CROSS-CASE ANALYSIS OF BUS OPERATION IN DIFFERENT CONTEXT: OVIEDO (SPAIN) AND TANGIER (MOROCCO)

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ABSTRACT

One of the main problems in urban areas is the steady growth in car ownership and traffic levels. Therefore, the main challenge to reach sustainable and liveable cities is focused on a shift of the demand for mobility from cars to collective means of transport. For this purpose, buses are a key element of the public transport system. This paper presents a cross-case analysis, from a diagnostic through big data management of the urban bus operation in Oviedo (Spain) and Tangier (Morocco). For this aim, several performance indicators (KPIs) were estimated for both networks and services. In the evaluation of the service the KPIs were grouped in five categories considering the consumption of resources (inputs) and the results or production obtained (outputs). Once the KPIs were estimated, they were compared to minimum requirements needed to satisfy demand depending on the cities characteristics (population, cover area, alternative transport systems). Finally, a qualitative comparison of the overall performance of the two networks was done. Results showed that even though at first sight, the service characteristics might seem different:

Tangier´s network is made up of 44 lines, with a length of 795 km and a fleet of 192 buses. While Oviedo´s network has 16 lines with an extension of 205.9 km and a fleet of 67 buses there are several common indicators like the monthly average of users in urban lines that rounds 125,000 passengers, a capture ratio of 40 persons per bus, and a similar bus availability every 1000 inhabitants (0.22 and 0.30). However, it was possible to observe some gaps in the system functioning, mainly in Tangier´s network which overall performance is worse than Oviedo´s in most of the analysed aspects.

1. INTRODUCTION

According to the World Economic Forum, by 2020, 56.2% of the world´s population lives in urban areas. Consequently, impacts related to mobility are growing; like traffic congestion, GHG emissions and pollutant, and traffic accidents.

The main problem is the excessive dependence on private vehicle, which without appropriate measures will derive in significant challenges to sustainability.

Among several factors, transport systems determine the form and socio-economic development of a city. Mobility and accessibility provided by the transport system play a major role in shaping cities, influencing the location of social and economic activities and the style and pace of life by facilitating trade, permitting access to people and resources (Zuidgeest, 2005).

Population growth produces urban expansion, which, together with dispersal of amenity and activity have increased the demand for and dependence on motorized transportation. To address these problems and their impact on the transport infrastructure, improvement in bus systems (and hence operations) in developed and developing countries can be considered a potential cost-effective approach to reach transport sustainability.

Regarding medium-size cities, bus is often the most common and, in most cases, the only public transport service available, as most of the cities have no metro o tram network. For example, in the European Union in 2014, 57.6 billion passenger journeys were made using public transport of which 55.8% used buses, with metro systems accounting for 16.1 %, tramways or light rail 14.5 %, and suburban railway 13.6% (UITP,2016).

In comparison to private vehicle dominated urban transport systems, those that are largely reliant on buses produce significantly less congestion, lower energy consumption and emissions. This is because buses are inherently efficient both in terms of road space and fuel consumption per passenger kilometre. Depending on the type of bus (standard, articulated, bus-train or double articulated), a fully load bus can replace between 5 and 40 cars with a corresponding fuel saving ranging from 40 to 97% (UITP, 2015). All the potential benefits mentioned, have produced a speedy evolution in bus and related technologies infrastructure, concepts of operation, business models and operations best practice or benchmarking, with increasing evidence that buses can be considered an appropriate alternative to meet sustainability requirements. This is in terms of efficiency, emissions, space occupancy as well as operational effectiveness as buses are more easily adapted to passenger requirements and do not require heavy infrastructure. Moreover, buses represent a safe transport mode registering low accident rates compared to other surface modes.

Public transport performance (in this case bus qualitative performance) can be understood in two dimensions. The first dimension relates to public values and users' expectations of the society (Jorgensen and Bozeman, 2007; Koppenjan et al.,2008). The second dimension of performance refers to ways of measuring broad goals into quantitative metrics.

These metrics are performance indicators (KPIs), such as emissions/passenger or average distance to public transport stops. Measuring the performance of bus systems service by different indicators can be influenced by different elements of the organisation of public transport systems, such as the ownership structure operator (public or private), contractual allocation of risks, or integration fares. (Hirschhorn et al., 2019). Therefore, when possible, the overall performance of the system should be estimated by composite indicators which can be useful due to their ability to integrate large amounts of information into easily understood formats.

The objective of this paper is to evaluate Oviedo´s and Tangier´s bus networks and services through the estimation of several KPIs based on the data provided by the operator (ALSA). The qualitative analysis of their overall performance, together with the cross-case analysis between their urban bus systems will allow designing policy-packages to improve sustainable operation according to each country´s reality.

This paper is structured as follows. Section 2 reviews the indicators to analyse a bus network performance. Section 3 sets territorial context and presents the indicators estimated for both study cases. The results of the cross-case analysis to evaluate the networks performance are presented in Section 4 and finally Section 5 provides some conclusions and propose future research.

2. REVIEW OF BUS PERFORMANCE INDICATORS

Efficiency and performance measures in public transport are necessary to monitor progress toward a planned target. Efficiency measures compare realized and optimal levels of outputs and inputs. They can also be used as means of evaluating recently realized or proposed extensive changes towards increased deregulation or reorganization.

The performance criteria´s should serve as an instrument to evaluate the system condition, level of service, and safety provided to costumers based on economic, environmental and community policy goals. Performance indicators should also evaluate day-to-day performance for strategic management, analysis of options and trade-offs. One of their main objectives is to give information for decision on how to allocate resources and help prioritize improvements to the neediest areas. In general performance measure indicators should be policy driven, which can be used in analysis of options and trade-offs, decision making on resource allocation, and monitoring to provide clear accountability and feedback. In addition, they can show trends, or warn of problems, influencing both immediate actions and long-term plans.

The efficiency of public transport system has been reported in terms of operational indicators, engineering indicators, labor indicators, social indicators, resource indicator and financial indicators on literature.

The NCHRP (2005) report categorizes performance measures for general transport assets under Preservation of assets, Mobility and accessibility. Operations and maintenance, and Safety. Public Transport Authority of Western Australia (2004) in their annual report used five categories of performance measure with indicators. This includes Use of public transport measured by passenger per service km and total passenger-kilometres, Service reliability, Level of overall customer satisfaction, Customer perception of safety and Level of notifiable safety incidents. In the context of developing countries Armstrong-Wrigth and Sebastian (1987) listed passenger volume, fleet utilization, vehicle-km, break-down in service, fuel consumption, staff ratio, accidents, and cost of bus services as operation performance indicators in addition to quality indicators. Additionally, Iles (2005) grouped efficiency indicators under labor, operational, engineering, personnel, and financial indicator. The relevance and appropriateness of each measure depends on the context of analysis and on data availability. For this research, data provided by ALSA which is the operator of bus services in both cases was used to estimate the indicators that will be presented in the following sections.

3.TERRITORIAL CONTEXT AND METHODOLOGY

3.1 Study cases and data sources

Despite their geographic proximity Spain and Morocco have considerable economical and cultural differences. A clear prove is their GDP, while Morocco´s GDP per capita is around 2.650 euros, Spanish GDP per capita is almost ten times higher reaching 24.500 euros.

This difference translated to transport is observed in their motorisation rates. By 2019 Spain had 513 vehicles each 1.000 inhabitants, while Morocco only 105.

For this research, Oviedo´s and Tangier´s bus networks were defined as case studies since both can be considered medium-size cities in their countries and have the same operator (ALSA) which ensures the availability of comparable data. The difference in context and countries reality of the two networks was considered of interest to be able to design policy-packages that include measures that can be transferable to other cities with similar characteristics but different contexts.

The municipality of Oviedo with a population of 220,000 inhabitants (INE 2019) is the capital of the region of Asturias, located in the north of Spain.

The Oviedo Metropolitan Area is composed of the core city and several parishes around, which are between 4 and 12 km away from the city.

The modal share is 66.4% for walking and biking, 24.1% for car and motorcycling and only 8.5% for public transport (Observatorio de la Movilidad Metropolitana, 2019).

Public Transport Authority of Asturias plans the urban bus network and Transportes Urbanos de Asturias (TUA) operates it under an administrative concession. In 2019 the total ridership was approximately 12.0 million.
The urban bus network of Oviedo has 15 daytime lines and 1 night-time line with a fleet of 67 buses to cover the service. Seven of the daytime lines run along the city and transport 90% of the users, while the other 8 lines connect the city with the parishes and carry the remaining 10% of demand.

Tangier, the capital of Tangier-Assilah Prefecture, has a population of 943,817 inhabitants (Haut-Commissariat au Plan, HCP). It is the most important prefecture in the Tangier-Tetouan-Al Hoceima region in Morocco. and is divided into three urban communes and nine rural communes.

Currently Tangier´s public transport network is covered by the urban and metropolitan bus network operated by ALSA. Tangier´s network is made up of 44 routes grouped in 27 urban and 17 rural lines. It had a total ridership of 40.3 million in 2019, from which 40 million of passengers used the urban lines. Although a feasibility study was carried out in 2015 for the construction of a tram network, following the examples of Rabat and Casablanca, no progress has yet been made on this issue.

To perform the performance analysis of this research, aggregated monthly data for all the lines in both networks have been gathered. Lines G, U and V from Oviedo, and 27 and 30 from Tangier were not considered due to unavailability of full data. Since they are recently incorporated lines, their performance does not affect the quality of this study.

Data has been obtained from different sources according to its nature:

- Urban area, route layouts and bus stops were downloaded from TUA and ALSA website.
- Monthly bus supply and demand variables were provided by ALSA, the operator of both networks.

Figure 1 presents the bus networks of Oviedo and Tangier which performance will be analysed in the following sections.

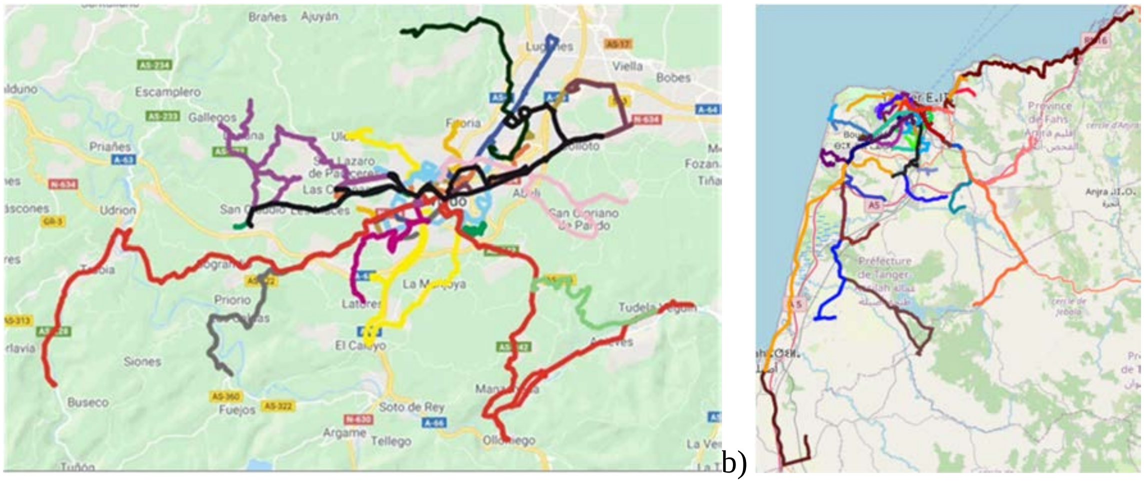
a)  b)

Figure 1 a) Oviedo's and b) Tangier´s bus network

3.2 Oviedo´s and Tangier´s network´s performance indicators

In order to evaluate the performance of the bus service of Oviedo and Tangier, and based on the data availability for each network, the service efficiency was estimated through the analysis of KPIs grouped in five categories. Fleet, supply, and accessibility (inputs) and quality and operational performance (outputs) presented in figure 2. These indicators take into account both users´ and operator´s perspective.

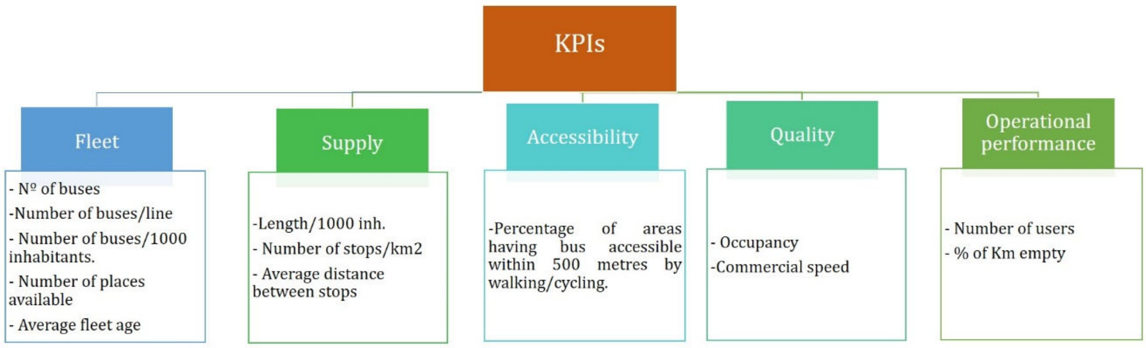


Figure 2 System efficiency indicators considered.

3.2.1 Fleet

One of the most important factors of quality and level of service of public transport is the availability of adequate infrastructure, including road and vehicle infrastructure. In both Oviedo and Tangier, road availability is not a key issue influencing the performance of the bus networks considered in the present research so no further analysis would be conducted.

On the other hand, vehicle infrastructure determines the capacity and speed of the bus. Number of spaces/vehicles offered on the line at a given time would influence on the comfort of the passengers specially on peak hours when the bus occupation is higher. Table 1 presents the details of bus infrastructure for both cases considered.

The most common bus configuration reflects the number of places available for people sitting, the number of places for people standing, and the number of places available for people with reduced mobility (RMP). It can be seen that Tangier´s most common bus configuration does not have places for people with reduced mobility. However, other bus configurations available on its fleet do.

Case	Most common bus configuration	Nº buses	Nº Buses/ line	Nº buses/1000 inhabitants	Nº places available/1000 inhabitants		
					Sitting	Standing	Reduced mobility
Oviedo	25+66vp+2rm+D	67	4.19	0.3	9.55	25.50	0.59
Tangier	33+62vp+D	190	4.32	0.2	6.70	11.08	0.10

Table 1 Vehicle data of both networks

The number of buses required per 1,000 population will depend on the public transport mode share, the presence or otherwise rail or other public transport modes, the capacity of the buses and the extent to which they may be utilized in terms of daily kilometres per bus.

With so many variables involved, the minimum requirement varies considerably from city to city, but typically lies between 0.5 and 1.2 buses per 1,000 population (Public-Private Infrastructure Advisory Facility- World Bank). Considering that in Oviedo and Tangier buses are the main public transport system, table 1 shows that both fleets have less buses than the required ones to fulfil the population needs properly. It can also be seen that, although the fleet sizes of the two cases are considerably different, they present a very similar number of buses available for each line. However, the number of places available each 1,000 inhabitants shows that Oviedo´s network has almost the doble of vehicle infrastructure for its population compared to Tangier.

3.2.1.1 Average fleet age

The average vehicle age is a useful indicator of the status of the fleet. If the fleet has an even age profile, the average age of the fleet will be approximately half the age of the oldest vehicle. An acceptable average age depends on factors such as the types of vehicles operated, levels of utilization and operating conditions, and is sometimes influenced by legislation, for example, in some countries the operation of the buses over a certain age is not permitted.

A high average age may be because high standards of maintenance enable vehicles to be successfully operated over a long life, but more often it is because there are not sufficient funds available for fleet replacement (more frequently in developing countries). For a reasonable well-maintained fleet of premium quality vehicles operating on urban services in developing countries, the average fleet age would typically be between five and eight years, being stricter in developed countries.

The average fleet age of Oviedo is 5.3 years with the newest bus having less than 1.5 years and the oldest one around 8.5 years. In the case of Tangier, the average age of the fleet is around 5.2 years with the newest having less than 2 years and the oldest around 6.5 years.

3.2.2 Supply

Supply refers to the presence of a public transport network or mode in an area/locality. There are several indicators that represent the supply of a transport system. The indicators considered for the present work are:

3.2.2.1 Length/1000 inhabitants

Network coverage measures use data that are generally already registered by the operator and thus are easier to calculate, however, they generally provide more macroscopic results that can be misleading at first glance.

Table 2 presents the length of the two networks, together with the network length every 1,000 inhabitants. The results show that despite the fact that Tangiers network is more than 4 times longer than Oviedo´s network, the length of network available every 1,000 inhabitants is 60% higher in Oviedo.

3.2.2.2Number of stops

Bus stops represent user´s access to the service. Table 2 shows that Oviedo´s network has a total of 273 stops while Tangier´s network has 386 stops over its entire length. Analysing the geographical distribution of the stops there is a similar number of stops every square kilometre in both networks (1.46 and 1.28 respectively). However, Oviedo´s network has triple the number of stops per 1,000 inhabitants than Tangier.

Case	Network length (km)			Network length/ 1000 inh.	Nº of stops	Nº of stops		Average distance between stops (km)	
	Rural length	Urban length	Total length			/km^2	/1000 inh.	Rural lines	Urban lines
Oviedo	115.7	80.01	195.71	0,81	273	1.46	1.24	0.86	0.59
Tangier	313.4	481.6	767.2	0,5	386	1.28	0.41	1.14	0.58

Table 2 Supply indicators

3.2.2.3 Average distance between stops

The average spacing between stops must find a balance between cost and journey time.

This last one includes the passenger´s walking time, waiting time, boarding time, in vehicle time, alighting time and walking to destination time. It is important to notice that in the case or urban lines, at first sight, very small spacing could seem more comfortable for the user, however, it produces an increase in the total time, since each passenger journey would be interrupted by numerous intermediate stops. On the other hand, more spaced stops make the journey faster, but forces the users to walk longer distances to reach the bus. An acceptable distance between stops rounds 500 meters.

Table 2 shows that urban lines of both networks are quite close to this recommendation (580 and 590 metres for Oviedo and Tangier). On the other hand, and as expected, rural lines have longer distances between stops, which is completely normal due to density in the areas covered by these lines.

3.2.3 Accessibility

The accessibility of a transport system is the ability to reach the mode (bus in this case) within a reasonable time period, by a reasonable path (unobstructed infrastructure) and presence of information systems to access to the stop.

It can be expressed as a percentage of areas having a stop of public transport accessible within 500 metres by walking/cycling and walkability in areas being served by bus system (Abreha, 2007).

Table 3 presents the percentage of area of Oviedo and Tangier that has access to bus service within 500 metres. As can be seen, Oviedo has lower accessibility to bus service within this distance compared to Tangier.

City	(%) Area covered by the service
Oviedo	44
Tangier	54

Table 3. Oviedo´s and Tangier´s accessibility to bus service

Regarding the availability of user information. None of the networks has real time information on the bus stops, this fact has been identified as one of the most important issues to solve to improve users ´perception of the service quality.

3.2.4 Quality

The quality of the service is related to the comfort of the service offer during travel/ride. To analyse the quality of the service in the two cases studied, the bus occupancy and average commercial speed were considered.

3.2.4.1 Bus Occupancy

The standard bus size in Oviedo has 25 seats and takes 66 further standing passengers, while the standard bus in Tangier has 33 seats and takes 62 standing passengers. The capture ratio of the buses in the different lines of the two networks are presented in figure 3.

This ratio shows the average occupancy of the buses and was estimated by dividing the total number of passengers of each line by the number of buses that provided the service to that line.

The red line in the figures presents the seats available in a standard bus of each fleet. Figure 3 a) and b) shows that almost all urban lines in both networks have all their seats occupied most of the time which can influence the quality and comfort perception of the user. It is also possible to observe that the occupancy of line 20 in Tangier´s network is close to the full capacity of the bus including seating and standing passengers. On the other hand, lines like B in Oviedo´s network and L4, L13 and L23 in Tangier´s network register really low occupancy (below half the seating capacity of the average bus of their fleet) showing that they could be optimized.

Regarding rural lines, figure 3 c) and d) shows an irregular occupancy in Oviedo´s lines, with line L registering a capture ratio 40% higher than the seating capacity of an average bus, while line K registers an average capture ratio of only 4 passengers. Tangier´s lines present less pronounced differences between them; however, it is also possible to see lines with really high and really low occupancy levels (LI9 and LI7 respectively).

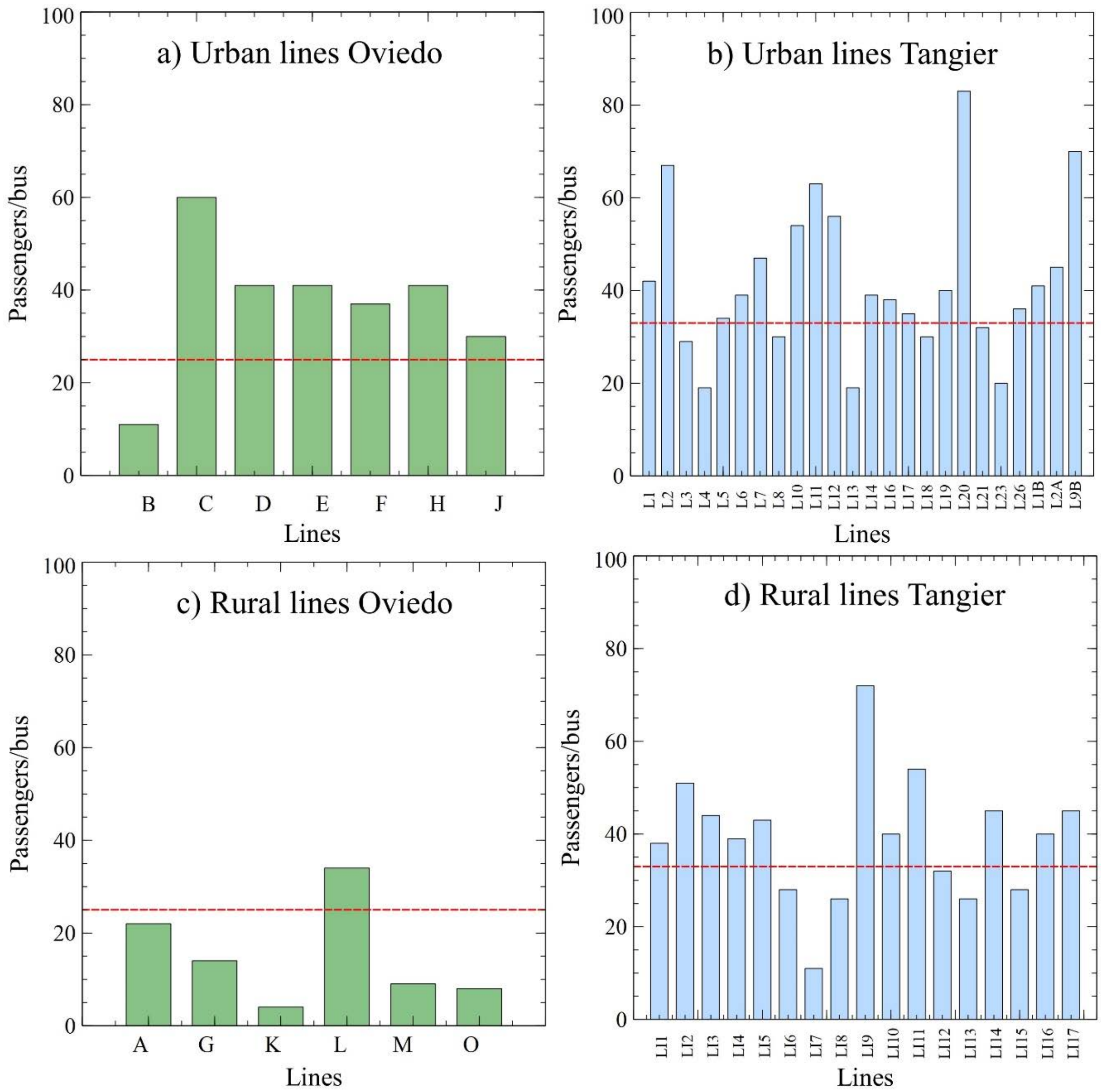


Figure 3 Capture ratio of urban lines a), b) and rural lines c), d)

3.2.4.2 Commercial speed

The bus operating speed is influenced by vehicle and alignment speed, as well as by stopping at passenger stops and traffic conditions. In this case, the average operating speed of bus travel along bus route was estimated dividing the total number of kilometres by the number of hours the bus was on service. Figure 4 presents the speed of all the lines of the two bus networks analysed (Oviedo and Tangier) and the average speed of each typology (urban and rural). It is possible to see that most of the lines with except of line B in Oviedo´s network have a commercial speed higher than 10-12 kph which according to Armstrong-Wrigth and Sebastian (1987) is the recommend minimum speed at which public bus systems should operate in dense areas with mixed traffic.

Figure 4 also shows a clear difference in the average speed of the lines depending on its category (urban or rural) as expected rural lines register higher average speeds due to traffic conditions and higher distances between stops in this typology.

For both categories, average commercial speed in Oviedo is lower than in Tangier.

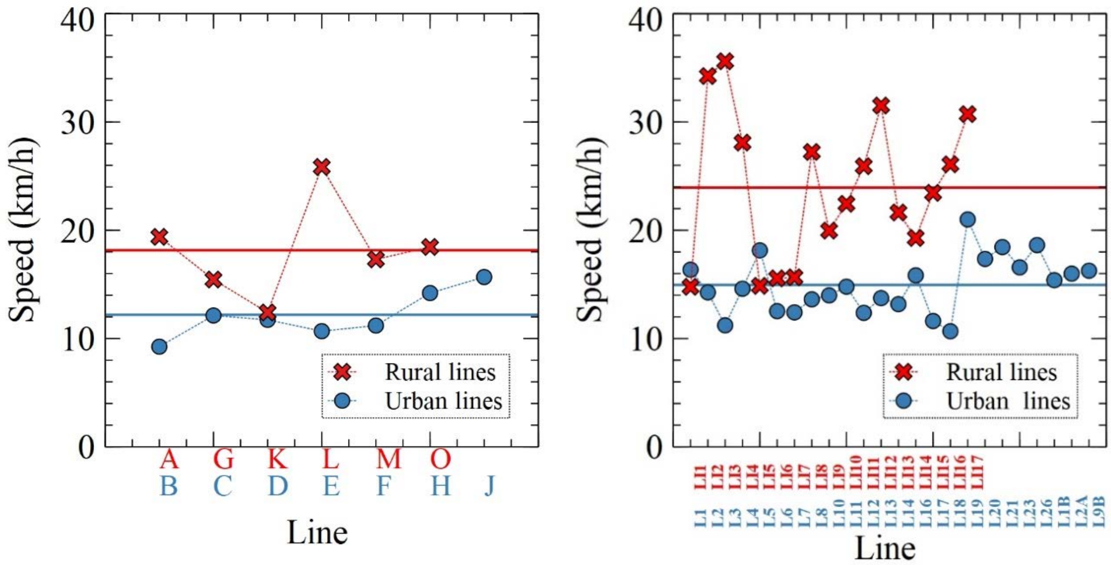


Figure 4 Commercial speed of the different lines of the networks.

3.2.5 Operational performance

To optimize the operational performance of the network is a major interest for the operator in order to get the highest profit offering at the same time a good service to the users. Three different KPIs were considered to determine the operational performance of the two networks:

3.2.5.1 Average users per month

The number of passengers per month of the different lines of the bus network is one of the most important data to take into account when analysing its performance. It allows the comparison among the lines of the network and helps to identify the ones that are beyond the average. Figure 5 a) and b) presents the average number of passengers registered per month in 2019 for the urban lines for Oviedo´s and Tangier´s networks. Although a uniform distribution of the number of passengers would be optimum, figure 6 a) and b) shows a considerable difference between the lines with the highest and the lines with the lowest ridership in the two networks. In fact, both networks have one special line (C in Oviedo and 20 in Tangier) that registers 2 and 5 times the average of passengers of the network, respectively.

Figure 5 shows that the highest ridership in Tangier´s network is almost three times the one of Oviedo. Despite the multiple differences between the urban lines of the two networks observed in figure 5, it is possible to observe that both register an average of 125,000 users per month.

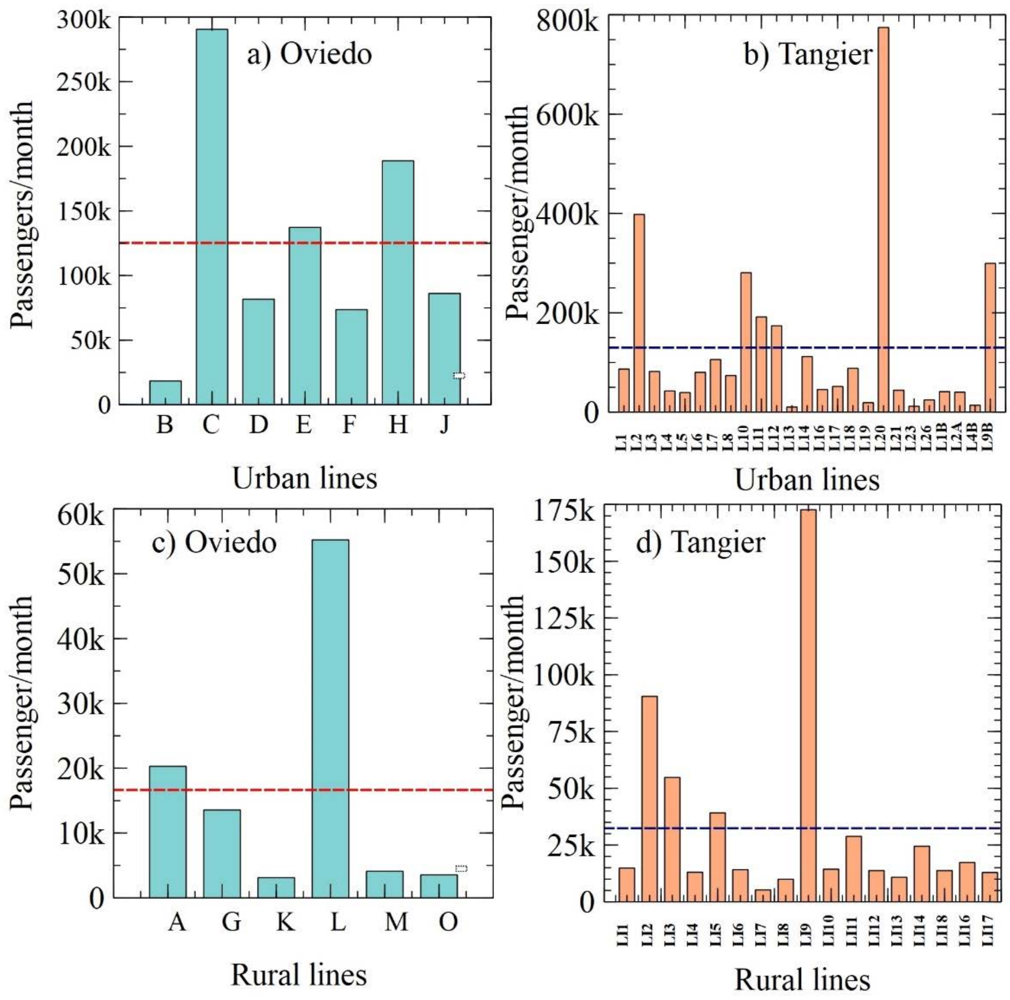


Figure 5. Average number of passengers urban lines a), b) and rural lines c), d)

With respect to rural lines, the same behaviour is observed, one line of each network hoards the passengers of the network. However, the average of users for this typology differs, Tangier´s rural lines have an average of passengers 80% higher than Oviedo´s lines.

3.2.5.2 Percentage of kilometres empty

This parameter presents the number of kilometres during the service in which the bus is empty, when it is not performing passenger transport service. This may be due to the routes to the fleet´s garages, to the service maintenance or because they are poorly planned. This is another very important factor to optimize the service of a bus line. The higher the percentage of empty kilometres, the worse the fleet operation will be, since empty trips are supposed to be journeys that in no case are generating any type of economic retribution for the operating company.

Figure 6 presents the percentage of kilometres empty of the urban and rural lines of the two networks.

Based on the operator’s experience, values between 5 and 10% are considered acceptable for urban lines. In this research a limit of 10% was established for the entire network. It is possible to see that Oviedo´s network has no problems with the percentage of kilometres empty since all its lines have values lower than 10%. On the other hand, Tangier has 7 urban and 4 rural lines that exceed this value, so they should be deeper analysed to identify the causes and optimize their performance.

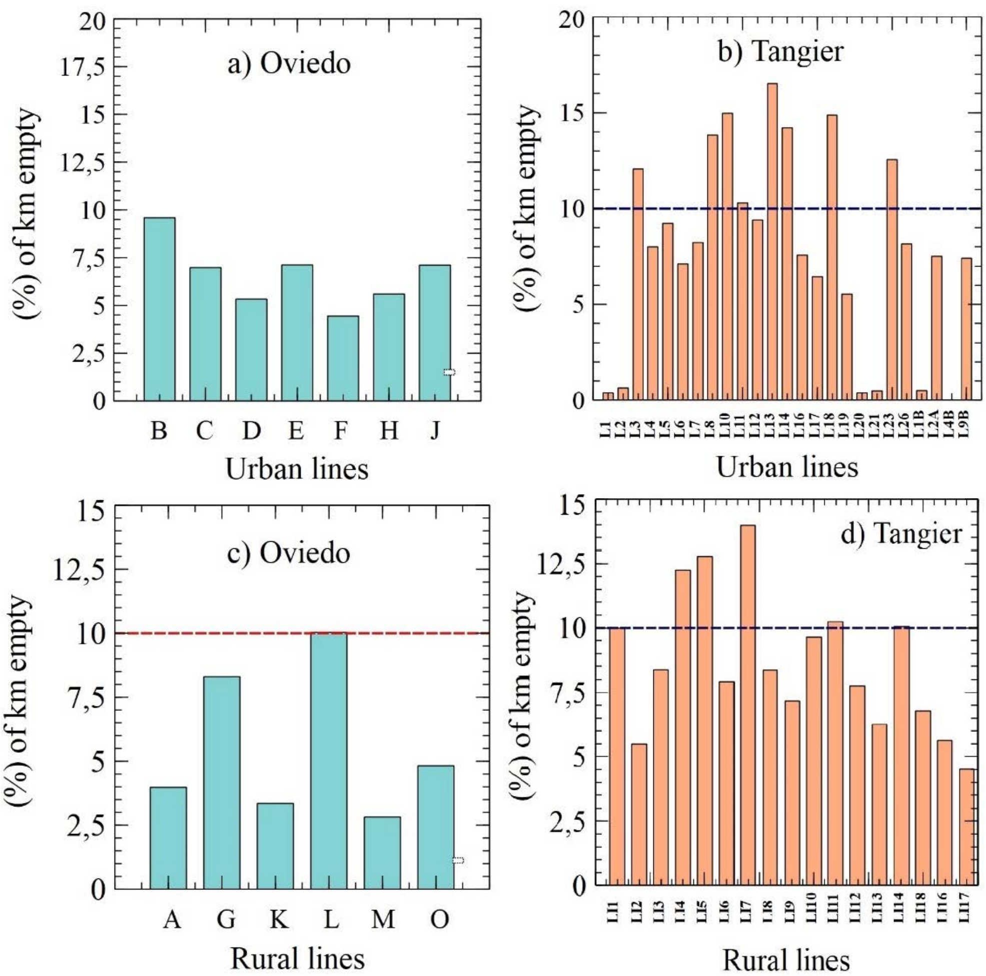


Figure 6. Percentage of kilometres empty for Oviedo´s and Tangier´s network.

3.2.5.3 Frequency

Frequency measures how often transit service is provided, either at a location or between two locations. The most commonly used measures are frequency (transit vehicles per hour) and its reciprocal headway (time interval between transit vehicles). Depending on the volume of transit vehicles and passengers moving through and stopping on a street, bus headways are recommended to be over 15 minutes for low volume, between 10-15 minutes for moderate volume, 2-6 minutes for high volume and combined headways under 2-3 minutes for very high volume (TCRP, 2003).

The average frequency of urban and rural lines is 21 and 65 minutes in Oviedo, and 33 and 120 minutes in Tangier respectively. As can be seen, the two networks analysed present higher headways than the recommended, which increases the passengers waiting time and makes them look for different transport alternatives.

4. OVERALL PERFORMANCE

The performance indicators presented in the previous sections, focused on specific aspects of the networks´ performance. In this approach, the indicators are readily measured and validated and are easy to interpret. However, there are two major drawbacks: they represent a partial indication of efficiency and they may provide conflicting message.

To estimate the overall performance of the two networks analysed, each of the indicators estimated in the previous section was compared with respect to efficient behaviour obtained from literature to identify the performance of each of the categories. As some of the variables are qualitative, the scores were given with personal judgment based on some characteristics.

Table 4 presents the summary of the qualitative evaluation of the two networks based on the values obtained for each of the KPIs estimated. Four different levels of efficiency were defined. Below poor (B.P.) when the system does not accomplish the minimum requirements, Poor to moderate (P-M) when the system satisfies the minimum requirements but there still is a lot to improve, Moderate to good when the performance is acceptable, and Above Good (A.G.) when there is no need to improve in any aspect.

Category		B.P.	P-M	M-G	A.G.
Infrastructure	Oviedo		P		
	Tangier		P		
Availability	Oviedo			P	
	Tangier		P		
Accesibility	Oviedo		P		
	Tangier			P	
Quality	Oviedo			P	
	Tangier		P		
Operational performance	Oviedo			P	
	Tangier		P		
Safety	Oviedo			P	
	Tangier			P	

Table 4 Qualitative summary of Oviedo´s and Tangier´s networks performance

Finally, as the scores given to the different categories of indicators are qualitative and subjective, a graphical technique was used to show the overall performance. Figure 7 presents the qualitative scores of all the categories studied in this analysis for the two networks analysed.

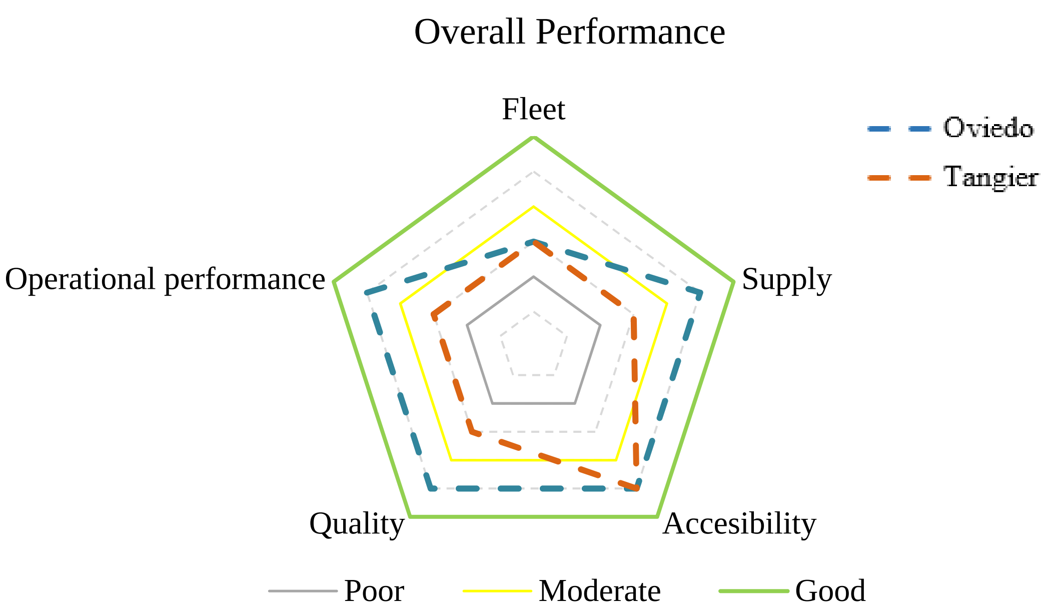


Figure 7 Overall performance of Oviedo´s and Tangier´s bus networks

5. CONCLUSIONS

This paper has aimed to realize a preliminary cross-case analysis of bus operation in different contexts, Oviedo (Spain) and Tangier (Morocco) through aggregated data provided by ALSA, the operator of both networks. Several indicators grouped into six main categories were estimated to evaluate the overall performance of the two networks operation. The results show gaps in the systems functioning that may be fixed through the implementation of some short-term solutions.

The infrastructure availability (mainly the vehicles of each network) can be considered insufficient to fulfil the needs of the population. According to the Public-Private Infrastructure Advisory Facility- World Bank, the ratio of buses per 1,000 inhabitants should be around 0.5 and 1.2 buses, but Oviedo has a ratio of 0.3 and Tangier of only 0.2.

This, together with the fact that in the two cities buses are the main public transport alternative, shows the need to increase the fleet of the networks. With respect to availability, Oviedo presents better indicators as higher frequencies and lower average distances between stops. Tangier´s network has higher distances between stops and really low frequencies existing lines where the buses pass every two hours, which is not comfortable for the users that end up looking for different transport alternatives.

Even though accessibility of both networks can be considered acceptable (more than 50% of the city has access to the bus service within 500 meters) it should be improved since one of the main characteristics and objectives of public transport, is to cover as much of the population as possible. Regarding the quality of the service provided, Oviedo´s network registers better quality indicators mainly due to its lower occupancy of the buses. The commercial speed of all the lines in the two networks meets the requirements of being at least 10-12 kph, and the average age of the fleet would never exceed the recommended limits due to contract conditions that force the operator to change the vehicles every certain number of years. Finally, based on accidents statistics and on the measures implemented by the operator (limited speed in Tangier and Speed control in Oviedo), both networks show a moderate to good safety in the service provided.

Oviedo´s network and services overall performance is better than Tangier´s. However, the problems identified through the analysis performed can be solve by implementing some changes in the network operation. Therefore, this work establishes the basis for two future works. The first one is to carry a quantitative analysis of the performance of the two networks including more data from other sources. The second one is aimed to propose a policy package to improve the performance of both networks according to each country´s reality.

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