International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 11 (2021), pp. 1143-1148

Selection of the Means of School Transport According to Quality Features

Alba Yajaira Sanchez Delgado[1], Albert Miyer Suarez Castrillon[2] and Sir Alexci Suarez Castrillon [3]

[1] Faculty of Engineering and Architecture, Civil Engineering Program, University of Pamplona, Colombia.

[2] Faculty of Engineering and Architecture, GIMUP, University of Pamplona, Colombia.

[3] Engineering Faculty, GRUCITE, University Francisco of Paula Santander Ocaña, Colombia.

Abstract

In this research an evaluation of the characteristics that can affect the quality of public school transport service such as: speed, capacity, frequency, comfort and speed that contribute to the realization of more optimal routes and selection of an appropriate transport, an appropriate solution that can serve for public education institutions that have similarity in terms of population and number of students of the institution as the Mega College Carlos Julio Torrado Peñaranda of the Municipality of Abrego is raised.

Keywords: School transport quality, speed, seat belts, route frequency.

I. INTRODUCTION

The safety of public transport is influenced by different variables or characteristics that allow providing a good service for the benefit of students and parents, in addition to reducing traffic and travel time to the educational institution. Thompson, Voigt, and Shumer as cited in [1], state that the main difficulty faced by the decision maker is to find features that guarantee the best transportation service. The characteristics can be very large and complex so it is necessary to select those that contribute to the efficiency of the service provided. Which can be speed, capacity, safety, frequency and regularity.

The relationship between the time taken to go from one point to another, and the distance that must be traveled for it, is known as speed. However, when it comes to satisfaction in transport logistics, an important variable enters as information and communication technologies which in the end help a customer to become more loyal to the transport company [1]. Speed is a variable that mismanaged can cause accidents causing an impact on road safety, and the main function of transport is the protection of all people who are daily in public service, especially when it comes to school transport, so the speed limits should be clear to achieve the desired quality with timely protection, in 2015 Johns Hopkins University showed that more than 40% of all accidents were marked by speeding [2].

While the capacity takes into account the number of passengers transported and that they can reach their destination on time and also how it is organized to serve them. Presenting failures such as overcrowding for which many transport companies are often sanctioned, which ultimately make the routes and characteristics are not functional for this reason [3].

School transport also has its benefits, because it is the safest transport where parents and relatives want the best for their children, not only because of the capabilities of the vehicle, but also because of the possibility of Covid-19 infection, which is why they are sterilized every time they must make a route, making school transport a quick and effective solution for students and parents and usually accidents occur by distraction and not by mechanical failure of the transport [4].

The frequency of school transport causes that sometimes several companies have only 20% of its occupation and travel the same routes for different educational institutions, where due to traffic can take up to 1 hour from its origin to its arrival, the solution would be to unify the transports that have similar routes to reduce vehicular traffic [5], this is where it takes a real importance the planning of school transport routes [6].

Having a clear and marked safety of the school transport and the automobile, it is important to carry out periodic reviews to the drivers of documentation and a technical-mechanical review outside those already arranged annually so that it can be known if the seat belts or fire extinguishers are being used or only have them as a luxury accessory without the educational institution and parents know the reality of these tools that can save lives in case of an accident [7]

This research evaluates the quality characteristics that can influence the school transport service in order to create adequate routes and select the best transport to have adequate security for all students who use school transport, taking as a model the educational institution Mega College Carlos Julio Torrado Peñaranda, located in Norte de Santander, Colombia.

II. METHODOLOGY

A sustainable means of transport should be selected for the respective operation of the routes. Where the most suitable characteristics are evaluated to meet the attributes of comfort, capacity, speed, speed, safety and speed.

Speed is related to aspects related to the operation of the system, such as transshipment needs, operation periods, level of supply of services and the way of charging. Physical aspects are related to the conditions of the boarding and transfer points, vehicle information, and the availability of parking spaces at the terminals.

There are four variables that directly affect travel time: origin and stop, waiting at the stop, travel in the vehicle, and travel between the stop and the destination.

The speed values for a homogeneous section are shown in Table 1 where the best level of service is considered.

Table 1. Design Speed Values

CATEGORÍA DE LA CARRETERA	TIPO DE TERRENO	VELOCIDAD DE DISEÑO DE UN TRAMO HOMOGÉNEO V_{TR} (km/h)									
		20	30	40	50	60	70	80	90	100	110
Primaria de dos calzadas	Plano							///	///	///	///
	Ondulado							///	///	///	///
	Montañoso						///	///	///	///	
	Escarpado						///	///	///		
Primaria de una calzada	Plano							///	///	///	
	Ondulado						///	///	///	///	
	Montañoso					///	///	///	///		
	Escarpado					///	///	///			
Secundaria	Plano					///	///	///			
	Ondulado				///	///	///	///			
	Montañoso			///	///	///	///				
	Escarpado			///	///	///					
Terciaria	Plano			///							
	Ondulado		///	///							
	Montañoso	///	///	///							
	Escarpado	///	///								

Source: [8].

The municipality of Abrego has primary roads of one and two carriageways that serve as interconnection between the departments of Norte de Santander and Cesar. It also has secondary and tertiary roads, the terrain in a large area is flat and undulating, for such reasons for the purposes of research speeds marked respectively are appropriate, but because it is a school transport system is decided to establish a maximum speed of 50 km / h.

III. RESULTS

Within the comfort attribute, the following aspects should be taken into account: possibility to travel seated, internal temperature, ventilation, noise, acceleration/deceleration, free height, door width, seating arrangement and material. Finally, some psychological aspects should be taken into account, such as claustrophobia, vertigo, anxiety and dizziness, among others (Table 2 and Figure 1).

Table 1 Quality indicators.

Quality of service	Occupancy density (passengers/m^2)	Minimum travel time (min)
Excellent	All seated	-
Optimum	0 - 1,5	< 90
Well	1,5 - 3	< 60
Regular	3 - 4,5	< 40
Bad	4,5 - 6	< 10
Lousy	> 6	< 2

Source: [9]as cited in [10].

Table (3) also recommends levels of service for urban buses. Level of service D, where up to two persons per seat and a minimum area of 0.46 m2 per person is allowed, provides a reasonable balance.

Table 2 Occupancy and service levels

Peak hour service level	m2 / passenger (approx.)	Passengers / seat (approx.)
A	>1.20	0.00 a 0.50
B	0.80 a 1.20	0.51 a 0.75
C	0.60 a 0.79	0.76 a 1.00
D	0.50 a 0.59	1.01 a 2.00
E(maximum programmed load)	0.40 a 0.49	2.01 a 3.00
F(agglomeration load)	< 0.40	> 3.00

Source: [11]as cited in [10]

Capacity

To calculate the precise passenger capacity of a public transport vehicle can be estimated by means of the following relationship:

$$\mathrm{Si} = \mathrm{Sn} + \frac{An}{Li} \quad (1)$$

Where:

- If = passenger/vehicle
- sn = seats per trolley.
- An = net area.
- Li = net area per standing passenger.
- Sn = 24 passengers.
- An = (0.44*6.49) m2/passenger.
- Li = 0.24 m2/standing passenger.

$$\mathrm{Si} = 24 + \frac{(0{,}44 * 6{,}49)}{0{,}24}$$
$$\mathrm{Si} = 35{,}89 \text{ pasajeros}$$
$$\mathrm{Si} \cong 36 \text{ pasajeros}$$

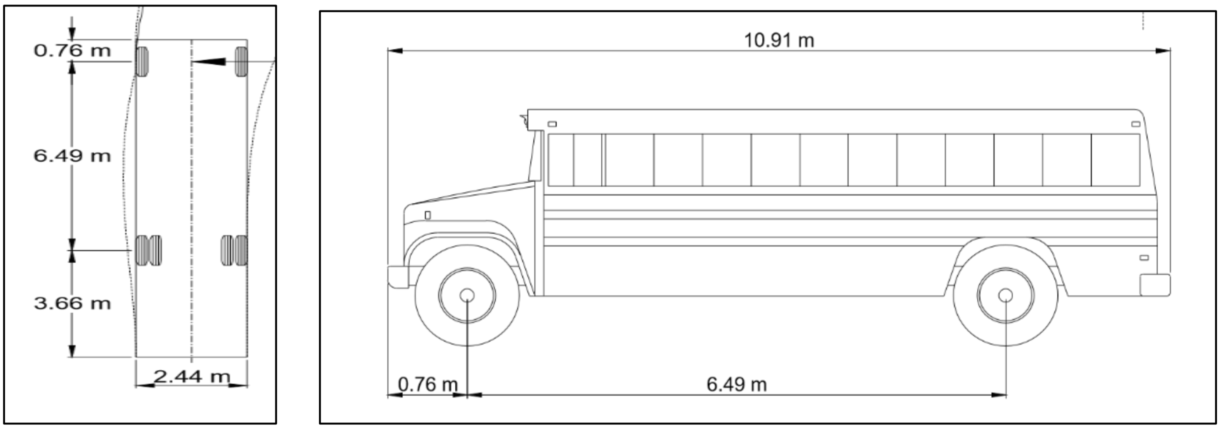

Fig. 11. Medium bus. Source: [8] .

The results of the speed attribute are related to the type of vehicle in which the last trip was made and the duration or time spent in each of the four variables mentioned above. The analysis of the time spent at the bus stop is detailed below (Table 4).

Table 3 Level of service

Level of service	Quality of the service	Time in whereabouts (min)	Relationship of acceptance
A	Excellent	≤ 2	0.17
B	Well	2 - 6	0.50
C	Regular	6 - 12	1.0
D	Bad	12 - 22	1.83
E	Lousy	22 - 27	2.25
F	Unacceptable	> 27	- –

Source: Calculations obtained from the application of the method in the city of Tunja as cited in [10]

Local road safety plan

The systems approach identifies and corrects major design deficiencies through Haddon (Table 5 and Figures 2 and 3).

Fig. 2. High pedestrian hazard.

Fig. 3. Eminent danger from overcrowding.

Table 4 Haddon Matrix.

Phase		**Human Being**	**Vehicles and Equipment**	**Environment**
Before the Shock	Prevention of shocks	Information Attitudes - disability Application of the regulation by the police	Good technical condition Lights Brakes Manoeuvrability Speed control	Design and layout of the public highway Limitation of the speed Pedestrian walkways
	Prevention of trauma during the shock	Use of devices restraint Disability	Occupant restraint devices Other devices security Protective design against accidents	Protective objects anti-shock
Then From the crash	Conservation of life	First Aid Access to medical care	Ease of access Risk of fire	Relief services Congestion

Source:[12] as cited in [8]

Selection of the means of transport

The means of transport selected and presented below is a proposal focused on the care of the environment, in order to generate an environment free of CO2 emissions, healthy, healthy and friendly to the planet earth, this means of transport is called IC Electric Bus Charge (Figure 4 and 5).

In addition, the electric school bus is another example of how the future of transportation is being driven by buses that provide a wide range of powertrain solutions, including electric, propane, and gasoline and diesel propulsion. ChargE includes connected systems and remote diagnostics that support vehicle safety, uptime and more efficient vehicle inspections. ChargeE also features an exclusive and specially designed camera solution, Rosco's IC Bus Full View Camera Technology™, which makes the driver's job easier and safer (Table 6).

Fig. 4. IC Electric Bus Charge: electric school bus. Source: [13]

International Journal of Engineering Research and Technology. ISSN 0974-3154, Volume 14, Number 11 (2021), pp. 1143-1148

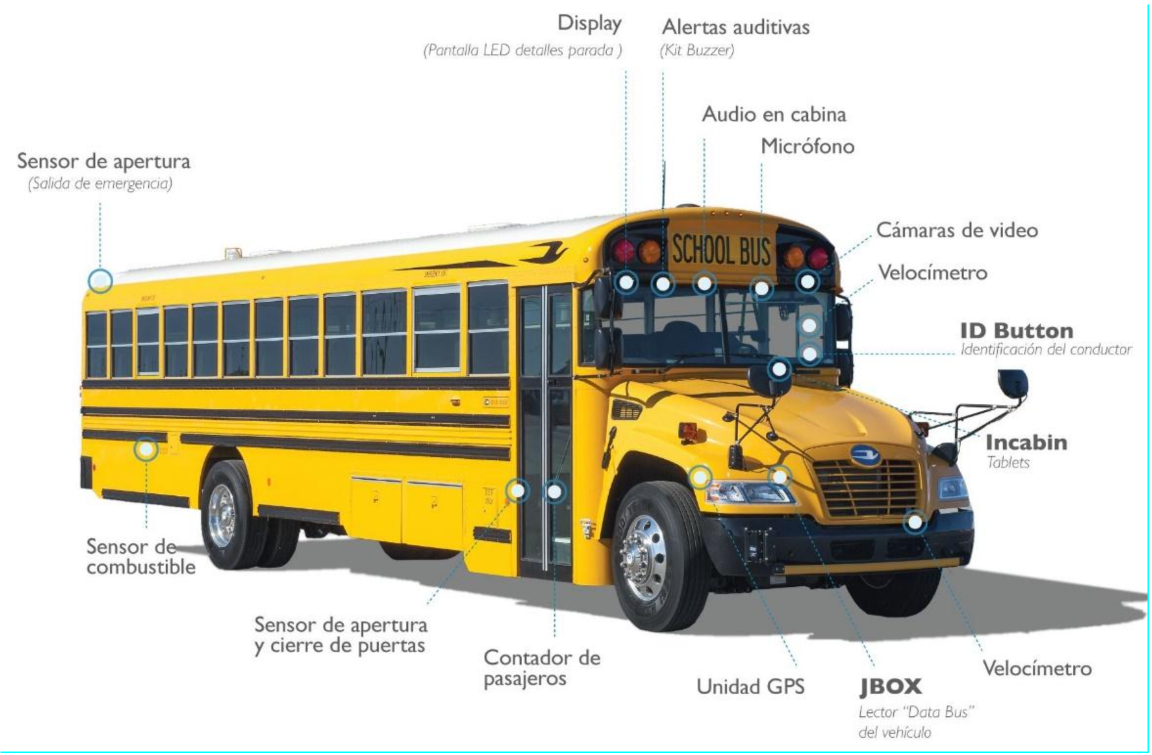

Fig. 5. IC Electric Bus ChargE technology: electric school bus. Source: [13]

Table 6. Attributes of the IC Electric Bus ChargE.

Entrance door location	Behind the front wheels
Passenger capacity (Minimum / typical)	(24)
Engine Location	Front (Under the windshield and on the driver's side)

Source: [13].

It is worth noting that the Ministry of Transportation, in Article 23 of Decree 174 of 2001, "By which the public service of special motorized land transportation is regulated," determined the requirements for school transportation in order to meet the minimum requirements for each driver and provide a safe service for students [14]

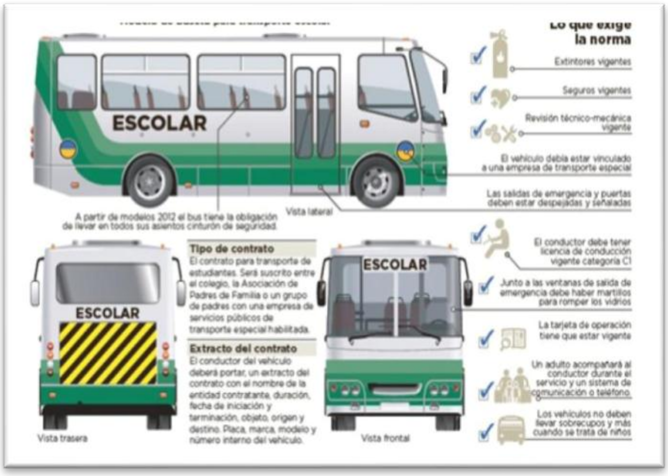

Fig. 6. School transport model based on the regulations of the Ministry of Transport. Source: [15].

IV. CONCLUSION

From the study and analysis carried out, it is concluded with the objective of establishing the school routes, since the routes present a good solution, which makes these the most appropriate to serve the most vulnerable student community. By configuring the quality variables and selecting the appropriate transportation according to the variables analyzed and implemented in the routes will work properly for the benefit of all students.

REFERENCES

[1] V. M. I. Rivera y M. L. Zaragoza, «Análisis De Los Sistemas De Transporte», p. 75.

[2] «Distrito lanza el programa de gestión de la velocidad», *Secretaría Distrital de Movilidad*, oct. 03, 2018. https://www.movilidadbogota.gov.co/web/Noticia/distrito_lanza_el_programa_de_gesti%C3%B3n_de_la_velocidad (accedido nov. 19, 2021).

[3] Í. P. A. Pérez, «Sancionados transportes escolares con sobrecupo», *www.vanguardia.com*. https://www.vanguardia.com/area-metropolitana/bucaramanga/sancionados-transportes-escolares-con-sobrecupo-OGVL144912 (accedido nov. 19, 2021).

[4] «Transporte escolar, el más seguro». https://revista.dgt.es/es/reportajes/2021/01ENERO/0112transporte-escolar.shtml (accedido nov. 19, 2021).

[5] «La logística del transporte escolar: una oportunidad para repensar el sistema - Zonalogística», sep. 11, 2018. https://zonalogistica.com/la-logistica-del-transporte-escolar-una-oportunidad-para-repensar-el-sistema/, https://zonalogistica.com/la-logistica-del-transporte-escolar-una-oportunidad-para-repensar-el-sistema/ (accedido nov. 19, 2021).

[6] J. Seguí, M. Ruíz, F. Guaita, F. Escalas, y A. Bauzà, «La planificación de rutas de transporte escolar a través de un SIG: El proyecto SIGTEBAL», *GeoFocus Rev. Int. Cienc. Tecnol. Inf. Geográfica*, n.º 3, Art. n.º 3, 2003.

[7] «CTP pide a padres verificar que busetas de transporte escolar se encuentran en regla», *La Nación*. https://www.nacion.com/el-pais/servicios/ctp-pide-a-padres-verificar-que-busetas-de/CXZNOTDRMBGBFLYSFWS44XDRFU/story/ (accedido nov. 19, 2021).

[8] «Manual de Diseno Geometrico de Carreteras.pdf». Accedido: nov. 19, 2021. [En línea]. Disponible en: http://artemisa.unicauca.edu.co/~carboled/Libros/Manual%20de%20Diseno%20Geometrico%20de%20Carreteras.pdf

[9] «ND Sistemas Transporte Pub | PDF | Transporte público | Transporte», *Scribd*. https://es.scribd.com/document/344509456/ND-Sistemas-Transporte-Pub (accedido nov. 19, 2021).

[10] W. F. Camargo Triana, *Manual de planeacion y diseño para la administracion del transito y el transporte*. Bogota; Cal & Mayor y Asociados: Alcaldia Mayor ;, 2005.

[11] T. R. Board, *Highway Capacity Manual 6th Edition: A Guide for Multimodal Mobility Analysis*. 2016. doi: 10.17226/24798.

[12] M. M. Peden, *Informe mundial sobre prevencion de los traumatismos causados por el transito: resumen*. Ginebra: OMS, 2004.

[13] «IC Electric Bus chargE: el nuevo autobús escolar eléctrico», *abc*, dic. 04, 2017. https://www.abc.es/motor/reportajes/abci-electric-charge-nuevo-autobus-escolar-electrico-201712041302_noticia.html (accedido nov. 19, 2021).

[14] «Resolución 1558 De Junio 5 De 2014». http://legal.legis.com.co/ (accedido nov. 19, 2021).

[15] E. Heraldo, «Lo que debe cumplir el transporte escolar», *EL HERALDO*. https://www.elheraldo.co/local/lo-que-debe-cumplir-el-transporte-escolar-181409 (accedido nov. 19, 2021).