Study on the Campus Rail Transit – Taking the Xipu Campus of Southwest Jiaotong University as an example

Xiuqi Zhang *

SWJTU-LEEDS Joint School, Southwestern Jiaotong University, Chengdu, China

* Corresponding Author Email: cn21xz2@leeds.ac.uk

Abstract. As most university schools occupy a large area, it is very inconvenient for students to travel between dormitory, teaching building and dining hall. The purpose of this paper is to propose a new campus rail transit model and extend it to university campuses. Therefore, this paper takes Southwest Jiaotong University as an example to establish a campus rail transit that is convenient for teachers and students to reach every place on campus. In this paper, from four aspects of society, economy, environment and technology, the most suitable transportation mode of campus rail transit - suspended monorail is selected by decision matrix, and the campus circle line is drawn. In this case, a total of 7 stations are set up, and the terrain field survey is carried out at the end to analyze the construction difficulties of the north-south two sections of the line. Finally, a campus rail transit route is obtained, which solves the problem of inconvenient traffic and congestion on campus.

Keywords: Suspension monorail; decision matrix; field investigation.

1. Introduction

At present, the number of pedestrians, non-motor vehicles and motor vehicles on campus is generally increasing, resulting in frequent congestion on campus [1]. At the same time, due to the particularity of its location, the campus road is excluded from the scope of "Road traffic Safety Law" adjustment [1]. Therefore, the campus traffic problem is a major problem that troubles teachers and students on campus travel. Taking Southwest Jiao tong University as an example, this paper aims to put forward a new rail transit mode to solve the problems of congestion and inconvenience for teachers and students on campus. At present, Southwest Jiao tong University mainly uses Bus Rapid Transit (BRT) campus transportation. However, due to the congestion on campus and the small number of buses, it is inconvenient for teachers and students to travel between campuses.

Social, economic, environmental and technological aspects are the most important factors to evaluate whether a transportation mode is suitable for the current conditions. The best campus transportation mode is selected by means of decision matrix below. The campus environment is also relatively complex, with trees, grass, lakes and other environmental conditions, which will affect important factors such as geology and topography. Therefore, the analysis of the actual situation of the route and countermeasures are given.

2. Choice of Transportation Mode

2.1. Choice of Decision Martix Index

In order to evaluate the feasibility of the plan, a standard should be established that can be used as a reference basis. This paper formulated external factors conforming to traffic regulations from four aspects: social, economic, environmental and technological, and extracted the requirements therein. The weight ratio is 35% for social, 25% for economic, 15% for environmental and 25% for technological.

From the social point of view, it is necessary to consider the impact of construction and operation on the surrounding residents, the efficiency of transportation mode operation, the safety of passengers, and the service for special groups. First of all, passenger safe is the most basic guarantee of a transportation mode, so the weight is set to 15. Secondly, considering that this program mostly serves university teachers and students, the weight of operation efficiency is set to 10 to ensure efficiency.

Finally, the impact of construction and operation on surrounding residents and the serviceability of special groups are set as 5.

From an economic point of view, the construction cost and operation cost should be taken into account. Unlike other large-scale projects, campus rail transit has a large amount of funds, so it is particularly crucial to choose an economical and efficient mode of transportation. Therefore, the weight of both construction cost and operation cost is set to 10. Secondly, for university teachers and students, most of whom do not have their own savings, fares are also very important in campus rail transit, so the weight of fares is set to 5.

From the perspective of environmental protection, it mainly refers to the pollution caused by the construction and operation of rail transit, including noise pollution, water pollution, air pollution, etc. In this paper, these pollution are summarized as one point - the pollution to the campus environment, and its weight is set as 15.

From the technological point of view, the most important thing to be taken into account in a project is the difficulty of construction and operation. First of all, the difficulty of construction will directly affect the construction period of a project, and too long construction period may cause other serious consequences. Secondly, the difficulty of operation, if the operation process requires a large number of personnel to participate in, or pay a great price, then the difficulty of operation will be greatly affected. Such a mode of transportation will not be adopted. The Durability of a mode of transportation will also be considered as a point, the construction of a campus rail transit, at least to ensure decades of stable operation. Finally considering that Southwest Jiao tong University is located in Sichuan province, and Sichuan Province frequent earthquakes, so durability is also an important part of the choice of transportation.

2.2. Choice of Transprtation Mode

2.2.1. Suspension monorail

Suspended monorail transportation (SMT) plays an important role in alleviating the urban traffic pressure, and its vehicle–bridge dynamic features are significantly different from those of the traditional railway [2]. Suspension monorail has a lower construction cost of about 100 to 150 million yuan per kilometer [3]. The suspension monorail has four cars and each car can carry 200 to 300 people, so the suspension Monorail can also meet the passenger flow demand of campus rail transit. And the suspension monorail has a strong climbing ability, a small turning radius, and can adapt to complex terrain [3].

2.2.2. Metro

Another optional system is the metro, an underground rail transportation system. Since the main lines of the subway are underground, such a transportation system can save ground space and reduce the impact on the ground system. The subway is electrically controlled, which is more environmentally friendly and has lower emissions. However, vibrations from subway operations can have a detrimental effect on houses, and subway operation noise is larger [4]. Therefore, sound walls should be built when building subway lines. The operation speed of the subway is about 80 kilometers per hour, which is highly efficient, but the cost per kilometer is about 700 million yuan.

2.2.3. BRT

BRT system refers to the use of improved bus vehicles, running on public transport lanes [5]. This mode of transportation is also the mode of transportation currently used in our school. The advantage of BRT is that it can effectively alleviate traffic congestion and reduce travel costs. And the BRT cost is low, only 0.5 to 0.7 million yuan per kilometer, but the carrying capacity of each vehicle is only about 30 people, carrying a small number of people, cannot cope with the needs of the peak number of school.

2.3. Decition Matrix

Socially, the suspension monorail is almost the same as metro, but it outperforms BRT in terms of operating efficiency and passenger safety. From an economic standpoint, the suspension monorail is cheaper to build and operate than metro, but slightly more expensive than BRT. From an environmental pollution perspective, both suspension monorail and metro are slightly better than BRT. Finally, from a technical point of view, suspension monorail has the best shake-resistance and durability, but it is difficult to operate. In the end, suspension monorail got 432 points, metro got 381 points, and BRT got 370 points, as shown in Table 1. Therefore, suspension monorail is the best choice for campus rail transit.

Table 1. Desion matrix.

Influence factor	Total weight	Concrete impact	Weight	BRT	Suspension -monorail	Metro
Social	35	The impact of construction and operation on the surrounding residents	5	5	3	3
		Operation efficiency	10	2	5	5
		Passenger safety	15	3	5	5
		Serviceability for special groups	5	4	3	4
Economic	25	Construction cost	10	5	3	1
		Operation cost	10	5	3	1
		Fares	5	5	5	5
Environmental	15	The pollution to the campus environment	15	4	5	5
Technological	25	Construction and operation difficulty	8	5	4	3
		Shake-resistance	8	1	5	4
		Durability	9	3	5	5
		Total	100	42	46	41
		Weight score	-	370	432	381

3. Scheme Section

Based on the distribution of campus accommodation area, teaching area and business District of Southwest Jiaotong University, suspension monorail's routes are divided into east and west lines by connecting the school library and gymnasium. Table 2 shows the basic parameters of the line.

Table 2. Alignment Plan Technical Indicators.

No.	Name	Unit	Indicator
1	Total strength of Main lines	M	3673.234
2	Number of curves		12
3	Total length of curves	M	1092.26
4	Maximum Radius of Curve	M	120
5	Minimum Radius of Curve	M	100
6	Number of station		7

3.1. The Northern Route

The line selection and station distribution of the northern line are shown in Fig. 1. The blue curve is the line distribution of suspension monorail, and the red circle is the station distribution. The Northern line mainly contains four high-traffic areas: north district gymnasium, north commercial district, teaching building, and library. Therefore, in the selection of stations, five stations are selected on the northern line to connect these four areas in series. Such route selection can ease the flow of students and teachers from the teaching area to the business district and the gymnasium, and improve the traffic efficiency between various high-traffic locations on campus.

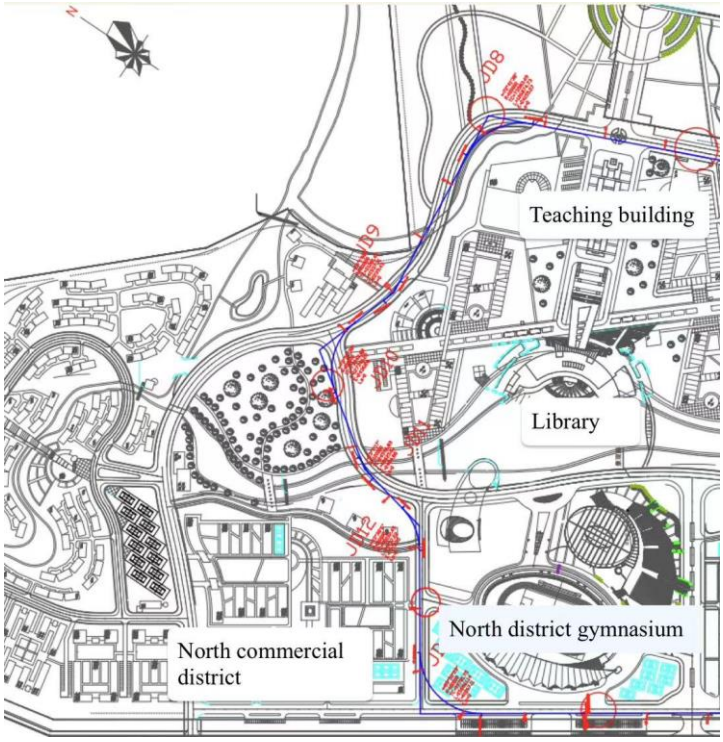

Fig 1. The northern route.

3.2. Field Investigation of the Northern Route

After field investigation, it is found that the road of the northern route is relatively narrow, and the terrain through is more complex, including lakes and buildings, grassland, trees and other places, so it needs to make more turns to reduce the cost. The specific road conditions are shown in Fig. 2, and the lake conditions are shown in Fig. 3. Due to the excessive Angle of the bend, part of the North District stadium may need to be demolished. The portion of the road that crosses the lake would require additional bridge construction to assume the suspension monorail's track. At the same time, considering that the road of the northern line is not spacious, it is necessary to set up suspension monorail Bridges on both sides of the road, so as not to occupy too much road, nor to affect pedestrians and vehicles. However, this may require the installation of specific suspension monorail piers, which may increase the cost.



Fig 2. Road condition.



Fig 3. Lake condition.

3.3. The Southern Route

The line selection and station distribution of the southern line are shown in Fig. 4. The northern line mainly includes four high-traffic areas: south district gymnasium, teaching building, dormitory area, west gate and south gate. Therefore, in the selection of stations, the selection of four stations on the south line can bring teachers and students from all parts of the campus to the west gate and the

south gate, which is convenient for teachers and students of the school to leave school. At the same time, it is convenient for teachers and students to travel from the dormitory area to the teaching building and the gymnasium. The route selection and station selection of the South Line take into account the situation of various high-traffic locations in the South District, which can alleviate the current traffic congestion. It also takes into account the location of the school gate, which can facilitate teachers and students to enter and exit the campus and transfer to other modes of transportation.

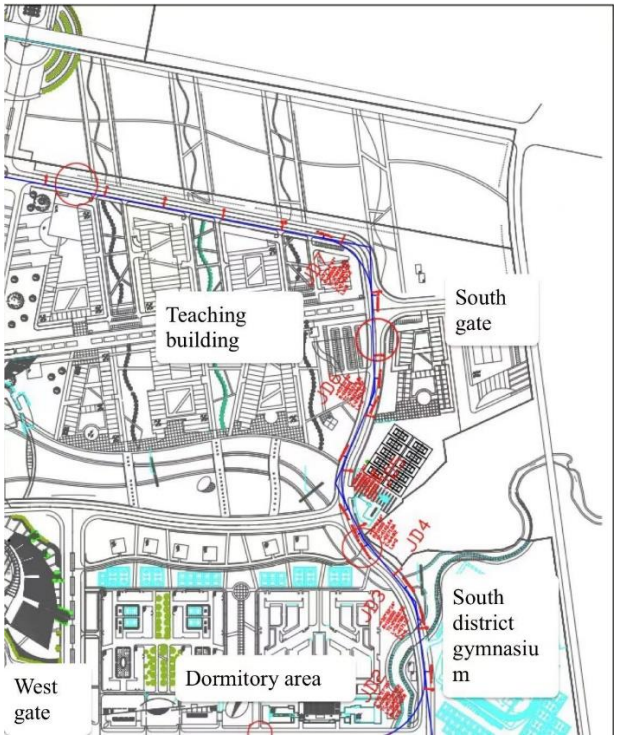

Fig 4. The northern route.

3.4. Field Investigation of the Southern Route

After field investigation, it was found that there were more trees on both sides of the road on the southern route, which could damage the surrounding vegetation during the laying of the track. The specific river situation is shown in Fig. 5. The terrain conditions of the south line are more complicated, and it needs to pass through two rivers, so it is necessary to set up suspended monorail piers in the water. Because the southern route passes through the dormitory area and the gate, there is a large flow of people, so it is necessary to consider the traffic situation during construction and the impact on the surrounding environment during the construction process. The corner from the south district gymnasium to the dormitory requires a large deflection angle, so the track is set on the west side of the road to facilitate the traffic situation and the space situation.



Fig 5. The river condition.

4. Conclusion

This paper studies the suspension monorail, a new type of campus rail transit based on the campus traffic situation of Southwest Jiaotong University.

(1) From the perspective of decision matrix, suspension monorail has great advantages in social, economic, environmental and technological aspects, and is the most optimal mode of campus transportation.

(2) After drawing the main line in cad, the terrain, geology and surrounding conditions of the campus environment were investigated, the different conditions of the campus environment were analyzed, and the problems that might occur in the erection of the track were put forward. The result is a suspension monorail double-loop line that circles the campus and allows students and faculty to travel between high-traffic locations.

(3) All in all, from the perspectives of social, economic, environmental and technology, suspension monorail is an economical and green choice that can not only solve the current congestion and inconvenient traffic on campus. Through drawing and feld investigation, it is proved that suspension monorail can be constructive. Therefore, suspension monorail as a campus rail transit is the optimal choice to solve the current campus traffic problem.

Reference

[1] Fang Zixhuo, Qin Yuyu, Li Ke. University campus road congestion problem analysis and mitigation strategy research. November 19, 2021. Retrieved on May 1. Retrieved from: https://wenku.so.com/d/9bf0d6d4b688e58d1c6c5d608389a32f

[2] He Qinglie, Yang Yun, Cai Chengbiao, et al. Experimental Investigation on Coupled Vibration Features of Suspended Monorail Train–Bridge System under Constant Speed and Braking Conditions. International Journal of Structural Stability and Dynamics, 2021, 21:12.

[3] Zhang Bing. The advantage of suspension monorail. February 1, 2015. Retrieved on May 9, 2024. Retrieved from: https://www.docin.com/p-1049984389.html

[4] Beijing Daily. People's Livelihood Survey | the noise of the subway disturbs the people, why is it difficult to install noise barriers in the later residential area. Jun 4, 2021. Retrieved on May 1, 2024. Retrieved from: https://news.bjd.com.cn/2021/06/04/101344t100.html

[5] Hu Jianmei. Analysis of Bus Rapid Transit System and Its Employment in China. Innovation, 2019, 11(4): 49-51.