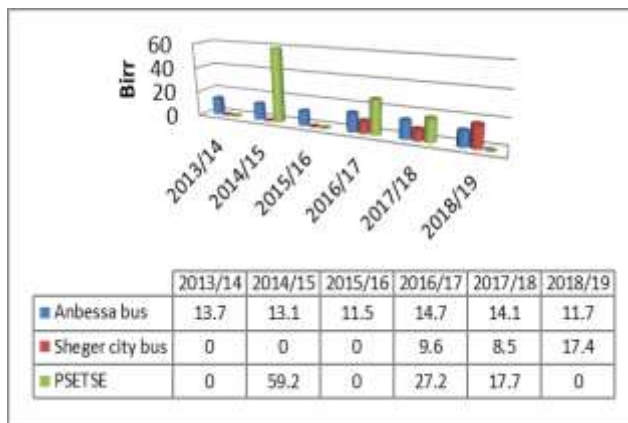


Fig. 8. Traffic revenue/km  
(in Ethiopian Birr)



Fig. 9. Total revenue/km  
(in Ethiopian Birr)

Similarly, the total cost per kilometer for Sheger city buses compared to Anbessa is the highest in the given year. As the results show, Sheger City Bus has less income per kilometer than Anbessa City Bus, and the fare is higher (Birr/km). This affects the profitability of the company because there is a difference between income and expenses.

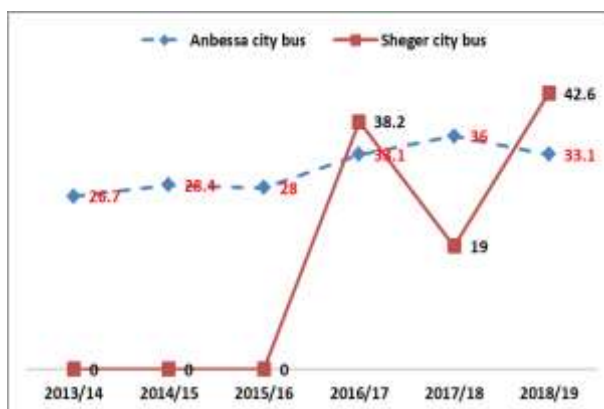


Fig. 10. Operating cost/km



Fig. 11. Total cost/km

#### 4.2.3. Net profit margin per kilometer (NPMKM)

Analysis of the net profit margin is conducted based on the total revenue and total cost of each enterprise in a year. Thus, Figure 12 shows the general profit/loss for each enterprise, and as shown, Sheger City Bus lost the highest amount of birr in 2018/19 compared to others.

Similarly, Figure 13 shows the net profit/loss per kilometer for each transit operator over the years. Thus, the result shows that Anbessa City Bus obtained a net profit of birr 1/km in 2018/19 for the first time in the previous six years. However, Sheger City Bus also obtained a net loss (-22.3 birr/km) in the same year.

In general, bus companies in the city have been operating at a loss for many years, as the profit and loss results demonstrate. Businesses and governments should therefore consider the operational and financial performance of operating services in their cities and work toward improving them.



Fig. 12. Net Profit/loss

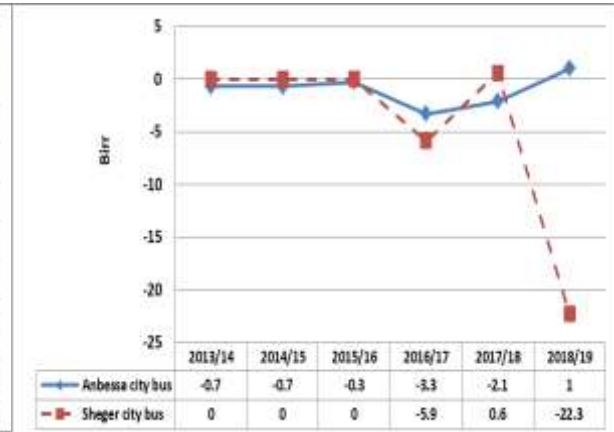


Fig. 13. Net profit/loss per km  
(in Ethiopian birr)

#### 4.3. Comparison of public bus transit performance

Finally, this study analyzes and compares the performance of each operator in the city over the years based on their individual average analysis.

Hence, a result of the operational performance of the Anbessa City Bus shows that the enterprise performed very well in service utilization compared to others. It means the Anbessa City Bus transported 768 passengers per bus/day on average for six years. In other words, the supplied service of Anbessa City Bus was well-consumed by customers in the city. But the result for PSETSE showed that it is the lowest consumed service in the city (that is, 102 passengers/bus/day). Moreover, the Sheger City Bus transported on average 546 passengers/bus/day for three years.

Also, as shown in the result for fleet utilization and vehicle productivity, Sheger City Bus had a better result, that is, 67.6% and 113.3 km/bus/day, respectively. The next one is Anbessa City Bus, with 52% of fleet utilization and 108.3 km/bus/day during the years under study. Moreover, the result for fleet utilization and vehicle productivity for PSETSE buses is the lowest in the city.

Moreover, the result for the bus-staff ratio and km/staff/day for Anbessa City Bus and Sheger city buses are nearly the same; it is 7.4 and 15.1 km/staff/day for Anabessa City Bus, and 6.7 and 17.1 km/staff/day for Sheger City Bus during the years (Figure 14).

Further, the performance of public bus service operators in the city is compared with some general standard indicators of the Urban Bus Toolkit [4]. Thus, Table 10 shows that in most indicators, public bus operators of the city have been found deficient and below standard categories. This indicates that they have delivered services with poor performance. Details for others are presented in Table 2.

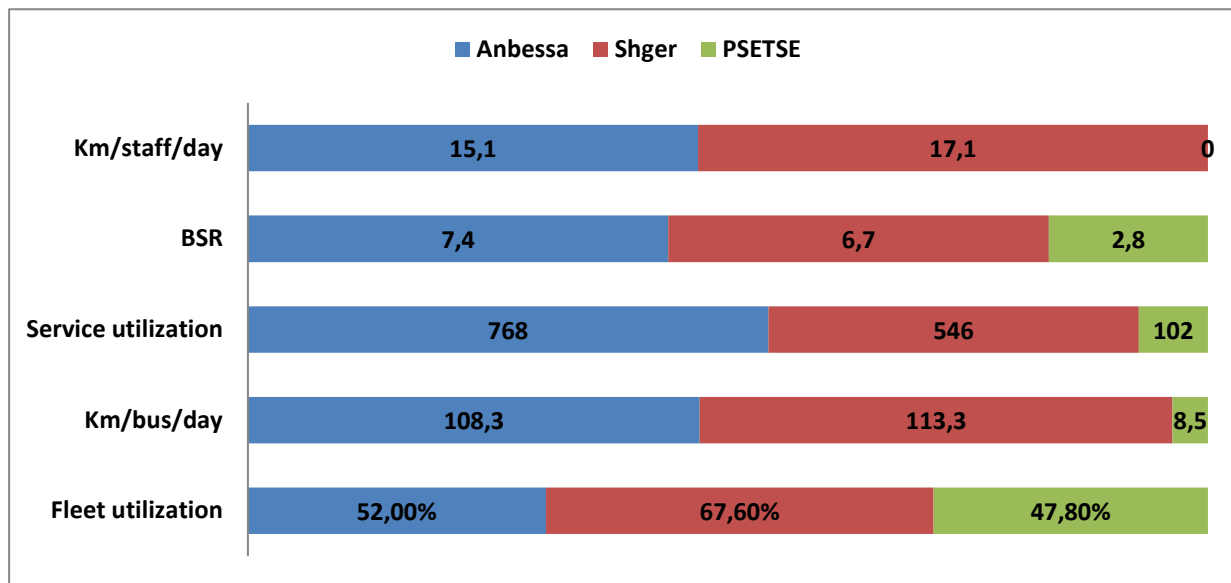


Fig. 14. Operational performance result on average over the years

Tab. 2

## Performance comparison with general standards

Indicators	Standard Value	Within standard range	Deficient than standard	Better than standard
Fleet utilization	80 - 90	Sheger (79.4%) near to 80	Anbessa bus, PSETSE	None
Staff-bus ratio	3 to 8	Anbessa, Sheger buses	Anbessa bus in 2018/19	None
Vehicle-km bus/day	210 to 260	None	All	None
Passengers volume	1,000 - 1,200 SD bus 80 1200 - 1500 SD bus 100	None	All Operators (Anbessa is best, PSETSE is the least relatively)	None
Accident rate	1.5 - 3	None	All Operators (Sheger is better, 3.95, in 2010 and near to the range)	None

Therefore, the operational performance of the city's public bus companies is rated as low-to-standard and poor-to-standard for most performance parameters [4]. However, Sheger City Bus' vehicle utilization to bus-staff ratio is somewhat better than other buses. On the other hand, PSETSE buses are the worst performing public bus service in the city. Usually, all shipping companies in the city. In particular, PSETSE needs to identify the root causes of its poor performance and close the gaps to improve its capabilities.

## 5. CONCLUSION

In this study, the operating performance of public bus companies was analyzed using the ratio analysis method. Based on the results obtained, Anbessa City Bus performed well compared to other operators on the following indicators: Fleet strength, service utilization, and vehicle utilization. However, it presents problems for employee bus rates, employee productivity and operational safety metrics. In contrast, Sheger City Buses excelled in vehicle utilization, staff-bus ratios, staff productivity, and operational safety indicators.

Additionally, PSETSE scores are among the lowest for most operational KPIs. In particular, PSETSE's service utilization rate was the lowest among the others. This means that the services provided by PSETSE are as underused as others in the city, affecting the effectiveness of the company. This relatively shows the existence of wasted resources in the industry. Thus, even if PSETSE has a role to play in providing taxi services to residents, the government should consider how the company should operate taxi services. That is, either provide public transport services independently or leave the sector.

Furthermore, when comparing the performance of the city's bus companies to the prevailing standards, they fall below par on most metrics. The results, therefore, show that bus operators, when subsidized by the government to run services to residents, will significantly improve their use of resources to improve their financial and operational performance. This suggests that there is a need, unlike other operators, the need to provide competent services to residents of the city.

In addition, to improve the productivity of bus operations as a whole, it is imperative to improve the conditions in which the buses run within the city. Primarily, one of the biggest challenges in running bus transport in cities is the use of mixed traffic in dense environments. Therefore, it is important to develop dedicated lanes for city buses. Effective parking regulations and parking fees should also be considered to free up roads and sidewalks for buses and other modes of transport to move smoothly around the city. Finally, these and other options should be evaluated to improve the productivity of bus operations and the vitality of the system to meet the city's growing transportation needs.

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