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The Performance Analysis of Public Transport Operators in Tunisia using Er Approach

Younes Boujelbene [α] & Ahmed Derbel [σ]

Abstract- The public transport sector in Tunisia has experienced economic, social and financial difficulties. The declining of the revenue shortfalls and the increased of public expenditure are the critical observed phenomenon. Our research is meant to discover the weaknesses, to find a practical solution and to improve the performance of the public transport sector by improving the performance of regional urban operators. For this reason, we have developed a model of performance that which ensures the comparisons between different operators working in similar conditions. This step is running by method of multi-criteria decision, appointed, Evidential Reasoning Approach (ER). This approach is proposed to deal with uncertain decision knowledge in multiple-attribute decision making (MADM) problems with both quantitative and qualitative attributes under uncertainties. It has been developed for supporting such decision analysis and the kernel of ER algorithm is based on the framework of the evidence combination rule of the Dempster–Shafer (D–S) theory. Therefore, we worked on a database that contains qualitative and quantitative data. For assessing different type of data, the evaluation grades may needs to be defined to facilitate data collection and the decision may be made using the technique of aggregation attributes and utility function via ER approach.

Keywords: evidential reasoning approach, intelligent decision-making, information and knowledge management, traffic engineering, public transport operator, quantitative and qualitative assasement.

I. Introduction

The field of road transport in Tunisia is very large, giving the diversity in institutional authorities and the different urban companies operators. The major concerns of the public operators converges for some theme for examples, ensuring the easy access to different functions of the city as well as the displacement of persons and goods, reducing the individual motor vehicle transport and limiting the adverse traffic effect on human health. Therefore, the public urban transport has an important role to play in the implementation of these policies, but the public transport sector in Tunisia knows a series of very serious economic difficulties and financial crisis preventing the sustainable development. The performance analysis has become an essential element in the public transport companies. However, the performance concept is extended. It covers at the same time; the costs, the transport quality, the user satisfaction and the financial results. Also, the establishment of evaluation indicators and monitoring service utility helps us to ensure good governance in resources management and to control expenditure budget. In this context, we examined the scope and objectives of the transport policy in urban planning area, for the development of a model of competition between various regional public transport operators. This step is managed by specific decision tools appointed, Evidential Reasoning Approach.

In this paper, we proposed six section, for the second section, a literature review has been defined for the MCDM problem applied in the analysis of transport sector. The third and fourth section, we indicated the mission of public transport operators in Tunisia urban, we mentioned, the issues and the challenges that hinder the development of this sector, we developed also a performance model that it ensures the competition between different regional operators. The fifth section is characterized to define the ER method and the advantage of using this theory. Finally, we fixed a conclusion with practical results that help us to find the best company exploits the road network.

II. Literature Review

The MCDM, Multi-Criteria Decision Making, was developed to facilitate the process of decision making. It is a discipline which has a relatively short history, about 40 years, and over 70 MCDM techniques have been developed, the most popular use in the transport sector, we have indicated, the methods with multi-attributes, such as (AHP, MAUT, MAVT, SMART, SMARTER, VISA) and methods of classification (PROMETHEE, ELECTRE). These methods have been designed to solve the problems of decision making. However, it is important to choose the most appropriate theory because the unsuitable method always leads to misleading and ineffective design decisions. So the choice of MCDM methods is a complex issue and should be handled with caution. Our research is essentially based on combining the various indicators applied in urban transport with to aim of finding the most efficient operator who exploits the road network. In the literature, we found a number of researches that have developed the problems of performance. Generally, it can be classified into three categories: environmental, social and economic. In addition, the performance analysis has been developed by several researchers, we mentioned (Nash, 2011)1 research, which measures the

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performance in the regional rail services, (Augustin & Walter, 2010; Hensher & Wallice, 2005)2,3 too, developed the performance problem for the bus networks. Similarly, many studies have dealt with the subject of performance for the public transport networks, we have indicated for example the study of (TRB, 2014)4 and (Ebola & Mazzulla, 2012)5. They proposed a good synthesis of the literature on measuring the public transport network performance. The proposed indicators covered different areas, the economic criteria (investment and operation management), the service quality (availability, travel time, safety and reliability) and the impacts on the community (environment, urban development, the traffic congestion) (TRB, 2014)4. After a thorough analysis, we get an interesting summary on the measures the performance of public transport, it has been proposed by (Schlossberg, Meyer, dill, & Ma, 2013)6, in order to gather all these key indicators. Also, the quality of service undoubtedly provided the area with the largest number of available indicator, such as the frequency, reliability, comfort, speed, safety and availability (Eboli & Mazzulla 2012; Sheth, Triantis & Teodorovic, 2007)5,7. In addition, the efficiency and effectiveness indicators of the public transport system must be taken into consideration, (FHWA, 2008)8 has developed the problem of measuring productivity, focusing on efficiency indicators and (Eboli & Mazzulla, 2011; Cinzia and al., 2015)9, 10 have addressed the problems of effectiveness.

ER approach is a multi-criteria decision making (MCDM) method that helps the decision-maker facing a complex problem with multiple conflicting and subjective criteria. Several papers have compiled the ER success stories in the field of transport. Specially, the performance analysis of public transport, we indicated for example, the research of (Lupo, 2013)11 for measuring the customer satisfaction analyses. We mentioned also, the research of (Katarzyna, 2014)12 which study the demand management used basic concepts of urban public transport integration. Also, the application of (Vaidya, 2014)13, they evaluated the relative performance of 26 public urban transportation organizations in India using various criteria. We found, also, the research of (Benjamin & David, 2015)14, they examined and compared two modeling methods (AHP, ER) used to inform a healthcare infrastructure location decision, they used an model structure on seven criteria (environment and safety, size, total cost, accessibility, design, risks and population profile) and 28 sub-criteria. In addition, the research of (DiZhang and al., 2016)15, they proposed an algorithm to conduct the navigational risk assessment of an Inland Waterway Transportation System (IWTS). The application of (Cyrille and al., 2015)16, they developed a unified approach to model and merge the detections coming from various kinds of sensors with prior knowledge about target location derived from topographical elements. They showed the ER approach provided an efficient measurement for data association between tracks and detections.

III. The Issues the Tunisia Urban Public Transport Policies: the Necessity to Improve Performance

We will analyze in this part the issues and the challenges of the public transport sector in Tunisia. We will show also what are the problems and the failures of public transport operators found, despite the efforts done to improve the performance.

a) Increased fleet and congestion of cities

The congestion road is an imbalance results in a point and a specific moment between the demand and supply. The public transport always seeks to restore the balance on the one part, improving the supply through the construction of the main and/or secondary roads, and increasing the capacity of network, on the other part, decrease the demand through strict mechanisms, such as penalizing motorists via toll charges, and parking fees.

The public transport currently is in direct competition with the particular car use. This competitive situation may be favorable, since, the fuel prices are continued fairly significant increase. This factor reduces the car demand. Especially, abandon use of private car in town centers at congestion moment. Several studies have demonstrated the public transport should be not exceeding 1.5 times by comparing with the particular car for that the collective transport offers may be attractive. This study was demonstrated by (Reinhold, 2008)17, he indicated for a journey time of 30 minutes, the driver agreed to a transit time between 25 to 45 minutes at maximum.

In Tunisia, the urban development has gradually made to the outside of city centers. This caused an imbalance in the geographical distribution of economic activity (workplace) and residential centers (living quarters). This it has created a high stress of transport on roads leading to the city center, for example, the western peripheral focuses 37% of the population of Greater Tunis and offers only 12% the jobs of its population. This development requires a rebalancing of the supply of transport links and the conduct of large investments accordingly. The efforts are being made through the network extensions of the metro, with the future "Fast Rail Networks" and "the Sfax metro" projects. In addition, the car park has almost doubled between 1996 and 2008 to over 1.3 million vehicles, at the end of 2013. The park has about 1.74 million vehicles. We have seen the registration at a rate of 10,000 vehicles per year in 1960, at the moment; it concerns nearly 60,000 vehicles per year since 2006. The increase in the fleet has resulted in a growing use of

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individual cars. In the three major cities (Tunis, Sfax, Sousse), the share of individual transport is about 60-70% against 30-40% for public transit. Nevertheless, the road infrastructure has not followed the development of the park, generally, roads suffer from bulky. This finding has negative impacts on various parameters, for example, the increasing fuel consumption due to a difficulty of driving in the congestion road, the risk of accidents and the decreasing of the efficiency of public transportation with more irregularity and less punctuality.

b) Increases atmospheric pollutants emitted by the transport public

Traffic congestion is a condition on road networks that occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queuing. The traffic congestion has an adverse impact on the health of people living beside to the city center. The road congestion is the prime generator of air and water pollution. Also, the emission of gas due of congestion road allows to changing the climate on the planet, according to (IPCC, 2014)18, the heating of the planet revolves between 1.1°C and 6.4°C for the last ten years. This warming phenomenon is expected to raise the sea level by 19 to 58cm and other assignments on the flora and fauna resources. This is therefore a new mission for public transport, since it contributes to the growth and development of the region for several reasons. First, it improves the quality of the environment and conserves energy resources. The subway, for example, produces no air pollution, while a bus is less polluting than the automobile. Second, the using of public transit reduces the cost of travel, road congestion and the costs of transporting goods. Finally, the greater traffic flow is in itself an additional source to reduce the polluting emissions.

Energy consumption of transport sector in Tunisia is estimated at 32% of final national energy consumption. The road transport consumes approximately three quarters. After a comparison with the Mediterranean countries, we have checked, this figure is nobly high in comparison with south and east Mediterranean countries. This consumption produced a poor quality of life, which means that it caused a real deterioration of public health through increase of respiratory diseases and the worsening of cancer risks, etc. Moreover, according to the National Agency of Environmental Protection, the traffic of Tunisian public transport would be responsible for at least 30% of the emissions of CO and NOX.

The public transport companies are engaged in a process to control the gaseous and the solid wastes. In this context, the following actions have been implemented:

- Most public companies have places of computer-assisted maintenance management systems enabling them to better manage the preventive maintenance of vehicle engines. This had an impact on reducing failures of these motors in energy consumption and toxic gases emissions.
- Public companies have outsourced the management of their solid waste to specialized companies.
- The regional transport companies Kairouan and Nabeul are equipped with a GPS system for rigorous monitoring of bus fleet, for example borrowed circuits, braking, cornering, etc. This system leads to a reduction in energy consumption around 7%.

These instructions are insufficient, on the one hand, they do not cover all the regional transport companies, and on the other hand, it is not possible to quantify the emissions of pollutants due to public transport and to assess the impact on public health.

c) The spatial planning and the urban development are insufficient

High quality urban realm is important to citizens' quality of life and to businesses deciding where to locate. Public transport has a huge impact on the quality of the urban realm, most significantly by reducing the volume of car traffic on cities roads, and hence the noise, congestion, danger and waste of space caused by such vehicles. Urban space is a precious commodity and public transport utilizes it more efficiently than a car dominant society, allowing cities to be built more compactly than if they were dependent on automobile transport. The imbalance in the distribution of economic centers and residential areas has created a high demand for displacement. These consequences demonstrate the desirability of introducing a sustainable transportation concept throughout the urban planning process. In order to contain any imbalances between supply and demand for transport, the UDM[1] has created projects for development of public transportation in urban areas, with the aim of organizing and controlling the private car in the cities center of Tunisia urban.

The UDM has developed strategies to limit the access of individual's cars in the cities center by the implementation of major public projects. Among the projects that have been planned, we indicate;

- The project implementation of Fast Rail Networks: this project will serve the towns surrounding the city of Tunis (Borj Cedria Fouchana, Mouhammdia, M'nihla, North Aiana, Ezzouhour, Zahrouni, Sejoumi). This network will provide one-third of public transit in Greater Tunis.
- Extension of Metro lines towards the Ennasar and Ain Zaghouan neighborhoods.
- Implementing auto fleet management software in the public transport operators.

[1] Urban Development Management

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Unfortunately, these projects are pending and waiting for approval. The planning process in Tunisia provides that each city has its own management plan. It has implied all regions will not benefit for an effective transport system.

d) The decline in the share of public transit

In major cities in Tunisia, the share of individual transport is about 60 to 70%. This is due the absence of a public transport service in the main residential areas of these cities, for example, some residential areas of Greater Tunis as (El Menzah and El Bouhaira), which represent a high concentration of the population, it is not well served by public transport. It has led to a high concentration of passenger cars with a low occupancy rate. Moreover, the offer of the TRANSTU[2], which represents 80% of the urban public transport in Greater Tunis, has evolved only 2% per year over the last ten years but the transit demand has grown to an average of 6% per year over the same period. In addition, a new form of non-regular collective urban transport has been well developed in recent years; it is the collective taxi which has grown from about 30% between 2011 and 2012 to reach 1,723 cars in Tunisia. This type of transport has filled some of the urban transportation needs and especially suburban, since it is available and used the same bus transport circuits. This type of transport has no reserved stations and exploited a parking area around the bus terminal stations which had the effect of increasing the congestion in the road. In terms of quality, the public bus loses more and more of its attractiveness. The density of travelers has much to do with that, since it has 9 passengers per square meter, which is a very high rate. In against part, to lower this ratio would require significant investment. For example, the transition to a density of 8 travelers per square meter requires an investment of 174 additional buses, which is still high. Also, the bus suffers from congestion at the rush hours. This results a very low commercial speed (7-10 km/h in Greater Tunis), which involves significant decreasing of travel time.

e) Mortality rates increase on the roads

The National Safety Council estimates that riding the bus is over 170 times safer than travelling by automobile. This is because with better public transport, many road users will minimize the usage of personal transport and opt for public transport instead less vehicles on the road could also mean less number of cases and fatalities on the road. Over the past twenty years, the Tunisian roads have recorded important results in terms of accidents and fatalities. Thus the number of car accidents has increased from 10,209 in 1996 to 10,980 accidents in 2006, which represents an annual growth rate of 1%. However, the number of road deaths has increased by an annual average of 1.6% between 1996 and 2006. In addition, the rate of roads mortality is generally measured by reporting the number of people killed with the population (million inhabitants). This ratio has declined relatively. It was 136 killed per thousand inhabitants in 2013, comparing that figure with the European average (27 European countries), it was equal to 86 killed per thousand inhabitants. We have identified, the transport system in Tunisia is far from the international standard when we are comparing with other countries. Based on the current number of new vehicles being registered, the roads here might not be able to sustain the number of vehicles in five years' time without better public transport. Moreover, there are many bad habits which can be kicked by many Tunisian drivers such as speeding, multi-tasking (driving and doing other things at the same time) and or not inspecting their respective vehicles before travelling, which can help reduce the number of road accidents significantly.

f) Analysis of the financial situation

The social mission has guaranteed the physical accessibility of the city for all social categories. The satisfaction of displacement needs is a strategy that is not preponderant part, since in most cases, the behavior of transport users is not always the same, the first customer for the public transport is the disadvantaged population (captive customers) as youth, school students and pensioners who occupy a very important part of the number of travelers, they generally have not their own means of transport. The public transport service has tried to create new lines to ensure maximum coverage and the social equity, i.e. all passengers can travel for a maximum accessibility with the minimum displacement cots. However, the financial constraints lead often to provide an offer that does not respond properly to the travel request. Generally policymakers' transport in Tunisia has effort to find a good compromise between social mission and financial constraints.

In Tunisia, the transport sector contributes about 7% of GDP and is experiencing an average annual growth of 5%, it provides about 140,000 direct jobs (equivalent to 3.7% of the workforce), and it produces 15% of the country's investments. During (2007-2011) these investments are reached 3.6 billion dinars, against 2.7 billion dinars in the period (2001-2006). We have built a comprehensive analytical study, particularly in the public transport sector. We have also identified the failure and the problem of land transportation.

i. *The decline in revenue per trip*

The revenue coming from the public transport can be divided into 3 modes;

- School resources: these are revenues by school subscriptions.

[2] Metropolitan Transport urban of Greater Tunis

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- Intercity transportation revenues: they are incomes gained usually from long distance travel.
- Other Resources: these are revenues from rental and advertising agreements.

The recipe in the period (2007-2014) was decreased. This finding is justified on the one hand, by the drop in passenger numbers, on the other hand, by the mismanagement, for example, the school transport is the first customer for the public transport in Tunisia, it is corresponding to 59.38% in the total number of travelers but financial recipe does not exceed 12.39% of total revenue in 2014. It may also explain the decrease in passenger by the competition with private transport sectors, the rapid development of the collective taxi, and the sharp increase in car fleet, especially, individual transport. In addition, the decline in revenue per trip directly raise the issue of pricing, for example, the recipe is not progressed at the same time with the quality of service offered (increased rolling stock, number of working). Therefore, we believed that public transport companies have faced by difficulties not only to tackle congestion and environmental damage, but also, they will suffer in severe financial crisis in the next years.

ii. *Evolution of the expenditure*

After a thorough analysis of the evolution of spending, we found that salary expenses in 2014 represent a large part of the sum total of expenditure, corresponding to 69.78%. This figure is justified by the massive recruitment of employees with growth of 13% over 2007 and 16% from 2010. So we focus on employee performance and productive efficiency that deteriorated and damaged by a shameful coverage rate not exceeding 35.39% in 2014. This disastrous situation shows that public transport in Tunisia has experienced an unbearable financial crisis, with time. It will become a major problem and a burden of the State. In addition, the stated prices of displacement do not cover their needs. For example, the TRANSTU sells the school subscription to 8% of its cost. Therefore, the selling prices of these subscriptions school have not increased since 2003 despite increases in inputs (wages, energy, etc.). Only a 5% increase was carried out in 2010.

Summing up, the public transport in Tunisia has lost its attractiveness, low quality of urban public transport, increased congestion and the decline the commercial speed, down revenue recipe, exploitation and investment (roads, rolling stock) deficit, increasing the use of private vehicles, all the factors were weakened the role of public transport. For this reason, we developed an approach to improve the performance of public transport by inclining a model of competition between different regional operators. Several indicators were emerged from public transport missions to judge how far objectives are being met. In the following section we have set the goals and tasks for public transportation, we developed some indicator that addressed the performance and to meet all the challenges and requirements in the urban transport system.

IV. Measuring the Performance

The term performance is frequently used in the transport sector. This concept refers often to very different criteria combined to solve the problem of profitability. We can define the performance as the achievement of objectives, specifically, the optimization of services provided to citizens. Our goal is to provide a management system for controlling the regional companies by measuring the effectiveness, efficiency, economic status and the quality of service offered to users. We reported that the choice of indicators should be established with pragmatism, we made sure to choose indicators that we will be able to calculate easily and with data availability. So the indicators have to be operational no questionable and reliable. We proposed the following indicators. We indicated also their definition and the method of calculation.

a) Economic criteria

To measure the economic state for public companies. Also the current situation of the public company can be identified. We can distinguish into two sub-attributes;

i. *Coverage rate*

The coverage rate is a ratio used in economics to bring the balance of the current account (trade balance (recipes) with invisibles balance (expenses)). It is an indicator measuring the economic independence of any company. It ensures the economic sustainability of public transport and the financial contribution from users. For this sub attribute we found 3 cases;

When the coverage is less than 100, the trade balance is in deficit. It is said that the trade balance is negative.

When the coverage is equal to 100, the trade balance is equilibrated and it is said that the trade balance is zero.

Finally, when the coverage ratio exceeds 100, the balance of payments surplus and the trade balance is become positive.

ii. *Investment*

The public transports require a very significant investment according to the technique used and the population areas density. However, investments costs are used for individual transport, an indirect manner, for example the renewal, repair the road network and the constriction of the parking area. In our research we are interesting the investment only concerns of the public transportation as an example the investment of create new lines of buses, renovation costs of rolling stock, etc. These performance indicators, measures investments, made to restore or improve the public transport. The

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investment is decomposed by two variables; the investment cost and the density population of each city during 7 years (from 2007 until 2014).

b) Efficiency criteria

(Citizens point of view) that it measures the expectation of citizens from public policies (e.g. reduce the phenomenon of congestion). We need to specify the objectives of the public transport company in Tunisia urban. We indicated, the policymakers of public transport are interested to increase the displacement, also increase the revenues per (employee and vehicle), and minimize the congestion in the road. Thus, four sub-attributes are appeared;

i. *The displacement per thousand people*

This indicator allows the easy physical access (installation of lines/territories) and to measure the demand for transport in volume.

ii. *The revenue Per Employee*

This criterion is used to qualify the profitability development. It can be measured by the ratio between the revenue and the number of employees.

iii. *The revenue per number of vehicle*

This criterion is used to qualify the income from vehicle. It can be measured by the ratio between the revenue and the number of vehicle.

iv. *Reduce the congestion (decongestion)*

Increasing congestion on urban roads presents a serious threat to the economic growth and live ability of our city regions. There is scope for public transport to help tackle congestion still further. Our urban public transportation system play more of a role, targeting schools and workplaces in particular to reduce peak time traffic and make our cities cleaner, safer and centered around people, rather than cars. Therefore, this indicator returns us the efforts that have been made by transport public operators to reduce the phenomenon of road congestion.

c) Effectiveness criteria

(Point of view of the taxpayer) that it focuses on the optimization of the means employed by relating the products obtained with the resources consumed. This criterion measures the ratio between the targets that have already set by the government with the satisfaction of customer. Generally, the effectiveness is defined as the optimization between the resources mobilized and results (service realized), differs from efficiency which is defined as the degree that the goals have been set. In the field of urban transport, the distinctions between the two terms are complex and varied as recalled (Baumstark et al., 2005)19. In addition, the authors emphasize the need to distinguish two types of effectiveness, depending on the nature of the considered output, input and supply, we found the concept of productivity effectiveness, for which the offer made is reported with the inputs. Second, the commercial effectiveness, which focuses on the use of this offer, it is equal to the ratio between outputs and supply (usually measured by the utilization rate, defined as the number of travelers per vehicle.km or km-products). In our research, we used two types of data for input {number of places, number of employees}, only one given for the output {number of travelers} and finally two data for offer {km-products, number of places-km offered}. For the productivity effectiveness, it is necessary to decompose this indicator into two sub-attributes;

The labor productivity is the ratio between the number of places offered in kilometer and the number of employees.

Capital productivity is the ratio between the number of places offered in kilometer and the number of places.

The two last sub attributes provide to measure the profitability of working in the public transport sector.

d) Quality of service criteria

(Point of view of the user) this indicator measures the improvement of the service provided to the user (e.g. reducing the travel time). It is an important element in the management of services. It helps to clarify goals achieved by the regional companies as far as customers and proposed equipment is concerned, also it manages performance of the transport operators and estimates the degree of customer satisfaction. In other words, the service quality defines the level of satisfaction expected by the customer depending on organization capacity. This indicator provides the opportunity to achieve one or more points of urban space, taking into account the different means of transport available. We have many criteria to measure the quality of service, we indicated:

Accessibility is good if the various vital functions of the city are connected in terms of time and comfort, they well be strictly acceptable by the user. We can be measured by two attributes.

Kilometer per inhabitants: This indicator measures the ratio of products kilometers with the population density.

Kilometer per length line: This performance indicator measures the ratio of products kilometers and line length.

We found other indicator allow to measure the service quality criteria, we mentioned, the quality of rolling stock is an element important to measure the quality of buses offered from the customers, we decomposed into three sub attributes;

Availability: The availability of equipment is a measure of the performance obtained by dividing the time, when the equipment is operational, by the total time. This ratio is conventionally expressed as a percentage.

Average age of the fleet: This performance indicator is used to ensure the sustainability of the transport

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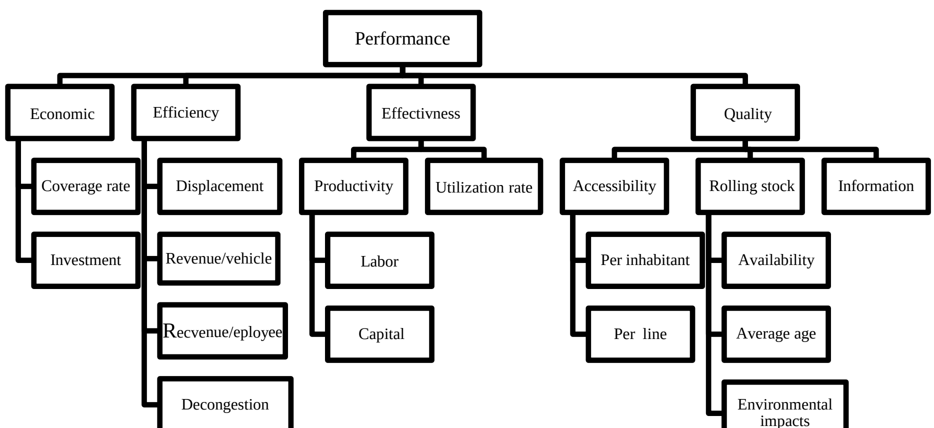
heritage and to measure the age of the rolling stock. Note: The life of a subway train or tram (30 to 35 years) is much greater than a road vehicle (7-15 years) that it is necessary to dissociate the average age of the fleet based on the type of material (road, rail).

Environmental impacts: The service aspect regarding the impacts of the bus systems on the environment includes effects in terms of emissions, noise, visual pollution, vibration, dust and dirt, odor, waste. This indicator measures the efforts that have been made by transport public operators to reduce environmental impacts.

Information and punctuality: Another service aspect affecting transit service quality is linked to the availability of information pertinent to the planning and execution of a journey. Passengers need to know how to use transit service, where the access is located, where to get off in the proximity of their destination, whether any transfers are required, and when transit services are scheduled to depart and arrive. Without this information, potential passengers will not be able to use transit service (TRB, 2014)4. Therefore, we measured the quality of information available to travelers in Tunisian urban. We presented this information as a qualitative data, because it is difficult to obtain exact accurate values. This indicator measures the quality and timeliness of information provided to commuters.

The hierarchy structure (fig 1) is used to study the interaction between the different indicators of our application. The indicators are quantitative and qualitative data under uncertainties. The level 0 is representing the theme of the performance. It is a root of the structure. The level 1 is representing the attributes such as economic, efficiency, effectiveness, and quality of service criteria. The level 2 is representing the sub attributes such as coverage rate, investment, displacement, revenue per (vehicle, employee), productivity, utilization rate, accessibility, rolling stock, and information. The level 3 is representing the sub sub-attributes such as labor, capital, and accessibility per (inhabitant and line). For each alternative, we combined these data to found the most efficient operator exploits the road network.



The figure 1 above shows the hierarchy structure of our research using 4 criteria (level 1), 11 sub-criteria (level 2) and 7 sub sub-criteria (level 3), these instructions can be determine the performance (level 0) for public transport operators. The table 1 below defined the variables, unit and computation method for all criteria of our model.

Table 1 : Different criterion for model competition

Criteria	Variables	Mode of computation	Unit
Economic			
Coverage rate	A: Total commercial revenue, in dinars B: Total operating expenses, in dinars	(A/B)*100	%
Investment	A: Investment expenditure associated with transport public companies B: Number of inhabitant according to the latest census by the National Statistics Institute, in 2014	$\frac{\sum_{i=2007}^{i=2014} A_i}{B}$	dinars/ inhabitant

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Efficiency			
The displacement per thousand people	A: Moving, action, for a person to go from one place (origin) to another place (destination) B: Number of inhabitants	A/B	displacement/ thousand people
The revenue Per Employee	A: The total revenue B: Number of employees	A/B	dinars/employee
The revenue per vehicle	A: Total revenue. B: Number of vehicles used	A/B	dinars/vehicle
Decongestion	Qualitative data		
Effectiveness			
labor productivity	A: Places kilometer offered, thousand places-kilometer B: Number of employees; thousand employees	A/B	places-km/employee
Capital productivity	A: Places kilometer offered, thousand places-kilometer B: Number of place; thousand places	A/B	places-km/place
utilization rate	A: Number of travelers; thousand travelers B: Number of km-products; thousand kilometers-products	A/B	travelers/km products
Quality of service			
Kilometer per inhabitants	A: Kilometer produced by all public transport vehicles B: Number of inhabitants	A/B	km/inhabitant
Kilometer per length line	A: Kilometer produced by all public transport vehicles B: Line Length: Average journey there and back, whether identical or not, including common routes to other lines of the same mode transport.	A/B	km/km line
Average age of the fleet	B: All vehicles used by operators of the transport network, including the reserve. A_i: Age of each vehicle, i years ranging from 0 to infinity	$\frac{\sum_{i=0}^{\infty} A_i}{B}$	Years
Availability	We are using equipment which has a mean time to failure (MTTF) of years and mean time to repair (MTTR).	$\frac{MTTF}{MTTF+MTTR}$	%
Environmental impacts	Qualitative data		
Information& punctuality	Qualitative data		

To summarize, the table 1 below, we presented the quantitative data with the method of calculations and units of measure, these are digital data that it has a reliable values. For a qualitative data, we have broken down by 5 graduations; worst, poor, average, good, and best, in order to qualify these variables. Another remark all the criteria are to maximize except the criterion of average age that must be minimized. In addition, the types of indicators are the main tool of our research. We used a support system for multi-criteria decision, including the ER method for ensuring the comparability and the virtual competition among the regional companies (operators of public transport). The Virtual competition arises from the possibility to compare the performance of several operators even when they do not use the same lines and the same network.

V. Evidential Reasoning Approach

Many decision problems in engineering and management involve multiple attributes of both a quantitative and qualitative nature. Several techniques have been emerged to solve the problem of decision making with multiple attributes data. The well-known method, we indicated the evidential reasoning, it uses an evidence-based reasoning process to reach an adequate decision, which differs from traditional MCDA methods. The ER approach has recently been developed on the basis of decision theory in different

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several disciplines, including decision sciences (in particular utility theory), artificial intelligence, statistical analysis, fuzzy set theory, and computer technology (D. L. Xu and al., 2013 & D. L. Xu and al., 2011a & D. L. Xu and al., 2011b)20,21,22. It has been used to support various decision analysis, assessment and evaluation activities such as environmental impact assessment (J. B. Yang and D. L. Xu, 2006)23 and organizational self-assessment (J.B, Yang and, Dale B.G, 2001)24 based on a range of quality models.

The motivation of using a distributed assessment include that it can include a large number of criteria having both a quantitative and qualitative nature. First, the ER approach is the only method so far capable of handling MCDM problems with uncertainties and hybrid data, and it describes and handles uncertainties by using the concept of the degrees of belief with a simplicity and practicality algorithms. Second, traditional ways of conducting such assessments and surveys include the use of average scores as performance indicators. However, an average score does not provide sufficient information on the diversity of the performances of public transport operators, nor can it indicate where the operators are doing well and where it needs to improve if its average performance is acceptable. Therefore strengths and weaknesses need to be identified separately to supplement average scores (J. B. Yang and D. L. Xu, 2006)23. Finally, these types of problems associated with other methods causes serious problems in decision making. For example, when we add another or new attributes of economic criteria with coverage rate and investment it can be seen that the ranking of the attributes in terms of their importance will be changed. The issues as mentioned can be addressed by using Evidential Reasoning Approach.

For our application, we attempt to evaluate the performance of company public operators in Tunisia urban, it involves multiple criterions such as, economic, quality of service, effectiveness, efficiency, which the sub attributes are quantitative and qualitative in nature. Numerical data which uses numbers is considered as quantitative data and can be measured with 100% certainty (M. Lisa, 2008)25. On the contrary, qualitative data is descriptive in nature, which defines some concepts or imprecise characteristics or quality of things. This type of data can't describe a thing with certainty, since it lacks the precision and inherits, ambiguity, ignorance, vagueness. It is difficult to measure the quality of a thing with 100% certainty (M. Hossain and al., 2013)26. Examples of qualitative data associated with in choosing a best performance are information, reducing the congestion, and environmental impacts. Therefore, for assessing different qualitative attributes, different sets of evolution grade may need to be defined to facilitate data collection such as Worst (W), Poor (P), Average (A), Good (G), and Best (B). Hence, belief structure is used to design a subjective model assessment with uncertainty for these linguistic evaluation grades. For example, an expert may sate that he is 50% sure, as the efforts that have been made by transport public operators to reduce environmental impacts, as it is good, and 30% sure it is best, in the statement, good and best denote distinctive evaluation grade, and the percentage values of 50 and 30 are referred to as the degrees of belief. The assessment can be expressed as the following expectation:

$$S(\text{environmental impacts})=\{(\text{good},0.5), (\text{best}, 0.3)\} \quad (1)$$

Where S(environmental impacts) stands for the state of the rolling stock's, and the real number 0.5 and 0.3 denote the degree of belief of 50% and 30%, respectively. Note that expectation (1) describes an incomplete assessment as its total degree of belief is 0.5+0.3 <1. Incomplete assessment are likely to acquire in real life decision problems and may result from the lack of data and evidence (incompleteness) or the inability of the assessor to provide precise judgments (imprecision) due to novelty and complexity of the problem in question.

a) Basic Evaluation Framework

One of the critical tasks of developing a decision support system is to acquire information and to represent them in appropriate format so that it will feed into a model. Since ER approach employs belief structure to acquire knowledge, appropriate information should be selected to feed the ER algorithm, which is used to process the information.

Suppose there are L basic attributes ei(i=1,…,L) associated with a general attribute Y. Define a set of L basic attributes as follows:

$$E=\{e_1,e_2,e_3,....,e_L\}$$

Suppose the weights of the attributes are given by $w=\{w_1,w_2,w_3,....,w_L\}$ where is the relative weight of the i-th basic attribute (ei) with . Suppose N distinctive evaluation grades are defined that collectively provide a complete set of standards for assessing an attribute, as represented by

$$H=\{H_1,H_2,H_3,...,H_n \,/\, n=1,2,3,...,N\}$$

For example, Let 'performance' (y) be an attribute at level 0 as shown in Fig. 1. Which is to be assessed for an alternative *(A)* (i.e. operators of public transport) and this assessment can be denoted by *A*(y). This is to be evaluated based on a set of weight for sub-attributes (such as economic (e_1), efficiency (e_2), effectiveness (e_3), and quality of service (e_4)) at level 1,

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also, The Performance *(y)* can be assessed by using a set of evaluation grades consisting of Worst (H_1), Poor (H_2), Average (H_3), Good (H_4), and Best (H_5).

The evaluation grades are mutually exclusive and collectively exhaustive and hence, they form a frame of discernment in D-S terminology. A degree of belief is associated with each evaluation may be mathematically represented as the following distribution:

$$A(e_i)=\{(H_n,\beta_{n,i}),n=1,...,N,\ i=1,...,L\} \quad (2)$$

Denotes that the top attribute y is assessed to grade Hn with the degree of belief βn. In this assessment, it is required that:

$$(\beta_{n,i}\geq 0;\sum_{n=1}^{N}\beta_{n,i}\leq 1)$$

If $\beta n,\ i=1$, the assessment is complete and if it is less than one then the assessment is considered as incomplete. If $\beta n,\ i=0$, then the assessment stands for complete ignorance. The incompleteness as mentioned occurs due to ignorance, meaning that belief degree has not been assigned to any specific evaluation grade and this can be represented using the equation as given below.

$$\beta_{H,i}=1-\sum_{n=1}^{N}\beta_{n,i} \quad (3)$$

Where, β_H is the belief degree unassigned to any specific grade. If the value of β_H is zero then it can argued that there is an absence of ignorance or incompleteness. If the value of β_H is greater than zero then it can be inferred that there exists ignorance or incompleteness in the assessment.

The ER algorithm, as will be discussed, has the procedures to handle such kind of ignorance. It is also necessary to distribute the degree of belief between evaluation grades for certain quantitative input data. For example, sub-attribute "coverage rate", which is at the level 2 of the Fig. 1, consists of five evaluation grades namely Worst, Poor, Average, Good, and Best. For example, If Coverage rate is 100%, it is considered as Best. If Coverage rate is 75%, it is considered as Good. If Coverage rate is 50%, it is considered as Average. If Coverage rate is 25%, it is considered as Poor. Finally, if Coverage rate is 0%, it is considered as Worst.

However, when a coverage rate is equal 62%, it can be both good and average. However, it is important for us to know, with what degree of belief it is good and with what degree of belief it is average. This phenomenon can be calculated with the following formula;

$$\beta_{n,i}=\frac{h_{n+1}-h}{h_{n+1}-h_{n,i}};\ \beta_{n+1,i}=1-\beta_{n,i}\ \text{ If }\ h_{n,i}\leq h\leq h_{n+1} \quad (4)$$

Here, the degree of belief βn,I is associated with the evaluation grade average while βn+1,i is associated with the upper level evaluation grade good. The value of hn+1 is the value related to good, which is considered as 75%. The value of hn+i is related to average, which is 50%. Hence, applying equation (4) the distribution of the degree of belief with respect to h=62% of the coverage rate from the economic criteria can be assessed by using equation (4) and the result is given below:

$$\beta_{3,1}=\frac{h_{4,1}-h_1}{h_{4,1}-h_{3,1}}=\frac{75-62}{75-50}=0,52$$

$$\beta_{4,1}=1-\beta_{3,1}=0,48$$

{(Worst, 0), (Poor, 0), (Average, 0.52), (Good, 0.48), (Best, 0)}

b) Attribute aggregation using ER algorithm

The degrees of belief as assigned to the evaluation grades of the attributes need to be transformed into basic probability masses (m_n,i). Basic probability mass measures the belief exactly assigned to the *n-th* evaluation grade of an attribute. It also represents how strongly the evidence supports *n-th* evaluation grade (H_n) of the attribute. The transformation can be achieved by combining relative weight (*wi*) of the attribute with the degree of belief (β_n,i) associated with *n-th* evaluation grade of the attribute. Let m_H,i be a remaining probability mass unassigned to any individual grade after all the N grades have been considered for assessing the general attribute as far as is concerned. m_n,i and m_H,i are calculated as follows:

$$\begin{cases} m_{n,i}=m_i(H_n)=w_i\beta_{n,i} \\ m_{H,i}=m_i(H)=1-\sum_{n=1}^{N}m_{n,i}=1-w\sum_{i=1}^{N}\beta_{n,i} \\ n=1,...,N;\ and\ i=1,...,L \end{cases} \quad (5)$$

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This aggregation can be presented by using the following matrixes equation (6, 7);

$$M=\begin{bmatrix} m_{1,1} & m_{2,1} & m_{3,1} & m_{4,1} & m_{H,1} \\ m_{1,2} & m_{2,2} & m_{3,2} & m_{4,2} & m_{H,2} \\ m_{1,3} & m_{2,3} & m_{3,3} & m_{4,4} & m_{H,3} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ m_{n,I} & m_{n+1,I} & m_{n+2,I} & m_{n+3,I} & m_{H,i} \end{bmatrix} \quad (6) \qquad N=\begin{bmatrix} m_{1,I(2)} & m_{2,I(2)} & m_{3,I(2)} & m_{4,I(2)} & m_{H,I(2)} \\ m_{1,3} & m_{2,3} & m_{3,3} & m_{4,3} & m_{H,3} \\ m_{1,4} & m_{2,4} & m_{3,4} & m_{4,4} & m_{H,4} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ m_{n,I} & m_{n+1,I} & m_{n+2,I} & m_{n+3,I} & m_{H,I} \end{bmatrix} \quad (7)$$

From matrix (6), it can be seen that each sub attribute is associated with five basic probability assignment *bpa*, where four first four bpa ($m_1,1$,$m_2,1$,$m_3,1$,$m_4,1$) are associated with five evaluation grades (H_1 ,H_2 ,H_3 ,H_4, H_5). The m_H,i is showing the remaining probability mass unassigned to any individual grades after the assessments on sub-attribute have been considered. Each row in this matrix represents *bpa* related to one basic attribute or sub-attribute. It is necessary to aggregate the *bpa* of different sub-attributes. The aggregation is carried out in a recursive way. For example, the *bpa* of first sub attribute (which is shown in the first row of the matrix 6) is aggregated with the *bpa* of second sub attribute. The result of this aggregation is illustrated in the first row of the matrix (7) and this can be considered as the base case of this recursive procedure. Since this will be used in the latter aggregation of the sub attributes. As used in (Yang and Singh, 1994)27, an attribute aggregation is again used to deduce ER algorithm for combining two assessments $S(e_i)$ and $S(e_j)$. The combined probability masses are generated by aggregating (denoted by $\oplus$) the assessments $S(e_i)$ and $S(e_j)$ are shown as follows:

$$\begin{cases} \{H_n\}: m_{n,I(i+1)} = K_{I(i+1)}\left[m_{n,I(i)}m_{n,i+1} + m_{n,I(i)}m_{H,i+1} + m_{H,I(i)}m_{n,i+1}\right] \\ \{H\}: \tilde{m}_{H,I(i+1)} = K_{I(i+1)}\left[\tilde{m}_{H,I(i)}\tilde{m}_{H,i+1} + \tilde{m}_{H,I(i)}\overline{m}_{H,i+1} + \overline{m}_{H,I(i)}\tilde{m}_{H,i+1}\right] \\ \{H\}: \overline{m}_{H,I(i+1)} = K_{I(i+1)}\left[\overline{m}_{H,I(i)}\overline{m}_{H,i+1}\right] \\ K_{I(i+1)} = \left[1 - \sum_{n=1}^{N}\sum_{\substack{t=1 \\ t\neq n}}^{N} m_{n,I(i)}m_{t,j+1}\right]^{-1}, i = 1,\dots, L-1, \end{cases} \quad (8)$$

Where, $K_{I(2)}$ is a normalization factor used to resolve the conflict. Let $m_{n,I(i)}, \tilde{m}_{H,I(i)}, \overline{m}_{H,I(i)}$ denote the combined probability masses generated by aggregating. The following of ER algorithm is then developed for combining the first assessments with the $th(i+1)$ assessment using the same process as shown in equation (8), with a recursive manner.

The $m_{H,I(i)}$ is decomposed into two parts; $\overline{m}_{H,I(i)}$ and $\tilde{m}_{H,I(i)}$ where;

$$\begin{cases} \overline{m}_{H,I(i)} = 1 - w_i \\ \tilde{m}_{H,I(i)} = w_i\left(1 - \sum_{n=1}^{N}\beta_{n,i}\right) \\ m_{H,I(i)} = \overline{m}_{H,I(i)} + \tilde{m}_{H,I(i)} \end{cases} \quad (9)$$

$\overline{m}_{H,I(i)}$ is the first part of the remaining probability mass that is not yet assigned to individual grades due to the fact that attribute i (denoted by ei) only plays one part in the assessment relative to its weight. $\overline{m}_{H,I(i)}$ is a linear decreasing function of w_i $\tilde{m}_{H,I(i)}$ is the second part of the remaining probability mass unassigned to individual grades, which is caused due to the incompleteness in the assessment $S(e_i)$.

After all L assessments have been aggregated, the combined degrees of belief are generated by assigning back to all individual grades proportionally using the following normalization process:

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$$\begin{cases} \{H_n\}: \beta_n = \dfrac{m_{n,I(L)}}{1-\overline{m}_{H,I(L)}}, n=1,\ldots,N \\ \{H\}: \beta_H = \dfrac{\tilde{m}_{H,I(L)}}{1-\overline{m}_{H,I(L)}}, \ where\ m_{n,I(1)} = m_{n,1}\ (n=1,\ldots,N) \\ \sum_{n=1}^{N} \beta_n + \beta_H = 1 \end{cases} \quad (10)$$

β_n generated above is a likelihood to which H_n is assessed. β_H is the unassigned degree of belief representing the extent of incompleteness in the overall assessment. Finally, similar to equation (1, 2), the generated assessment for (*y*) can be represented by the following distribution;

$$S(y(a_l)) = \{(H_n, \beta_n(a_l)), n=1,\ldots,N\} \quad (11)$$

Which (y) is assessed to the grade Hn with the degree of belief of β_n $(n=1,\ldots,N)$.

c) The Utility Function

Utility function is used to determine the ranking of the different alternatives. In this research different operators of public transport sector have been considered as the alternatives. Therefore, the determination of ranking of the alternatives will help to take a decision to decide the suitable company. There are three different types of utility functions considered in the ER approach namely; minimum utility, maximum utility and average utility. In this function, a number is assigned to an evaluation or assessment grade. The number is assigned by taking account of the preference of the decision maker to a certain evaluation grade.

Suppose the utility of an evaluation grade u(Hn), then the expected utility of the aggregated assessments u(y) defined as follows;

$$u(y) = \sum_{n=1}^{N} u(H_n)\beta_n(a_l) \quad (12)$$

The belief degree $\beta n(a_l)$ represents the lower bound of the likelihood that al is assessed to Hn, whilst the corresponding upper bound of the likelihood is given by $(\beta_n(a_l) + \beta_H(a_l))$.

An alternative *(a)* is preferred to another alternative *(b)* on *(y)* if and only if $u(y(a)) > u(y(b))$, and the maximum, minimum and average utilities of al can be calculated by:

$$\begin{cases} u_{\max}(a_l) = \sum_{n=1}^{N-1} \beta_n(a_l)u(H_n) + (\beta_N(a_l) + \beta_H(a_l))u(H_N) \\ u_{\min}(a_l) = (\beta_l + \beta_H)u(H_l) + \sum_{n=2}^{N} \beta_n(a_l)u(H_n) \\ u_{average}(a_l) = \dfrac{u_{\max}(a_l) + u_{\min}(a_l)}{2} \end{cases} \quad (13)$$

VI. Results and Discussion

In the previous section, we have discussed about the ER method and how to implement it. Therefore, in this section we will look at the results from using this method on the different operators exploits the road network. The ER distributed modeling framework for the different criteria, the recursive ER algorithms, for aggregating multiple attributes, is used to combine probability masses between different levels, and the utility function based ER ranking method which is designed to compare and rank alternatives. We studied the possibility to compare the performance of several operators by determining the most efficient regional operator .i.e. what is the best regional companies exploit the road network. If this comparison shows that the performance of the public operator is insufficient, it will suffer a strong pressure to become more effective and efficient. We calculated the scoring of performance for all possible alternatives. We assured the comparison between 4 operators of urban transport, TRANSTU, SORETRAS, STS and SRTGN, whose activities is to provide passenger transport service by bus in the Tunisian territory, respectively, the Greater Tunis (governorates, of Ariena, Tunis and Ben Arous), Sfax, Sahel (the governorates of Sousse, Monastir and Mahdia) and the governorate of Nabeul. The table 2 below illustrates the data of original performance

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assessment of public transport operators, these data has been proposed by the minister of transport for the year 2014.

Table 2 : Original performance assessment of public transport operator

Criteria	TRANSTU	SORETRAS	STS	SRTGN	Weight
• Economic					0.54
Coverage rate	17,56	26,42	34,36	61,99	0.5
Investment	5,5	5,78	4,7	5,9	0.5
• Efficiency					0.09
Displacement per thousand inhabitant	0,3	0,24	0,23	0,21	0.25
Revenue per employee	5,42	9,5	14,4	28,89	0.25
Revenue per vehicle	26,15	38,68	49,58	151,85	0.25
Decongestion	(P, 0.3);(A,0.4)	(W,0.5);(P,0.3)	(A, 0.4);(G,0.4)	(G, 0.8)	0.25
• Effectiveness					0.13
Productivity					0.5
Labor	0,71	0,72	1,93	1,05	0.5
Capital	35,2	29,35	44,48	55,36	0.5
Utilization rate	4,46	4,61	5	3,72	0.5
• Quality of service					0.24
Accessibility					0.33
Kilometer per inhabitant	15,85	11,94	14,47	9,84	0.5
Kilometer par line	5706	1120	1564	1141	0.5
Rolling stock					0.33
Availability	64,16	57	81	83	0.33
Average age of park	7,83	8,08	7,75	8,75	0.33
Environmental impacts	(A, 0.3); (G, 0.5)	(P, 0.5);(A,0.3)	(A,0.5);(G,0.25)	(A,0.5);(G,0.45)	0.33
Information	(W, 0.6);(P, 0.3)	(W, 0.5);(P,0.4)	(P, 0.2);(A,0.7)	(A,0.4);(G,0.3)	0.33

The table 2 above illustrates the local weights for each criterion in each level. The results show that in the second level and third level of criteria, it had been prioritized as the first level followed by economic criteria (0.54), efficiency (0.09), effectiveness (0.13) and quality of service (0.24). Another way, the local weight of each criterion and their importance is proposed by the decision maker of minister of transport in Tunisia urban. The economic criterion was named the most important criterion. It has a more weight in comparison between different criteria for Level 1. This implies that the transport authorities have an interest to improve the economic situation by increasing the revenues and reducing the expenses budgets. In terms of the importance, the quality of service is classified in the second place in order to provide an easy access for commuters. When the quality of service is better than the public of transport will be attractive. In the same way, the effectiveness is classified in the third place. This criterion ensures a comparison between different operators in terms of productivity and commercial profitability. Finally, the efficiency criterion is classed in the fourth place, it is used to measure whether the objectives set have been reached. For measuring the weight of each criterion several techniques have been emerged, and the well-known method, we indicated, the pair-wise comparison in AHP method (Saaty, 1980)28. This technique is used to determine the relative importance of each alternative in terms of each criterion using a scale of importance. Another remark, the sub-attributes and sub sub-attributes of the level 2 and level 3 are a similar weight for each higher criterion. We worked on quantitative and qualitative data under uncertainties as presented in the table 2, for transforming the distributed assessment, a qualitative criterion can be assessed using the grades and a degree of belief to which each grade is assessed, quantitative criteria can also be defined and used together with qualitative criteria for assessment, it can be transformed in the same way as presented in Eq. (4). The assessment problem shown in table 3 is the same format as that defined in the Eq. (1) and (11), The attributes of our model is assessed to a grade, then the over performance also should be assessed to a large graduation, such as, Worst (W), Poor (P), Average (A), Good (G), and Best (B).

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Table 3 : Transformed of distributed assessment

Attributes	TRANSTU	SORETRAS	STS	SRTGN
Coverage rate	{(W, 0.29), (P, 0.71)}	{(P, 0.94) ; (A, 0.06)}	{(P, 0.62) ; (A, 0.38)}	{(A, 0.52) ;(G, 0.48)}
Investment	{(A, 0.8) ; (G, 0.2)}	{(A, 0.68) ; (G, 0.32)}	{(P, 0.12) ; (A, 0.88)}	{(A, 0.6) ; (G, 0.4)}
Displacement	{(A, 0.6) ; (G, 0.4)}	{(P, 0.08) ; (A, 0.92)}	{(P, 0.16) ; (A, 0.84)}	{(P, 0.32) ; (A, 0.68)}
Revenue/vehicle	{(W, 0.47) ; (P, 0.53)}	{(W, 0.22) ; (P, 0.78)}	{(W, 0.01) ;(P, 0.99)}	{(G, 0.98) ; (B,0.02)}
Revenue/employee	{(W, 0.27) ; (P, 0.73)}	{(P, 0.73) ; (A, 0.27)}	{(P, 0.08) ; (A, 0.92)}	{(G, 0.14) ; (B, 0.86)}
Reducing congestion	{(P, 0.3) ; (A, 0.4)}	{(W, 0.5) ; (P,0.3)}	{(A, 0.4) ; (G, 0.4)}	{(G, 0.8)}
Use rate	{(A, 0.45) ; (G, 0.55)}	{(A, 0.36) ; (G, 0.64)}	{(A, 0.02) ;(G, 0.98)}	{(A, 0.87) ; (G, 0.13)}
Labor	{(P, 0.56) ; (A, 0.44)}	{(P, 0.58) ; (A, 0.42)}	{(G, 0.14) ;(B, 0.86)}	{(A, 0.9) ; (G, 0.1)}
Capital	{(A, 0.65) ; (G, 0.35)}	{(P, 0.04) ; (A, 0.96)}	{(A, 0.03) ;(G, 0.97)}	{(G, 0.3) ; (B, 0.7)}
Accessibility per inhabitant	{(G, 0.13) ; (B, 0.87)}	{(A, 0.86) ;(G, 0.14)}	{(A, 0.08) ; (G,0.92)}	{(P, 0.51) ; (A, 0.49)}
Accessibility per line	{(G, 0.23) ; (B, 0.77)}	{(W, 0.9) ; (P, 0.1)}	{(W, 0.54) ;(P, 0.46)}	{(W, 0.88) ; (P, 0.12)}
Availability	{(A, 0.53) ; (G, 0.47)}	{(A, 0.72) ; (G, 0.28)}	{(G, 0.76) ; (B,0.24)}	{(G, 0.68) ; (B, 0.38)}
Average age	{(P, 0.08) ; (A, 0.92)}	{(P, 0.15) ; (A, 0.85)}	{(P, 0.06) ; (A, 0.94)}	{(P, 0.33) ; (A, 0.67)}
Environmental impact	{(A, 0.3) ; (G, 0.5)}	{(P, 0.5) ; (A, 0.3)}	{(A, 0.5) ; (G, 0.25)}	{(A, 0.5) ; (G, 0.45)}
Information and comfort	{(W, 0.6) ;(P, 0.3)}	{(W, 0.5) ; (P, 0.4)}	{(P, 0.2) ; (A,0.7)}	{((A,0.4) (G,0.3)}

We can be aggregated using the ER algorithm in Eq. (5) and (8). The ER algorithm can be employed to calculate the overall distributed assessment on performance. The result of calculation is presented in the fig 3. For selecting the best company exploits the road network, the main purpose of such assessment includes the identification of strengths and weaknesses for each operator, which could form a basis for subsequent detailed assessments and for creating action plans to address the weaknesses identified. Clearly, the company has achieved the best performance in many areas, as over 3.61% of the areas are assessed to be “Best”, 40.48% to be “Good”, and 49,31% to be “Average”. So probably the best operator is SRTGN. However, the company TRANSTU needs to improve in nearly 22% of the worst assessed grade. Also, the fig 2 above shows the variation in scores for each regional operator of public urban transportation. This operation has shown that companies are often different within specified criteria, such as TRANSTU has the best quality service, compared to other operators, but it knew, too, a weakness in the other indicators. This is an important element, for each regional operator needs to monitor their performance for all different criteria.

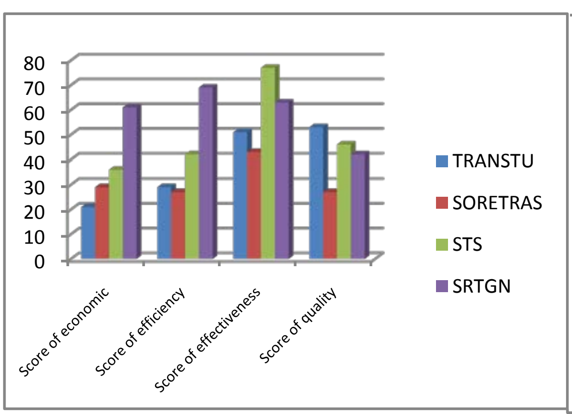

Fig. 2 : The company performance in different criteria

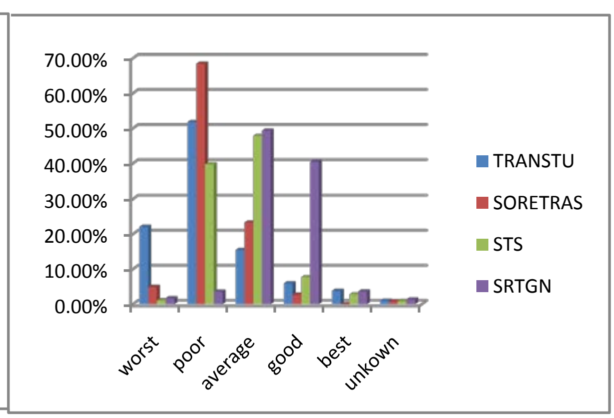

Fig. 3 : The distributed assessment on performance

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For calculating the score of each alternative, we used the method of utility function Eq. (13). The assessments in Figure 2 should be used. The numbers under each grade indicate the aggregated assessments of evaluation grade, for example, we applied this method for a STS company. The results for STS presented as follows: STS is assessed to be 1.08% worst, 3.57% poor, 49.31% average, 3.61% good, and 1.32% best. The total degree of belief does not add up to one (or 100%) as a result of incomplete and/or missing assessments. The results in table 4 are supported by the decision making. The operator of public transport could be ranked in order of preference by comparing them with each other as in table 3. However, a comparison may not be possible when the different operators have a very similar degrees of belief assigned to each grade. Therefore, a probability assignment approach could be used to estimate the utilities of five evolution grade. To illustrate the following transformation process and simplify discussion, we proposed the different utilities that it is assigned to each grade;

u(W)=0, u(P)=0.25, u(A)=0.5, u(G)=0.75, u(B)=1.

For example, the result of STS Company is defined as follows;

$$\begin{cases} u_{\min}(STS) = (\beta_1 + \beta_H) \times u(H_1) + \sum_{n=2}^{N} \beta_n \times u(H_n) = 0.424 \\ u_{\max}(STS) = \sum_{n=1}^{4} \beta_n \times u(H_n) + (\beta_5 + \beta_H) \times u(H_5) = 0.43 \\ u_{average}(STS) = \frac{u_{\min} + u_{\max}}{2} = 0.427 \end{cases}$$

We applied the method of utility function for all alternatives, we get;

Table 4 : The Expected Utilities of Alternative

Alternatives	Min score	Average score	Max score	Rank
TRANSTU	28%	28,5%	29%	4
SORETRAS	30%	30,5%	31%	3
STS	42%	42,5%	43%	2
SRTGN	59%	59,5%	60%	1

The operators of public transport may be ranked based on the average utility but this may be misleading. In order to say that one company theoretically dominates another, the preferred alternative minimum utility must be equal or greater than the dominated alternative with a maximum utility. The result in the table 4 above shows that the Nabeul 's regional operator (SRTGN) in 2014 is the most successful public company, respectively STS Company, SORETRAS and TRANSTU are ranked in ascending order. We can also measure the degree satisfaction of the customer, by relating the criteria efficiencies with the criteria of effectiveness; it is illustrated in the figure 5. These finding shows that the public transport companies do not reach relieve the travel request, since this ratio is less than 50% of the maximum capacity.

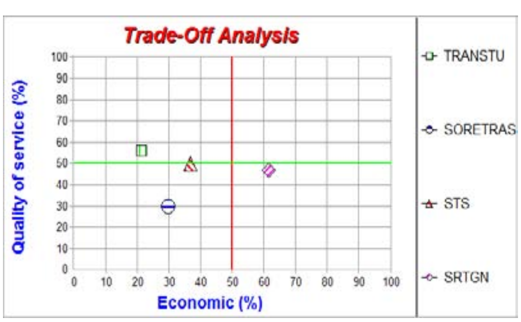

Fig. 4 : The rapport between quality and economic criteria

Fig. 5 : The degree satisfaction of the customer

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The rapport between economic and quality of service criteria, view in fig 4, illustrates the company of SRTGN is very far compared to other operators. This company has tried to find a good compromise between expenditure and qualities offered to users, but it can do better when they exploit the resources of a suitable manner.

We have proposed possible solutions to cushion the failure and improve performance in the coming years. We mentioned some indicators of regulations.

- Encourage more the person using public transport
- Reduce the number of people who tend to take the cars during peak hours.
- Develop multimodal platforms that connect public transport with other modes by improving service quality with a modal competitiveness. This means, all modes of transport are competing to ensure the movement.
- Share the power of decision, it must be consistent with the distribution of financial responsibilities, that is to say, the authority decides should have a financing responsibility.
- Share accountability and decision-making power between the Department of Transport and Regional companies.
- Improve business efficiency and productivity by increasing the use rate. Is it justified to make run in distant peripheral, diesel bus consuming 40 liters per 100 km, to transport just 2 people?

VII. Conclusion and Future Work

The regulations related to land transport require a larger contribution of the State, such as the compensation to the operator a loss of earnings due to reduced rates and to free displacement. Also, the financing of investment in equipment (spare parts, fuel consumption, etc.) is funded solely by the state. It is true that the state pays more than 200 thousand dinars per year as reduced internal rates but this amount is insufficient to cover the deficits. This is why the question of the performance of regional public transport companies arises, firstly, we can justify an improvement in regional companies can improve the performance of the transport system. Secondly, the regional companies do not use their full capacity; it is believed that these companies could do better in terms of economic, effectiveness, efficiency, and quality of service. They can improve the decision making in order to amortize some financial damage. Finally, it is convenient to have an approach which can tackle the uncertainties or incompleteness in the data gathered. Therefore, the ER is seen as reasonable method for the performance analysis of public transport operator using both quantitative and qualitative data.

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