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COMPARATIVE ANALISYS OF THE MAIN SYSTEMS OF TRANSPORTATION OF BRAZILIAN CENTRAL WEST REGION

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ABSTRACTS

This article presents a comparison regarding the users and workers´ perception on METROBUS from Goiânia-GO and METRÔ-DF from Brasília, in relation to: information, route, satisfaction, price, security, pollution, available information, system guarantee and exchange. Exploratory (bibliographical data) and descriptive (structured interview) were conducted. The theoretical-methodological instrument of intervention selected is Constructivist Methodology of Multiriteria For Decision Support (MCDA-C). The research is qualitative in the whole model structure and quantitative in criteria measurement and evaluation from each system users and workers´ perception. 44 axes of performance evaluation to be considered in this study were identified. Thus, it is concluded that it was possible to structure a model of assessment of users and workers´ perception that identified the best performance presented by METRÔ-DF.

Keywords: *Multi-criteria Analysis; System of Transportation; Subway; BRT; METRÔ-DF; METROBUS*

1. INTRODUCTION

The situation of mobility in the urban center has represented a significant expense for the population of large Brazilian cities, which leads to loss of time, inconvenience and suffering in traffic for users of the roads. In general are due to the congestion of vehicles at peak hours. Urban areas are considered of great attractiveness for fixation of the population, mainly by providing more opportunities for jobs, greater access to governmental investment and greater supply of manufactured type products, compared to residents of rural areas.

The 2010 Census from IBGE (2011) presents that 82% of the Brazilian population live in urban environment, what determines an increase of the demographic concentration in urban centers. Taking into account that the 1960 Census presented most of the population fixed in rural areas, so, according to Figure 1, the fifty years apart show that the urban centers had significant transformations in land use. This diagnosis brings demand of actions from the public power that aim to smooth social economic problems, as well as generate fluidity of the population displacement in urban centers.

The Brazilian urban scenario which has been formed over the last years needs a diagnosis of the modes of transportations available to population in the urban centers and answer whether they are meeting the increasing demands, resulted from the increase of the Brazilian urban population. The modes of mass public transportation more implanted or being implanted in the main Brazilian cities are: road, that has as main system the called Bus Rapid Transit-BRT (METROUS-GO); and rail, which is focused on the subway system (METRÔ-DF).

According to Vasconcellos (2000), the urban development results from a wide unit of economic, social, political and cultural factors, as well as concrete actions adopted by State, by the private sector, by individuals and by the organized society. In order to choose a new transportation project, necessarily it is required a study that determines the alternative which, after technical and operational analysis, proves to be the best amongst the diverse analyzed alternatives.

The comparative analysis of rail (METRÔ-DF) and road (METROBUS-GO) modes will make use of the multicriteria analysis tool, which permitted the identification of the users and workers´ perception, regarding each one´s importance, for urban populations´ displacements in Brasília-DF and Goiânia-GO. The two locus of the research are in the urban centers with the biggest demographic concentrations in Center-West and each system transports in average 150 thousand users on working days. The perception from research´s subjects provided an analysis of the public administration regarding the operations of transport systems subway and bus, with the identification of the point of operation of the systems, due to the existing demand, as well as of public resources invested in public transportation.

According to Ostrowetsky (2001), in contemporaneous cities´ building there was the observation of several processes involved which determine economic, social and cultural characteristics and form of organization, which can be thus summarized: population growth push in favor of the intensification of land use and/or the incorporation of new areas; and the public investments (circulation, sanitation, energy, telecommunications, education, health infrastructures, etc.) and private (residential and/or commercial buildings) tend to concentrate spatially.

2. BUS AND SUBWAY SYSTEMS OF TRANSPORTATIONS

Bus and subway systems of transportation are considered the main in order to attend transport demands of the great urban central in Brazil and other countries.

2.1. Bus Systems of Transportation - METROBUS-GO

Bus system of transportation is the more effective today for Brazilian population´s displacement. However, it is limited when regarding operational capacity to accommodate and transport users in vehicles, mainly related to fleet comfort, security, rapidity and modernization. In some urban regions, it is observed the bus sizes according to average demand of passengers of a certain schedule, which allows the rational use of the equipment, with alternation of vehicles: traditional bus and minibus.

Bus system of transportation presents an average capacity to displace people at low cost of implantation and operation. Since there is a major demographic concentration in the Brazilian capitals, in these cities is mainly identified the use of one or even bi-articulated buses, called articulated or bi-articulated vehicles. Therefore, the alternative for transporting a great number of passengers is by doubling the vehicles´ size. The bus is replaced by an articulated configuration, with a motor that drags two bodies, that through a flexible structure or folding concertina type, allows the connection of the bodywork. If the greater need to transport user in a single vehicle persists, the bi-articulated becomes an option for the operation, which is characterized by an engine pulling three bus bodies, which are joined by two accordions. These vehicles called articulated and bi-articulated buses are suitable for moments of great demand or peak times of major urban centers, however, feature restrictions complete maneuvers in sharp curves.

In order to obtain operational gains, transport a higher number of passengers and intensify the vehicle´s use, the public transportation managers can use the resource of segregating the road and separate it for being used exclusively by mass transportation of buses. In this way, the road will be separated for bus traffic exclusively, determining fluidity and will prioritize urban roads for mass transportation, in detriment of particular and generally individual transport. In segregated roads shall be possible to use the motor or vehicle power system for traditional fuels and also electricity. However, it is simpler for the infrastructure of this BRT system, when the operation relies on diesel oil based vehicles, segregated roads, departure/arrival platforms at the height of the floor of the bus and tariff payment to enter the platform.

In the history of the emergence of the "BRT-fast bus transport – public" are underlying difficulties, which caused a fundamental innovation in the transport capacity to meet the overall increase of demand for public transport. The use of segregated roads, passenger vehicles with greater volumetric capacity, specially designed stations for receiving the fare and lodging of users, are elements that allow the bus system to have higher capacity and speed to carry passengers, with operation approach of the subways. However, with a lower cost, which happens to be an option of great attractiveness for the public managers, as is noted in the world map of emergence and growth of BRT systems, which has its first operating system in the Brazilian city of Curitiba-PR, as shown in Figure 2 on the left.

It was initially identified the adoption of BRT so highly grouped in the main cities of Brazil. Following were included with highlight Santiago, Quito, Pittsburgh and Essen in Germany. Then, at the end of the decade of 1990 the dynamic changes, with an explosion of new systems in Central America, Canada, Australia, and especially smaller cities in Europe. Taipei led the adoption of BRT in China, with many new emerging systems. Recently, the BRTs were included also in the regions of Istanbul and Tehran.

The city of Goiania, capital of Goias State, uses mass transit based on modal with a segregated line road that cuts across its central region. This system, which is called METROBUS-GO and presents significant operational advantages, with a focus on structuring the urban environment of the city, with regard to large-capacity transport systems operational, as shown in Figure 2 and Table 1.

2.2. Subway System of Transportation and METRÔ-DF

With the growth of cities after World War II, the existing systems were saturated and in the 1950 the need for inclusion of a new mass transportation service already existed. The main urban centers of the countries crossed serious problems of displacement of the population in this period, in what was characterized as a central point of the problem changing the operating structure of modal rail "streetcar", by "road" bus, which wouldn't take as a mass transport.

However, this same period was marked by the beginning of the operations of the subway systems in the countries most financially structured and able to invest resources considered high for the construction of the new mode of transport on rail.

Figure 3 shows the importance and the distribution of subways in the various countries and regions with its chronology and capacity.

The London subway had its construction and operating tests begun in the 1860s and in the same decade it went into commercial operation. Currently the London system operates with approximately 400 miles of subway lines and 274 stations. Hook and Wright (2008) state that the subway system presents deployment and maintenance cost higher than those of light rail vehicle systems (VLT) and bus rapid transport (BRT). The service is made available for so-called "greater London", in a way that serves several neighboring towns. Data from 2005 show significant numbers of users of the system, a total of users who came to an average number of 2.67 million passengers per day.

With the demographic concentration in large cities that occurred after World War II, including in Brazilian cities, according to IBGE (2011), the public transport tram and buses formed, which predominated in the main cities of the country, he wouldn't take the increasing demand from users. In 1904 the New York subway, in 1913 the Buenos Aires subte, in the year 1974 the São Paulo subway, the Rio de Janeiro subway in 1977 and the Federal District (Brasilia) subway in 2001, these subway systems in the Americas are highlighted in this paper, for discriminating the year of beginning of each commercial operation soon is evidenced to the early to mid-20TH century the introduction of subway transportation system for: a) meet on a large scale urban public transport users; b) use the subsoil of the city for their tracks; c) allow other interactions in urban surface, as shown in Figure 4.

In proportion as the number of users of public transport grows and generates strangulation or bottlenecks for displacement of the urban population of a city, which features the edge of operational capacity, soon come into being the need for a transport system of higher production volume, that determine more fluidity of traffic in areas of high concentration of population and therefore you can correspond to continuous increases in demand. The subway transportation system as well as having superior operational capacity to run by bus is considered more comfortable, reliable, fast, efficient, less polluting, in addition to other advantages, so this is an appropriate mass transport to meet high demand, customers demanding and urban centers aimed at modernization of its equipment, however, their deployment and maintenance costs are higher than those of the road modal.

The growing urban circulation problems, arising from the increase in the demographic concentration, became part of the life of the inhabitants of the largest Brazilian cities. The problems arising from the rural exodus led to lawmakers to search for alternatives that are viable for mass transport.

In Brazil in the decade of 1970, from public investments, started appearing new rail systems to generate benefits for the population located in the two largest cities. Were installed and began to operate in this period the subways in the cities of São Paulo, in 1973 and Rio de Janeiro, in 1979. The moment was regarded as the first wave of investments in the transport sector. In the decade following investments of the same nature contemplated metropolitan regions of Belo Horizonte, Recife and Porto Alegre. The last decade of the 20th century was marked by the beginning of the construction of the Brasília, Fortaleza and Salvador subways (see Table 2).

2.2.1 Main Benefits and Technological Advances of the Subway

The globalization of markets and the internationalisation of the economy have given direct reflections according to the division of the market for the supply of transport services, both in Brazil and in other countries. Rail systems incorporated in recent years an increased number of new technologies, which consequently began to offer its users new benefits, getting the other mass transportation modes with technological developments less representative and smallest aggregation of benefits. The private sector has worked significantly in rail transport, which is resulting in several favorable changes from constant interventions determined by scientific researches, which are quickly transformed into reality and start to generate benefits for users of the system. New electronic control elements of the system are made available to users, which are considered key as follows: traffic management, door sensors, traction control, engine and other. The "automatic ticketing system, the" Smart Card "is adopted with more intensity, being applied in the process of integration with other modalities such as single ticket and may also be useful as a credit card for purchases in general in a near future.

Private initiative has awakened interest for subways´ operation. The Brazilian model features the Rio de Janeiro subway, in which the operation was granted to private enterprise in 1998. In the Federal District it attempted to privatization of subway operation, coming to be published and disseminated in edict in the year 2001, obtaining interest of approximately 50 companies or private groups to participate in the process, but at the instigation of the public prosecutor's office of the Federal District the bidding process was suspended.

2.2.2 Travel Time

The travel time of the subway's drive has little variation between the periods considered of low and high demand, i.e. between the peak hours and non-peak, as shown in the Table 3.

By giving focus to the public transportation system through bus, Vasconcellos (2000), consider how the mass transit system most widely used in the country, yet its duration of travel features significant variations between the timetables of the course. By concentrating the focus on transportation by automobile, which is considered private and individual vehicle, proves that your travel time is still higher than the subway, as presented in Table 3.

According to Santos (2001), in the pursuit of quality and productivity management, operators of public transport by bus in the country have been developing real-time control mechanisms. The control has the function to monitor the provision of the service on a daily basis, to ensure the effectiveness and usefulness of the service, managing terminals and support points, monitoring vehicles, drivers/debt collectors, as well as controlling the operation and some unforeseen events that occurred during the process.

When considering the congestion that occur in the main major urban centers are growing in a Brazilian larger proportion to the increase in population, as consequently lost time on the trip becomes larger, it is observed a significant aggravation of urban diseconomies, according to IPEA (2003), contained in Table 4. In a primary comparison can highlight that the subway system has electronic control of traffic and exclusive use of railroads, which did not suffer direct or indirect influence of the flow of vehicles from other modes of transport, while the traditional bus road system allows competition in the use of via with other vehicles and traffic control technology considered technologically intercropped with other vehicles.

3. ENVIRONMENTAL POLLUTION AND ACCIDENTS

3.1. Environmental Pollution

The environmental indicators that identify the environmental qualitative transformations show that pollution determined by the subway system of transportation is considered as of low impact. According Bell & Morse (2003), the environmental indicators are those which identify the transformations in the qualitative conditions of the physical environment, as well as in the social and cultural landscape historically produced and accumulated in local communities.

The use of traction based on electric power allows you to not generate gases to the atmosphere and therefore does not interfere with the air quality in urban centers, while automotive vehicles pollute significantly the Brazilian urban centers. Interference with respect to the level of noise and visual intrusion, which are determined by the subway system are smaller, insofar as the same has its wholly or partly underground pathways. In relation to users inside the vehicle, the bus system determines sound pollutions, and sociocultural landscape inferior to the subway system.

According to Vasconcellos (2000), the urban center will have to be supported by its transport planning, as well as the proper feedback system adjustments, by necessity of management of its dynamism. The unstructured transport systems feature a level of atmospheric pollution and energy costs much higher than those of cities that possess structured and more efficient. The main reason to stimulate use of individual transport and use of informal transport is the lack of supply of public transportation that meets the needs of the population, generating more inefficiency, excessive fuel consumption and higher level of pollution. Table 5 demonstrates the concern of the Brazilian environmental legislation on motor vehicles, which determine the pollutant emission ceilings, as are regarded as major polluters in urban centers.

3.2. Accidents

The subway system is designed from guidelines whose basic premise is the supply of transport services that provide security, regularity, comfort, small interval between trains, low pollution and high capacity for population displacement. To meet the conditions and security parameters, which meet national and international standards, the system typically indicates the need for duplication of equipment. Technological development is aimed at constant improvement in human resources and materials, having as goal the full automation of its primary operational functions.

The subway is a transport system that has been characterized for being pioneer in the application of automation techniques and equipment based on microprocessors, as well as the rapid way to incorporate results of scientific research. With regard to the security system, it is considered to be effective and comparing it with the road modal, makes your system superior in evaluating this attribute, by using large number of electronic control devices. Table 6 presents the main reasons of deaths in six cities in several countries and some of them operate on the subway.

This table shows numbers of accidents considered more common in large urban areas of some countries, which do not appear cases of death from trains, although these are operating within the territorial limits of such cities. Therefore, rail transport, in which the tube is inserted, are considered the most secure, because their accidents are small proportion, in a way that does not appear in the statistics highlighted or frames that deal with the topic.

4. RESEARCH METHODOLOGY

This section presents (i) methodological framework; and (ii) procedures for construction of the model**:**

4.1. Methodological framework

The methodological approach used in this study can be classified as quali-quantitative since that makes use not only of instrumental in the collection and statistical processing of data, but also qualitative dimensions, when identifying the criteria that will compose the model. As an instrument of intervention for the construction of the model, the Multi-Criteria Methodology for Decision Support – Constructivist (MCDA-C) was used. We decided to use this methodology for its ability to encapsulate the perceptions of users and servers.

According to Espíndola et al. (2007) the Multicriteria Methodologies are an evolution of Operational Research (PO). Within the same scientific community, two main currents of thought developed multi-criteria: Multicriteria Decision Making (MCDM) and Multicriteria Decision Aid (MCDA). The main difference between these methods is that while the MCDM intends to develop a mathematical model to explain a situation and come to a good decision, based on a situation recognized as real, regardless of those involved, the MCDA aims to model the decision-making context, in order to generate the knowledge involved in the process, in such a way as to allow the construction of a model in which the decisions are based on what is believed to be the most suitable to the specific situation (ROY, 1990, p. 23).

4.1.1 Structuring Phase

In case of this survey, interviews were conducted semi-structured in nature and with the use of the technique of brainstorming to generate knowledge about the decision-making context, with a view to identify subsidies for the construction of the model of evaluating the perceptions of users and employees with respect to the Metrobus and to the Subway.

The next step is to identify the criteria and cleave in sub-criteria because it is easier to measure along with the makers of Metrobus de Goiás and Brasília Metro's decision-makers, This were constructed two models of multi-criteria analysis and analyzed the perceptions of users and employees of the Metrobus and the subway. Were identified 10 criteria, sub-criteria 29 2nd level and 3rd level 22 sub-criteria. Figures 5, 6, 7, 8 and 9 show the value with the criteria tree decomposed by the sub-criteria.

5. EVALUATION PHASE

The evaluation phase determines the local cardinal scales, through the construction of value functions for levels of descriptors. To this end, reference levels are defined for each descriptor (BANA and COSTA and SILVA, 1994, p. 33), also known as anchor levels. These levels determine the adjacent tracks, inside of which impacted levels are considered to be market level. The level beyond "Good" is considered – benchmarking the level of excellence sought; the level below the "neutral" is considered binding and is penalized in the model. After anchoring, it is important to identify the difference in attractiveness between levels determined previously; for this purpose, it creates a value for each of them, using the method of semantic judgment, through peer-to-peer comparisons and using the software Macbeth-scores (BANA E COSTA, STEWART, PRAVAT, 1995, p. 268), as shown in Table 9.

The next step of the evaluation phase consists in the identification of the weights of the criteria, which tell the relative importance of each criterion in the model. To determine the weights of the criteria using the software Macbeth-scores (ESPÍNDOLA et al., 2007) since the viewpoints were built and tested with regard to preferred independence to ordinal and cardinal can represent the overall performance through the additive aggregation model (compensatory model), proposed by the Equation 1 (ENSSLIN; NORONHA, 1997).

V(a) = W1*V1(a) + W2*V2(a) + W3*V3(a) + ... Wn*Vn(a)

where:
V (a) = total value of status quo
(A) v1, V2 (a), to ... VN (a) = partial value in the criteria 1, 2, 3, ..., n.
W1, W2, ..., Wn = ... and Replacement Rates in criteria 1, 2, 3, ..., n.
n = number of criteria of the model.

5.1. Results Obtained

With the structured assessment model, the next step was to use it to evaluate the performance of actions and generate alternatives together with decision-makers. To this end, it used Hiview (BARCLAY, 1984), which is a software for the analysis, evaluation and justification of complex decisions, which can be used in decision support processes, particularly in the evaluation of models obtained by Multi-Criteria Decision Support Methodologies that use an aggregate function (additive ENSSLIN; NORONHA, 1997). This application eliminates the manual use of additive aggregation formula, Equation 1

In this research 31 users and 9 employees of Metrobus de Goiás and 31 users and 11 employees of the Brasília Metro through 44 descriptors, came to the following results. As shown in Table 10 and Table 11.

Table 10 shows the scores on each criterion of Metrobus de Goiás, where the results of the evaluation of the employees have always been higher in relation to users with the exception of criteria 1 nformation and 8 Information Available. The users ' overall score was 60 points while staff was 77 points, corresponds to 28.3% more for employees.

Table 11 shows the scores on each criterion of the Brasília subway, where the results of the evaluation of officials always were higher with the exception of the criterion 3 User Satisfaction which was approximately equal. The criterion Price shows a great disparity of the score obtained by users with respect to employees. The users ' overall score was 60 points while staff was 81 points, corresponds to 33.3 percent more to employees.

The overall score of users of Metrobus and Subway was equal although transport systems and cities are different.

5.2. Phase Recommendations

On construction of multi-criteria models it is important to do a sensitivity analysis, in order to test the robustness of the model under the variations of its various parameters, due to the inaccuracy of the data context, as well as the uncertainties of the decision-makers in the construction of the model. In this way, with the construction of the model and your transcript for the application, it was possible to analyze the Hiview weights of criteria both locally and globally and the result showed that for the larger criteria weights: safety; Price; User Satisfaction; Environmental Pollution showed robust model.

6. FINAL CONSIDERATIONS

As limitations of the research, pointed to the following aspects: (i) the low representation of the decision-makers, since, for the template in its current configuration, were considered just 9 employees and 31 Metrobus users and 11 employees and 31 users; (ii) With the two models, the Metrobus and the Subway, research was unable to be detailed and deepened in the polls, becoming very extensive and laborious because of the need to offset for Goias to search.

From the limitations pointed out, the following are suggested topics for future research (i) increase the representativeness of the universe of decision-makers; (ii) separate the models in two studies.

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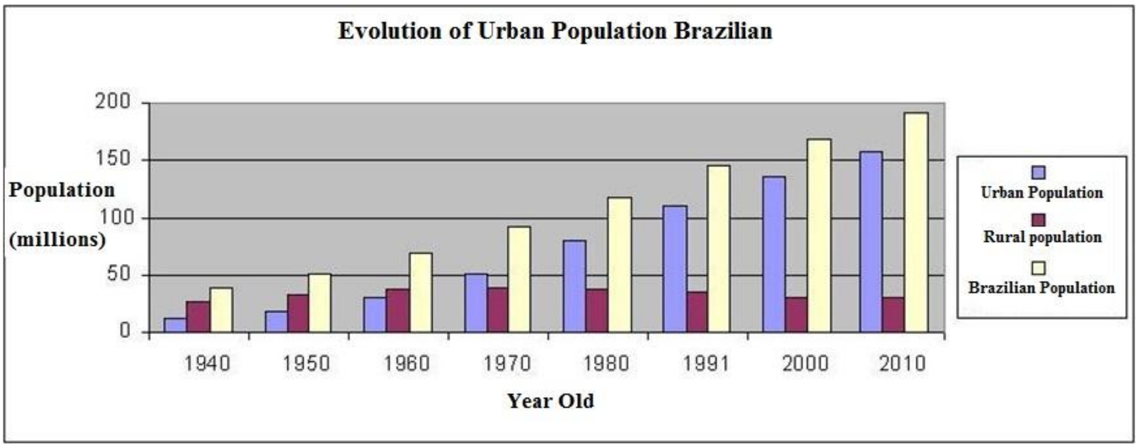
Annexe

Figure 1 – Evolution of Brazilian Population in the Last Census



Source: IBGE (2011)

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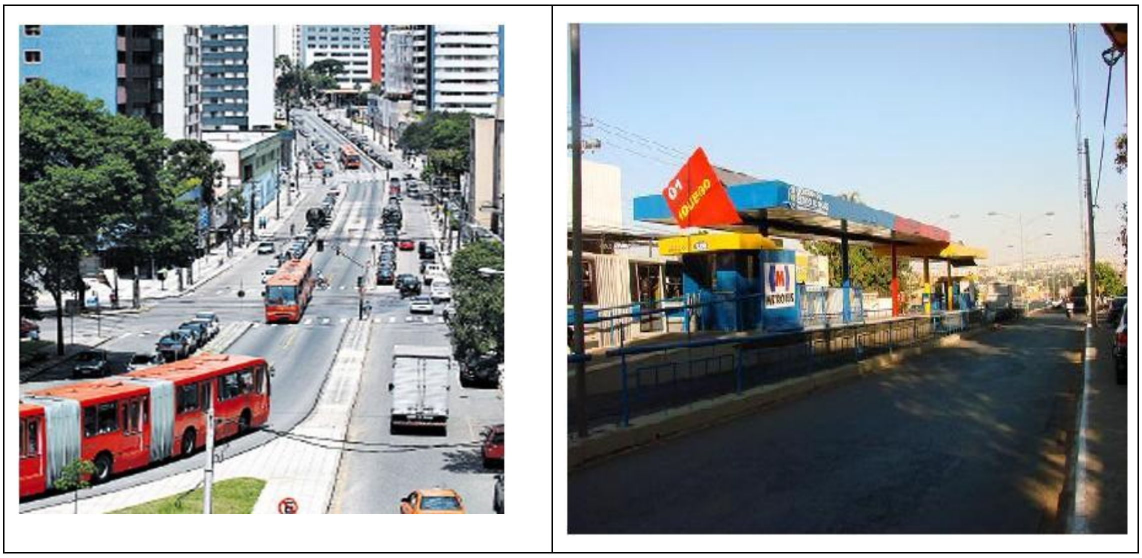
Figure 2 – Segregated Routes for Buses of Curitiba - PR and Goiânia – GO



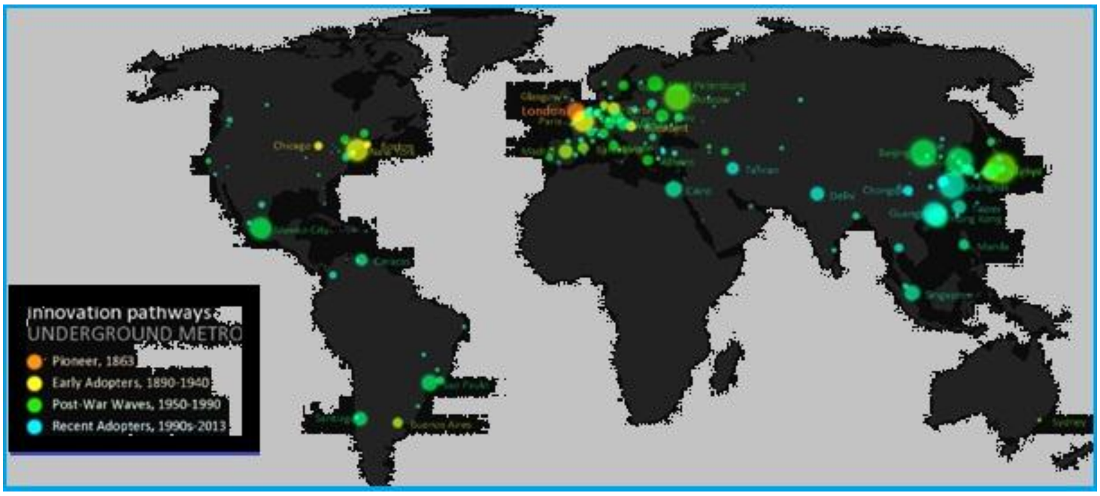
Source: from left to right – Municipal Prefecture of Curitiba (2009); Metrobus (2009).

Table 1 – Bus System in Operation (Metrobus)

City	Transmission Line	Nº of Stations	Nº of Vehicles	Beginning of the Commercial Operation	Users/day	Working Hour
Goiânia	14 Km	14	101 Articulated Buses and 5 Bi	1997 (from 2007 – GNV)	150 thousand	24 h

Source: Modified of Metrobus (2009)

Figure 3 – Subways´ Map in the World



Source: Smith (2013)

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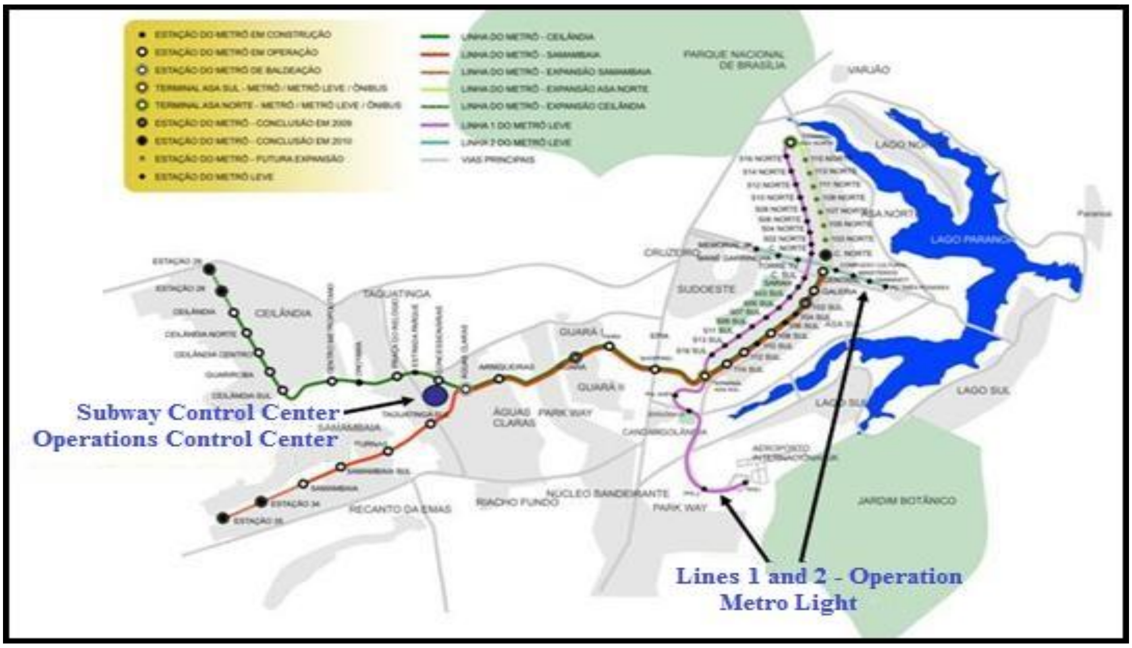
Figure 4 – Map of Subway´s Line of Distrito Federal



Source: Modified from Metrô-DF (2009)

Table 2 – Brazilian Subway Systems

Subways in Country	Transmission Line	Nº of Stations	Nº of Trains	Beginning of Commercial Operation	Users/day	Working Hour
São Paulo	61,3km	58 (4 lines)	118 (6 cars)	1974	3,3 million	4h to24 h
Belo Horizonte	21,3km	19 (1 lines)	25 (4 cars)	1985	150 mil	5h to 23h
Recife	39,5km	28 (2 lines)	25 (4 cars)	1985	190 mil	5h to 23h
Rio de Janeiro	36,9km	33 (2 lines)	32 (6 cars)	1980	500 mil	5h to 24h
Porto Alegre	33,8km	17 (2 lines)	25 (4 cars)	1985	150 mil	5h to 23h20min
Brasília	42km	23 (1 line)	20 (4 cars)	2002	150mil	6h to 23h30min
Fortaleza	(in construction)	-	-	-	-	-
Salvador	(in construction)	-	-	-	-	-

Source: Modified from the Official Sites of the Respective Subway Systems in Brazil (2009)

Table 3 – Rapidity and Segurity the Minimum Travel Time At Rush Hour

Origem	Travel Destiny	Subway	Bus
Bus Station Pilot Plan (Centre of Brasília)	Guará	16 min	40 min
	Águas Claras	21 min	1 hour
	Taguatinga	27 min	1 h and 10 min
	Samambaia	31 min	1 h and 29 min
	Ceilândia	40 min	1 h and 20 min

Source: Subway of Distrito Federal (2009).

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Table 4 - Excess Time Lost, in millions of Passengers/hour/year

Cities	Excess of time lost in 1998	
	Automobile	**Bus**
Belo Horizonte	6,06	40,54
Brasília	0,50	2,41
Campinas	3,51	2,45
Curitiba	2,82	2,37
João Pessoa	0,77	1,21
Juiz de Fora	0,18	1,69
Porto Alegre	3,00	3,42
Recife	1,79	3,67
Rio de Janeiro	33,03	80,41
São Paulo	198,43	117,87
Total	**250,09**	**256,03**

Source: IPEA (2003)

Table 5 – Limits defined by the Brazilian environmental legislation

Light commercial vehicles-mass – Ref. to 1700 kg (from 01/01/98)		
Pollutants	**Limits**	
Carbon Monoxide (CO g/km)	2,0	
Hydrocarbons (HC g/km)	0,3	
Nitrogen Oxides (Nox g/km)	0,6	
Particulate matter (MP** g/km)	0,128	
Aldehydes (CHO* g/km)	0,03	
Light commercial vehicles-mass – Ref. Higher than 1700kg (from 01/01/98)		
Pollutants	**Limits**	
Carbon Monoxide (CO g/km)	6,2	
Hydrocarbons (HC g/km)	0,5	
Nitrogen Oxides (Nox g/km)	1,4	
Particulate matter (MP** g/km)	0,16	
Aldehydes (CHO* g/km)	0,06	
Heavy vehicles (from 01/01/98)		
Pollutants	**Limits (01/01/96)**	**Limits (01/01/2000*)**
Carbon Monoxide (CO g/km)	4,9	4,0
Hydrocarbons (HC g/km)	1,23	1,1
Nitrogen Oxides (Nox g/km)	9,0	7,0
Particulate matter (MP** g/km)	0,7/0,4**	0,25
Smoke (K)	2,5	-

Notes: (*) urban bus - anticipated to 01.01.1998; (* *) applicable to Diesel cycle engines

Source: IBAMA (2009)

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Table 6 - Number of Cases of Death as Trauma in the Regions - Year 2000

Trauma Mechanism	San Francisco (EUA) n: 437	Monterrey (México) n: 327	Seattle (EUA) n: 423	Denver (EUA) n: 289	São Paulo (Brasil) n: 205
Motor vehicle accident	12	35	25	26	21
Motorcycle accident	-	6	4	3	7
Bicycle accident	-	-	2	1	2
Hit by car	6	23	9	7	23
Fall	28	8	15	8	17
Other closed trauma	7	5	13	4	6
Firearm injury	32	8	16	42	21
Penetrating injury (other)	8	15	16	7	3
Burn	7	-	-	2	-

Source: Vasconcelos (2001)

Table 7 - Daily Displacement of the Inhabitants of The Metropolitan Region of São Paulo

Means of Shift	Year of 1987 (daily shift)	Year 1997 (daily shift)	Year of 2007 (daily shift)
Bus	8.050.000	7.200.000	8.100.000
Ferrovia	2.263.000 (urban train and subway)	1.000.000 (only urban train)	1.200.000 (only urban train)
Subway	-	2.100.000	3.200.000
Automobile	8.022.000	8.600.000	8.900.000
On foot	10.591.000	11.300.000	12.200.000
Total	29.407.000	30.700.000	33.600.000

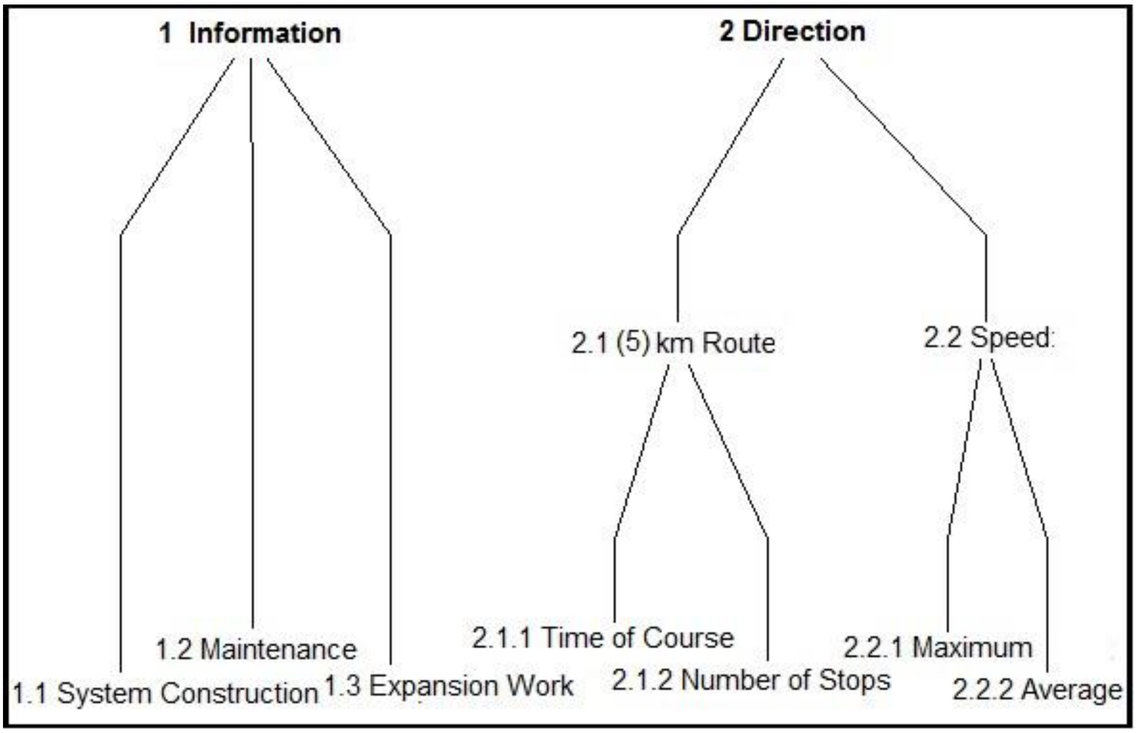
Source: Modified by the Transport State Secretary of São Paulo (2009)

Table 8 – Metrobus and Subway System in Central-West Brazil

Sistemas of Transportation	Line Extension	Number of Stops	Number of Vehicles	Beginning of Commercial Operation	Users/day	Working Schedule
Goiânia (Metrobus)	14 km	14	101 articulated bus and 5 Bi	1997 (from 2007, GNV)	150 mil	24 h
Brasília (Subway)	42 km	23 (1 line)	20 (4 cars)	2002 (electric)	150 mil	6h to 23h30

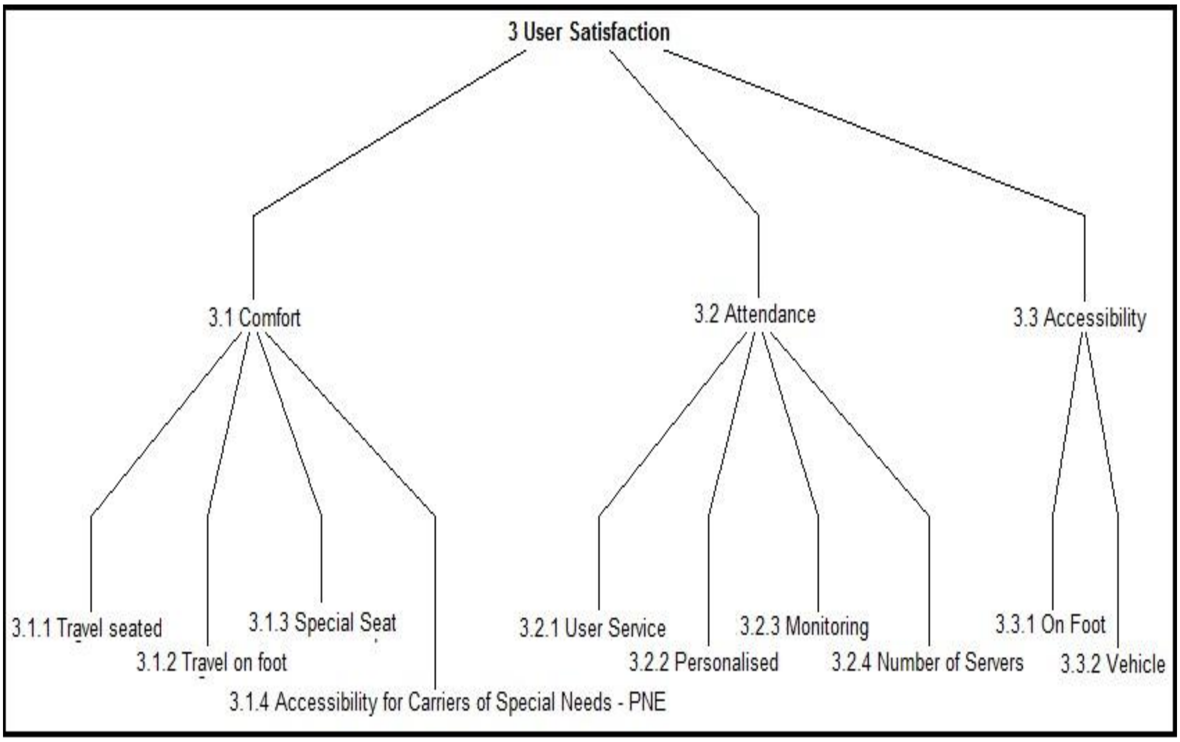
Sourcs: Modified from Metrobus (2009) and Metrô-DF (2009)

Figure 5 - Criteria Value Tree: 1 Information and 2 Direction



Source: Elaborated by the authors, 2014.

Figure 6: Criteria Value Tree: 3 User Satisfaction



Source: Elaborated by the authors, 2014.

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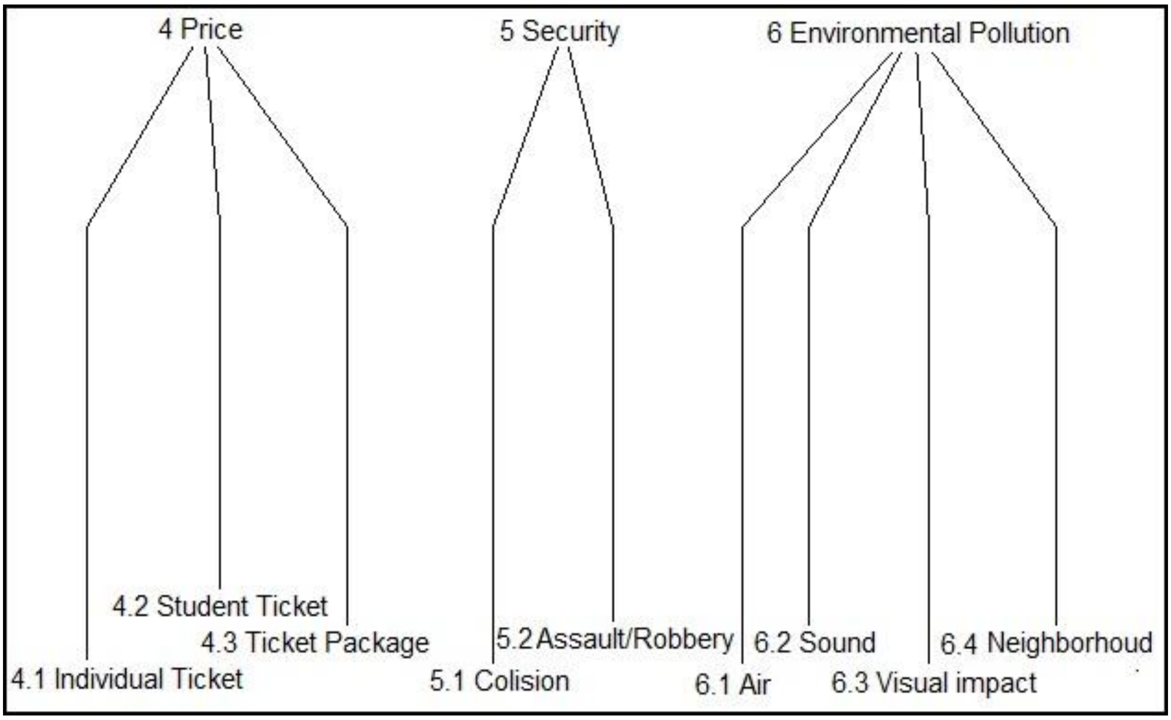
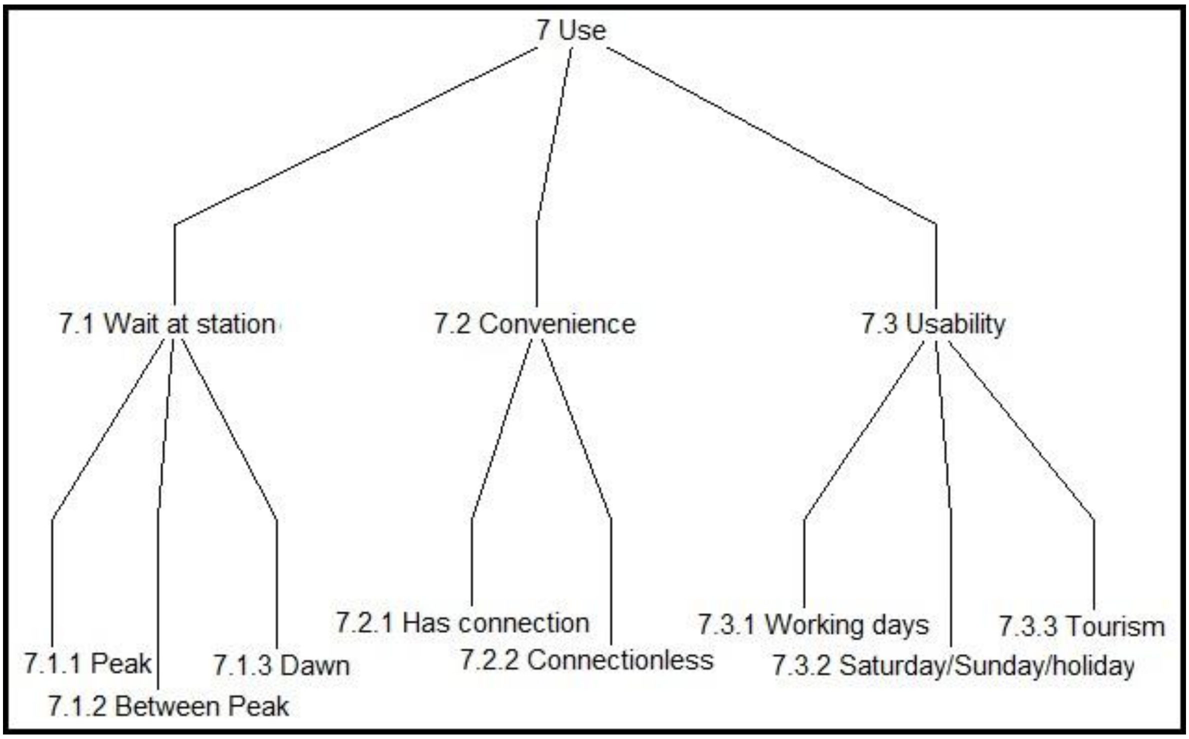
Figure 7: Criteria Value Tree: 4 Ticket Price; 5 Secutiry and 6 Environmental Pollution.



Source: Elaborated by the authors, 2014.

Figure 8: Criteria Value Tree: 7 Use.



Source: Elaborated by the authors, 2014.

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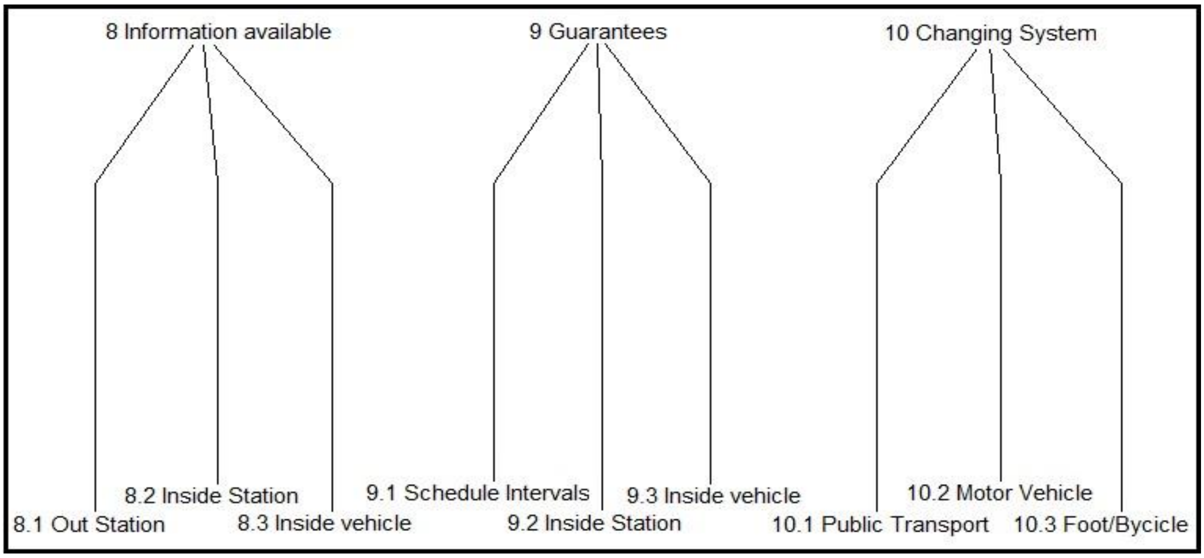
Figure 9: Criteria Value Tree: 8 Information Available; 9 Guarantees; 10 Changing System.



Source: Elaborated by the authors, 2014.

Table 9: Qualifier Price and its levels of impact.

Price of Individual Ticket			
Level of Impact	**Level of Reference**	**Description**	**Value Function (Macbeth)**
N_5		Price 0.5% below the minimum wage	150
N_4	Good	Price 0.5% below the minimum wage	100
N_3		Price between 0.51% to 0.6% of the minimum wage	50
N_2	Neutral	Price between 0.61% to 0.7% of the minimum salary	0
N_1		Price 0.7% above the minimum salary	-50

Source: Elaborated by the authors, 2014.

Table 10: The criteria with their respective weights and punctuation from users and workers related to Goiás Subway.

GOIÁS	Weight	User	Employee	Cumulative Weight
1- Information	5	39	39	5,0
2- Direction	9	68	84	9,0
3- User Satisfaction	14	52	81	14,0
4- Price	13	84	99	13,0
5- Security	16	51	70	16,0
6- Environmental Pollution	12	75	99	12,0
7- Use	10	83	79	10,0
8- Information available	6	20	21	6,0
9- Guarantees	8	35	75	8,0
10- Changing System	7	58	71	7,0
TOTAL	100	60	77	100,0

Source: Elaborated by the authors, 2014.

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Table 11: The criteria with their respective weights and punctuation from users and workers related to Brasília Subway.

BRASÍLIA	Weight	User	Employee	Cumulative Weight
1- Information	5	84	47	5,0
2- Direction	9	84	51	9,0
3- User Satisfaction	14	65	64	14,0
4- Price	13	16	86	13,0
5- Security	16	70	100	16,0
6- Environmental Pollution	12	113	150	12,0
7- Use	10	17	66	10,0
8- Information available	6	42	65	6,0
9- Guarantees	8	83	75	8,0
10- Changing System	7	24	43	7,0
TOTAL	100	60	81	100,0

Source: Elaborated by the authors, 2014.