

Study on an Estimating Model of Total Area for Land-Saving Driving School in China

Bin Cheng¹, Haifeng Lan^{1*}, Zefeng Huang¹

¹ School of Civil Engineering and Architecture, Southwest University of Science and Technology, Mianyang, China

Email Address

chengbin@swust.edu.cn (B.Cheng), lanhaifeng@mails.swust.edu.cn (H. Lan),
huangzefeng@mails.swust.edu.cn (Z. Huang)

*Correspondence: lanhaifeng@mails.swust.edu.cn (H. Lan)

Received: 28 June 2018; **Accepted:** 20 June 2018; **Published:** 13 August 2018

Abstract:

In recent years, Driving schools in China's cities has maintained an annual growth rate about 7.6%. As a result, there is shortage of land for driver education within urban areas. How to evaluate the scale of driving school scientifically is a problem. Given the fact that the current calculation method of the total land area for driving school in China is low in practical value and easy to lead land waste. Based on the green development concept of saving energy and land, and on the law concerning China's driving examination. This paper considers the area of single training item (α_i), the number of training tasks (n_i), the length of the corresponding training vehicle (β_i), the width of the buffer sections (δ_i), and the number of buffer sections (m_i), these five parameters to establish an estimating model, and examine the land area threshold value of driving schools at all levels. Finally, we selected 100 built driving schools at each level, a total of 300 samples, to prove the scientificity and rationality of the estimating model.

Keywords:

Land-Saving, Land Area, Estimation Method, Driving School, Training Tasks

1. Introduction

With the rapid development of China's economy, the expansion of the city is also becoming more and more widespread [1]. On the one hand, urban erosion of rural land resources and good ecological environment. On the other hand, the China's rapid economic development model caused a lot of land waste in the city [2]. Against this background, China has proposed development strategies such as smart growth and stock planning to enhance the value of land use. Aims to activating the urban stock land, promoting the efficiency of urban parcels and so on [3].

A special land that provides driving training also should be saved. In recent years, the number of Chinese driving school training institutions has been maintaining at a growth rate of 7.6%, from 9,500 in 2010 to 15,903 in 2017, an increase of 44.6% in recent 5 years. It is expected that the number of driving training institutions in China

will reach 19763 by 2020 [4]. Due to the lack of rules and regulations in site design and planning of driving training institutes, there are a series of problems existing in driving schools. In particular, there are varying degrees waste of land for driving school[5]. The area requirement of each driving school is not less than 37000m². Now it occupies about 2.06 % in urban built-up areas in China at least. In Japan, there are 1178 driving schools training institutions with a total land area of about 9.42km², Accounting for 0.52 % of Japan's built-up area [6]. There are 807 driving schools training institutions in South Korea with a total land area of about 9.21km², accounting for 0.74 % of the built-up area of South Korean cities [7]. Obviously, China's driving school occupies much more land than South Korea and Japan. Under such a circumstance that China advocates saving land, the scale of land for driving schools should also be restricted. Driving schools should ensure that lands are intensified and functions are rationalized [8]. Therefore, how to forecast the scale of driving school efficiently and accurately to guide the transfer of driving school land will be of great significance to the intensive urban land use and to alleviate the contradiction of urban land use [9].

1.1. Chinese Driving Schools' Test Tasks and Classification Criteria

There are two main systems for obtaining driver's license internationally. One is that after passing the assessment of the knowledge of road safety driving, the corresponding road test can be carry out on the urban road. The other is that after passing the examination of the knowledge of road safety driving, it is necessary to field test on a specific site before the urban road test, that needs driving training institutions provide a specific venue to for driving learners to field training or exams. At present, this driving school test system is mainly practiced in Asian countries [10].

In China, On-site driving test is a necessary part to obtain the driver's license, and the purpose is to test the operator's driving skills and ability to judge the space position in the vehicles [5]. Small cars and small automatic cars (hereinafter collectively referred to as the “car”) test tasks are: reversing parking, start at a slope, side parking, S-turn, and T-turn, a total of 5 tasks. Test tasks for tractors, large buses, large trucks, medium buses (hereinafter collectively referred to as the “large vehicle”) include: shift parking, side parking, starting at slope, unilateral bridge, S-turn, T-turn, consecutive turn, limited wide doors, continuous obstacles, narrow road U-turn, stimulated highway, emergency stop, tunnel passing, wet slippery road, and ups and downs road, a total of 16 tasks. In accordance with the driving school classification provisions. A level 1 driving school is more than 7 hectares with the total number of training vehicles not less than 80. A level 2 driving school is more than 5.7 hectares with a total number of training vehicles not less than 40, and a level 3 driving school is more than 4.7 hectares with the total number of training vehicles not less than 20.

1.2. The Deficiency of the Current Estimating Model for Driving School Area

The current formula to calculate the total area of driving training tasks as (1) shows:

$$S_T \geq \sum_i^k (a_i \times n_i) + \sum_i^k (1.5 \times \delta_i \times \beta_i \times m_i) \quad (1)$$

Where, the total area of the tasks is (S_T), the area of individual tasks is (a_i), the number of corresponding tasks is (n_i), the width of the buffer section is (δ_i), the length of the corresponding vehicle model is (β_i), the number of buffer sections is (m_i), and the types of the training vehicles(k), the 1.5 means that the buffer sections between taining tasks are more than 1.5 times of length of the vehicles generally.

The following deficiencies are identified when using the current estimating model to predict the area of driving school training tasks

(1)The method of determining the number of buffer sections is not applicable

The parameter of the number of buffer sections (m_i) is contained in the formula, but the value of this parameter is related to the number of all kinds of training tasks. In fact, the connection between buffer sections and training tasks are different in various training sites of driving school, so the quantitative relationship between them is also different. There by, a new method of calculation is required to perfect this formula.

(2)Lack of constraints on the number of training tasks

If there are no regulations on the number of driving tasks (n_i), that will mean some training programs are unused and some training programs are in short supply. Therefore, the whole training area is very chaotic, affecting the land use efficiency.

(3)Inaccuracy of δ_i , β_i

The value of δ_i and β_i is related closely to the model size of the test vehicles. However, the value of δ_i and β_i as adopted in the formula is a minimum requirement. The exact range of value is not specified in accordance with the size of different vehicle models. Therefore, there is a certain error between predicted results and actual land use.

1.3. Problems Solved by the New Prediction Model

Because the current estimating model for the area of a driving school has above deficiencies. It reduce the practical significance greatly, and also may cause the land to be wasted at all levels of driving schools. Therefore, this paper analyzes the potential of the mathematical relationship between the total number of the driving tasks $\sum(n_i)$ and the total number of buffer sections $\sum(m_i)$, to solve the problem that buffer sections can't be calculated accurately. Then, The proportion of the actual time of the tasks should be used to regulate the number of training tasks , so as to improve the efficiency of the use of the site. Finally, By investigating and summarizing the type of vehicles used in training and test on the market, the sizes of the training vehicles are used to further accurately evaluate the value of δ_i and β_i . These aim to improved prediction accuracy of the model.

2. Methodology

The estimating model of the total area for land-saving driving school selected $\alpha_i, n_i, \beta_i, \delta_i, m_i$ as the five parameters to build the model. The value and method of the five parameters are detailed in the explanations that follow.

2.1. The Area of a Single Training Item

The area of a single training item is a relatively fixed value. Graphic design and size requirements for various training tasks are shown in Figure 1, where β_i represents the length of the corresponding training vehicle, and θ_i represents the width of the corresponding training vehicle.

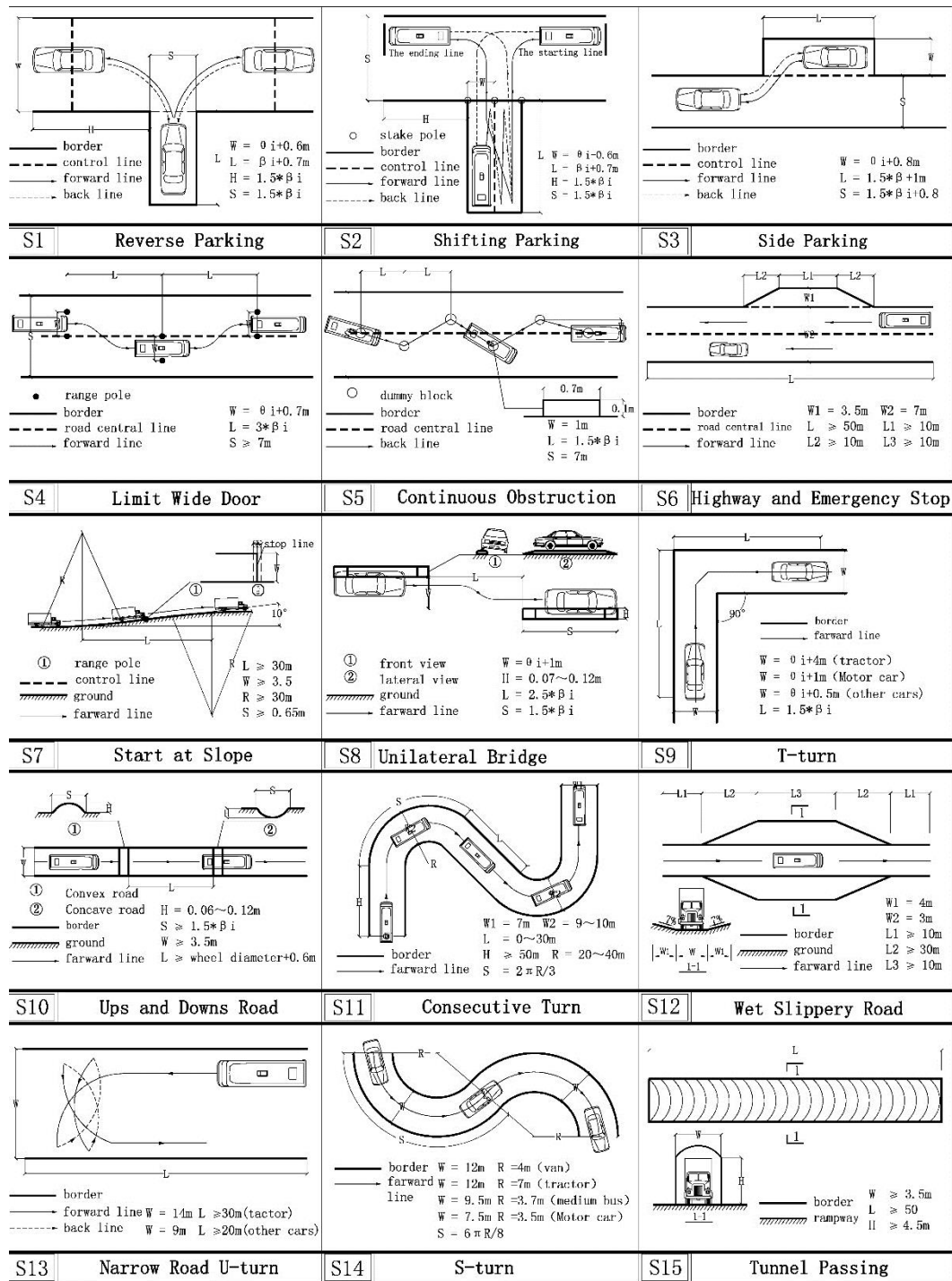


Figure 1. Graphic design and size requirements of training tasks.

2.2. The Number of Buffer Sections

In the paper, 100 samples are taken from each level, in a total of 300 samples. The 300 samples come from all prefecture-level cities in China and are distributed within the provinces of China. They contain a variety of driving schools which constructed under the influence of climate, topography, sunshine and other conditions, in order to reflect a representative sample selection [11]. The distribution of the samples chosen is shown in Figure 2. The total number of training tasks (n_i) and the total number of buffer sections (m_i) are counted respectively. Firstly, the covariance of these two

groups of data are used to judge the correlation coefficient of the two groups of data to their relevance. After that, linear regression analysis will be done on the two sets of data to find out the linear relationship between them.



Figure 2. The distribution of driving school samples.

(1) Validation of correlation

Covariance and the correlation coefficient are two measures to determine the two random variables X , Y , and they are important evidence of an existing a linear relationship in algebra and probability theory [12]. The two sets of statistical data are imported into Excel, and calculate the covariance between the two sets of data to verify the correlation between the two sets of data. The formula for calculating the covariance and correlation coefficients used in this process is shown in (2), and the calculation results of the correlation coefficients are shown in Table 1.

$$\begin{cases} \text{Cov}(m, n) = E(mn) - E(m)E(n) \\ \rho_{mn} = \frac{\text{Cov}(m, n)}{\sqrt{D(m)}\sqrt{D(n)}} \end{cases} \quad (2)$$

In the formula, $\text{Cov}(m, n)$ is the covariance of variables m and n . $E(m)$ and $E(n)$ are the mathematical expectation of m and n variables. ρ_{mn} is the correlation coefficient of m and n . The closer its absolute value is to 1, the higher is the correlation. $D(m)$ and $D(n)$ are the standard deviations of m and n , respectively.

Table 1. The correlation coefficient of t training tasks to the buffer sections.

Vehicle model	Small car	Large bus	Large truck	Medium bus	Tractor
The correlation coefficient between m and n	0.993	0.882	0.962	0.894	0.900

According to the results, it can be seen that the correlation coefficient between $\sum(mi)$ and $\sum(ni)$ is above 0.88, and it can be said that there is a very high correlation between the training items and the buffer sections [12].

(2) Regression analysis

The two sets of data are made multiple types linear regression analysis. The

logarithmic form is selected as a linear regression equation, because of its highest linear fitting degree (R^2), the analysis results shown in Figure 3, Figure 4. According to Table 2 and Table 3 the analysis of variance (ANOVA) results show that the P-value is less than 0.01, and F is greater than F-crit, the formula has significant statistical significance. The above analyses have verified the credibility of the linear regression. [13]

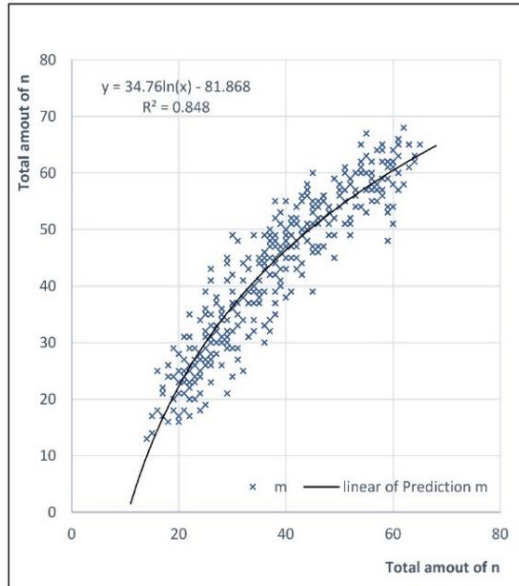


Figure 3. Linear analysis for car.

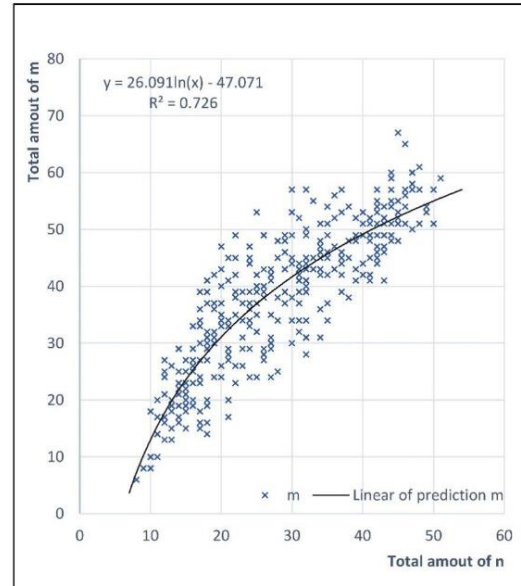


Figure 4. Linear analysis for large vehicle.

Table 2. ANOVA of figure 3.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Group	7300.75	1	7300.76	45.02	9.9E-11	3.87
Within Group	47996.83	296	162.15			
Total	55297.59	297				

Table 3. ANOVA of figure 4.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Group	6358.70	1	6358.70	33.17	1.35E-08	3.86
Within Group	114244.68	596	191.69			
Total	120603.48	597				

(3) The formula for calculating the total number of buffer sections

Through the curve of linear regression analysis, the relationship between the total number of training tasks and the number of buffer sections can be obtained by mathematical calculation. The formula is shown in (3).

$$\sum_i^k(m_i) = \begin{cases} 26.091 \ln[\sum_i^k(m_i)] - 47.071, & i \text{ for car's tasks} \\ 34.76 \ln[\sum_i^k(m_i)] - 81.868, & i \text{ for large vehicle's tasks} \end{cases} \quad (3)$$

The number of corresponding training tasks is n_i , the number of corresponding buffer sections is m_i , the number of types of the coach vehicles is k .

2.3. The Allocation of Different Training Tasks in the Training Field

The method for determining the number of training tasks is to calculate the actual time required to complete corresponding tasks and then obtain the proportionate relationship among the number of different training tasks by means of conversion and rounding. According to the actual carrying capacity of driving schools at all levels, the reasonable configuration of different training tasks are calculated.

(1) Sample data collection and collation

Due to the large number of samples, each driving school can't be field-tested. This paper adopts the method of stratified sampling. A sample of driving schools at each levels are randomly selected in each province to reflect the overall situation of driving schools in various provinces. The time taken for each training task of the selected samples are collected 5 times. Then, to detect the collected data whether it conforms to the Pauta criterion (4), and eliminating outliers in data [14].

$$\left\{ \begin{array}{l} \bar{t} = \sum_{i=1}^n (t_i/n) \\ r_i = t_i - \bar{t} \\ \sigma = [\sum_{i=1}^n (r_i^2/n - 1)]^{1/2} \\ |t_i - \bar{t}| > 3\sigma, t_i \text{ is gross error and should be discarde} \\ |t_i - \bar{t}| < 3\sigma, t_i \text{ is normal data and should be retained} \end{array} \right. \quad (4)$$

Where: $\bar{t}$ is the average time spent on the corresponding tasks. t_i is the time taken to collect the corresponding tasks. n is the frequency of collected data. r_i is the residual error. σ is the root mean square deviation.

(2) The number of training tasks

After processing the above data, the average time-taking ($\bar{t}$) of each task can be obtained. The proportion of the time consumption in each training task will be calculated. Taking into account the vehicle capacity of driving schools at different levels the number of corresponding training tasks can be calculated. The configurable numbers of tasks are shown in Table 4 and Table 5.

Table 4. Cars' training tasks configuration quantities.

No.	Trainin g tasks	Amount			No.	Trainin g tasks	Amount		
		L1	L2	L3			L1	L2	L3
1	S1	16	8	4	4	S7	2	1	1
2	S9	1	1	1	5	S3	16	8	4
3	S14	1	1	1					

Table 5. Large vehicles' training tasks configuration quantities.

No.	Trainin g tasks	Amount			No.	Traini ng tasks	Amount		
		L1	L2	L3			L1	L2	L3
1	S2	16	8	4	9	S10	1	1	1
2	S5	4	2	1	10	S1	2	1	1
3	S9	2	1	1	11	S6	1	1	1
4	S7	4	2	1	12	S12	1	1	1
5	S3	16	8	4	13	S15	1	1	1
6	S8	4	2	1	14	S11	1	1	1
7	S4	1	1	1	15	S13	8	4	2
8	S14	2	1	1	16				

2.4. The Length of the Corresponding Training Vehicle

The survey results of the vehicles used for test show that the 82.6% large vehicles for training and test are the Dongfeng original series of products, and the 91.3% cars for training and test are FAW-Volkswagen Jetta. Table 6 shows the information on the size, brand model, etc. of the vehicles that meet the requirements in the survey. β_i represents the length of the corresponding training vehicle, and θ_i represents the width of the corresponding training vehicle, and h_i represents the height of the corresponding training vehicle.

Table 6. Various types of training and test vehicles information.

Model	Tractor	Large Buses	Large Trucks	Medium Bus	Car / Automatic Car
Length Requirements	$\geq 12\text{m}$	$\geq 9\text{m}$	$\geq 9\text{m}$	$\geq 5.8\text{m}$	$\geq 4\text{m}$
Brand	Dongfeng	Dongfeng	Dongfeng	Dongfeng	Faw-volkswagen
Model	E5100xlhf3	Eq5100xlhtv	Eq5120xlhf7	Eq6606lt1	Jetta cex/Jetta cl
$\beta_i * \theta_i * h_i$ (mm)	12000*2470*2480	9000*2480*3160	9000 * 2480*2600	5990 * 2250 * 2780	4501*1704*1469

2.5. The Width of Buffer Sections

The width of the motor vehicle lane includes the width of the vehicle body and the lateral swinging distance on both sides. The lateral swinging distance depends on factors such as vehicle speed, road surface quality, driving skill and traffic order [15]. According to international experience, combined with the actual survey data of Chinese cities, taking into account the coincidence degree between the relevant calculation theory and other references, Jurij A.Poljakov (5) in "Traffic Engineering Manual" is used to calculate these values [16].

$$\begin{cases} D_1 = 0.7 + 0.02(V_1)^{\frac{3}{4}} \\ D_2 = 0.4 + 0.02(V_1)^{\frac{3}{4}} \\ D_N = D_1 + \frac{D_2}{2} + \theta_i \end{cases} \quad (5)$$

Where: V_1 is the speed of the road, km / h. D_1 is the lateral swing distance between vehicles in the same direction. D_2 is the swing distance of the side of the vehicle. D_N is the width of a single lane. θ_i is the width of the corresponding training vehicle.

In order to meet the requirements of safety and adaptability to different speed, all the roads within the driving school training site take the form of one-way and two-lane. With the limited speed of 15km/h, the distance between the two sides of various vehicles can be calculated [17]. Coupled with the horizontal spacing of the curbs on the edge of the driveway, 0.25~0.5m is generally adopted to calculate the recommended value of the width of the buffer section (δ_i), as shown in table 7.

Table 7. Recommended value for the width of buffer section.

Vehicl Model	Large Vehicle				Car
	Tractor	Large bus	Large truck	Medium bus	Car/ Automatic Car
Result(m)	6.73	6.59	6.68	6.53	5.54
$\delta_i(\text{m})$	7.0				6.0

3. Result

3.1. Estimating Model Calculation Formula

By using the above methods and values of the five influencing factors, a new estimating model of the total area of a driving school training tasks can be constructed as shown in formula (6).

$$\begin{cases} S_T \geq \sum_i^k (a_i \times n_i) + \sum_i^k [1.5 \times \delta_i \times \beta_i \times f(n_i)] \\ f(n_i) = \sum_i^k (m_i) \end{cases} \quad (6)$$

Where, the total area of the tasks is S_T . The area of individual tasks is a_i . The number of corresponding tasks is n_i . The width of the buffer section is δ_i . The length of the corresponding model is β_i . The number of buffer sections is m_i , and the number of types of the coach vehicles is k .

3.2. Validation of Estimating Model

In order to avoid the problem that an objective comparison can't be made because of the different number of tasks, a comparison is made on the area of the training tasks required for per vehicle at each level. The calculation formula is shown in (7).

$$S_P = \frac{S_T}{C_T} \quad (7)$$

Where: S_T is the total area of the project facilities. C_T is the capacity of vehicles that can be trained at the same venue. S_P is the average demand area per vehicle.

In order to verify the accuracy and land-saving of the estimating model of the driving school, this paper selected 100 standard driving schools at each level as the samples, (a total of 300 samples). By distinguishing between cars and large vehicles, it calculated per vehicle actual required training land area, and compare these results with the prediction of the estimating model and the current national standard. As shown in Figure 5, Figure 6. In order to presentation the distribution of data more directly, the data of the actual area are represented in boxplot, where marked minimum value, whisker lower limit, median, whisker upper limit, maximum. Between the whisker lower limited and whisker upper limits contain 25-75% of the data, which reflects the concentration of the data. [18] It can be seen that the actual area required by per vehicle fluctuates within a certain range and decreases with the level of driving school. The estimating model of land-saving prediction area is also present this law. However, the data in the current national standard are constant because the area of the driving school site increases linearly with the number of cars. Obviously, the predicted land use area of the land-saving estimating model is more in line with the actual land area for standard driving schools at all levels. The model predicts the area required for per vehicle is slightly higher than the actual needs of all levels of driving schools, that meet the actual needs of the area. The comparative analysis shows that the land-saving estimating model is more economical using land than the current national standard. The rates of saving land for car, is 9.06%, 5.31% and 3.12% respectively, for large vehicle the saving land rate is 14.5%, 9.10%, and 3.30% respectively.

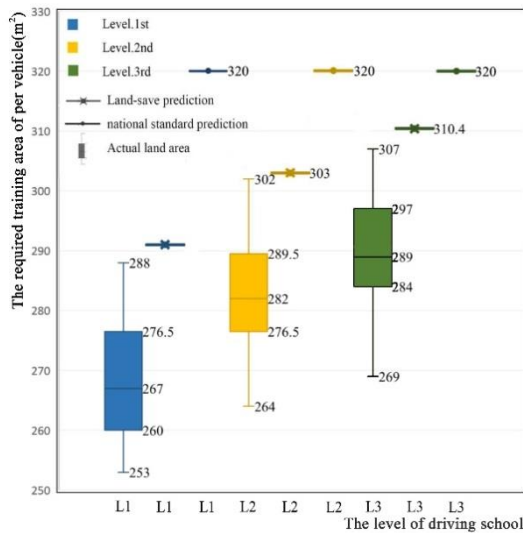


Figure 5. Comparison chart of land area for car.

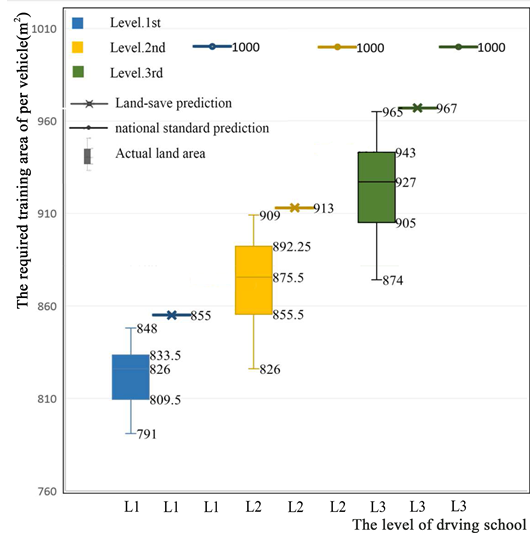


Figure 6. Comparison chart of land area for large vehicle.

4. Discussion

Different layouts of training tasks on the site demand different land area. The current main styles of layouts of driving school are Karting and Ring, as shown in Figure 7, Figure 8. The karting road design pattern is designed as a chain, where tasks along the entire training road, each training tasks is connected compactly, the area of the buffer section is relatively small, but the area for arranging training tasks is relatively large. However, the Ring design pattern makes full use of the site, but it also increases the area of the buffer section [5]. The land-saving model statistical data of m_i and n_i , which are used to build a linear regression relationship to calculate the number of buffer sections. Both styles of layouts are included in the statistical sample, so the result of the prediction is a compromise result. Among the statistical samples, the number of Karding-style layout is 91, accounting for 27% of the total, and the number of Ring-style layout is 209, accounting for 73% of the total. Of course, this scale is closely related to the selection of samples, which inevitably has great subjectivity. Increasing the number of statistical samples is important to improve the validity of the estimating model [19].

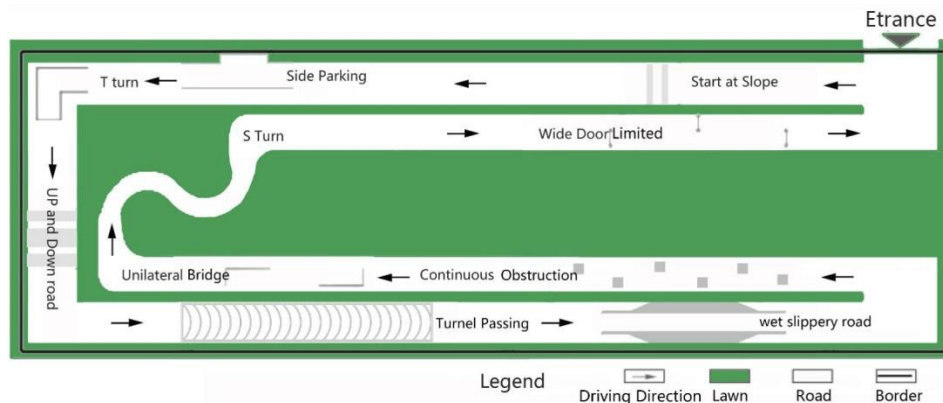


Figure 7. The Kading layout.

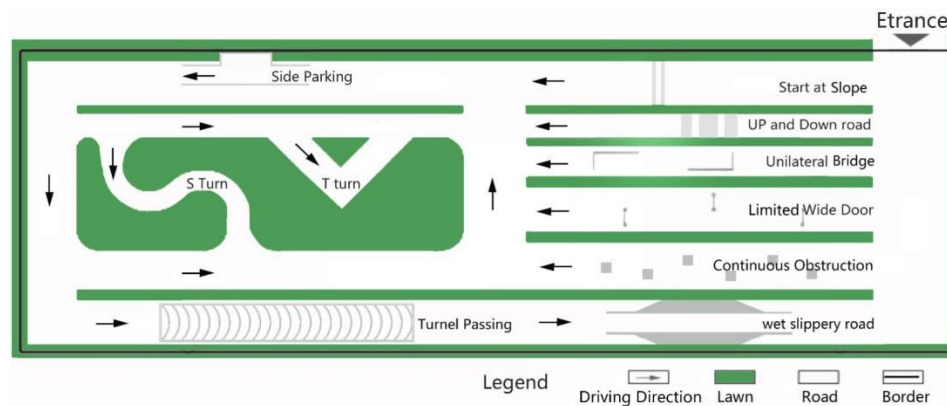


Figure 8. The Ring layout.

In addition, For predictive models affected by multiple factors, Jiang et al.[20] proposed a multi-criteria access selection algorithm is presented to solve the built model. The idea of model construction in this paper is similar, but it lacks further simulation analysis to verify the validity of the estimating model.[21]. The prediction model is the result of linear regression of statistical data. If the deep learning method can be used to analyze a large number of driving schools sites, the accuracy of the prediction model will be further improved.[23].

5. Conclusions

This paper summarizes the shortcomings of the current Chinese national standard method to predict the area of driving schools and amends the original estimating models for these deficiencies. The five factors that affect the area of driving training tasks are examined, and the value of each factor is determined according to the principle of land-saving and practicability. The calculation results show that the land-saving estimating model is more land-conserving than the current national standard forecasting model. The rates of saving land are 9.06%, 5.31% and 3.12% respectively in predicting the area for cars, and the land-saving rates for large vehicles are 14.5%, 9.10%, and 3.30% respectively. Consequently, it plays a positive role in alleviating the contradiction between urban development and urban land use conservation.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgments

The equipment and financial support provided by the School of Civil Engineering and Architecture of Southwest University of Science and Technology, in China. The market research work and basic data provided by Beijing zhilin information technology co., LTD.

References

- [1] Huang, L.; Yan, L.; Wu, J. Assessing urban sustainability of Chinese megacities: 35 years after the economic reform and open-door policy. *Landsc. Urban Plan.* 2016, *145*, 57-70, DOI: 10.1016/j.landurbplan.2015.09.005.

- [2] Zaman, A. U.; Lehmann, S. Urban growth and waste management optimization towards “zero waste city.” *City, Cult. Soc.* 2011, 2, 177-187, DOI:10.1016/j.ccs.2011.11.007.
- [3] Hao, L.; Lei, X.; Yan, Z.; ChunLi, Y. The application and implementation research of smart city in China. *Int. Conf. Syst. Sci. Eng.* 2012, 288-292, DOI:10.1109/ICSSE.2012.6257192.
- [4] China Industrial Research Network 2018-2025 driving school market depth investigation and research and development prospect analysis report. Available online: <http://www.cir.cn/2014-01/JiaXiaoHangYeYanJiuBaoGao/> (accessed on Jan 1, 2018).
- [5] Yu, Y.; Cheng, B. Study on optimization design of driving space with land saving type. *Anhui Archit.* 2012, 2, 51-52, DOI:10.16330/j.cnki.1007-7359.2012.01.093.
- [6] Japan Federation of Authorized Drivers School Associations List of Japanese Driving Schools. Available online: <http://www.zensiren.or.jp/nwide/nwide.html> (accessed on 7 Dec 2017).
- [7] Korean National Police Agency 2017 Driving School Education Results. Available online: <https://www.police.go.kr/main.html> (accessed on 8 Jan 2017).
- [8] Huang, Z.; Gao, Y. Self-improvement of driving school market competition. *Commun. Sci. Technol. Heilongjian.* 2014, 2, 168-169, DOI:10.16402/j.cnki.issn1008-3383.2014.11.142.
- [9] Wang, J.; Chen, Y.; Shao, X.; Zhang, Y.; Cao, Y. Land-use changes and policy dimension driving forces in China: Present, trend and future. *Land use policy*, 2012, 29, 737-749, DOI:10.1016/j.landusepol.2011.11.010.
- [10] Classen, S.; Monahan, M.; Brown, K. Indicators of simulated driving skills in adolescents with attention deficit hyperactivity disorder. *Open J. Occup. Ther.* 2014, 2, 1-9, DOI:10.15453/2168-6408.1066.
- [11] Yoshida, H.; Omae, M. An approach for analysis of urban morphology: Methods to derive morphological properties of city blocks by using an urban landscape model and their interpretations. *Comput. Environ. Urban Syst.* 2005, 29, 223-247, DOI:10.1016/j.compenvurbsys.2004.05.008.
- [12] Evans, A. C. Networks of anatomical covariance. *Neuroimage*, 2013, 80, 489-504, DOI:10.1016/j.neuroimage.
- [13] Altman, N.; Krzywinski, M. Points of Significance: Simple linear regression. *Nat. Methods.* 2015, 12, 999-1000, DOI:10.1038/nmeth.3627.
- [14] Lewis-Evans, B.; Charlton, S. G. Explicit and implicit processes in behavioural adaptation to road width. *Accid. Anal. Prev.* 2006, 38, 610-617, DOI:10.1016/j.aap.2005.12.005.
- [15] Ma, Y.; Zeng, Y.; Yang, X. Impact of Lane Width on Vehicle Speed of Urban Arterials. Tenth International Conference of Chinese Transportation Professionals (ICCTP), Beijing, China, 2010.
- [16] Manuel, A.; El-Basyouny, K.; Islam, M. T. Investigating the safety effects of road width on urban collector roadways. *Saf. Sci.* 2014, 62, 305-311, DOI:10.1016/j.ssci.2013.09.005.

- [17] Qiu, L.; Zhu, J.; Pan, Y.; Hu, W.; Amable, G. S. Multi-criteria land use suitability analysis for livestock development planning in Hangzhou metropolitan area, China. *J. Clean. Prod.* 2017, 161, 1011-1019, DOI:10.1016/j.jclepro.2017.07.053.
- [18] Hubert. M.; Vandervieren, E. An adjusted boxplot for skewed distributions. *Comput Stat Data An.* 2008, 12, 5186-5201. DOI:10.1016/j.csda.2007.11.008
- [19] Irwin, E. G.; Geoghegan, J. Theory, data, methods: developing spatially explicit economic models of land use change. *Agric. Ecosyst. Environ.* 2001, 85, 7-23, DOI:10.1016/s0167-8809(01)00200-6.
- [20] Jiang; D.; Huo, L.; Lv, Z.; Song, H.; Qin, W. A joint multi-criteria utility-based network selection approach for vehicle-to-infrastructure networking. *IEEE T Intell Transp.* 2018, 99, 1-15, DOI: 10.1109/TITS.2017.2778939.
- [21] Jiang, D.; Xu, Z.; Chen, Z., Han, Y.; Xu, H. Joint time-frequency sparse estimation of large-scale network traffic. *Comput Netw.* 2011, 15, 3533-3547, DOI:10.1016/j.comnet.2011.06.027.
- [22] Nie, L.; Jiang, D.; Guo, L.; Yu, S. Traffic matrix prediction and estimation based on deep learning in large-scale IP backbone networks. *J Netw Comput Appl.* 2016, 76, 16-22, DOI: 10.1016/j.jnca.2016.10.006.



© 2018 by the author(s); licensee International Technology and Science Publications (ITS), this work for open access publication is under the Creative Commons Attribution International License (CC BY 4.0). (<http://creativecommons.org/licenses/by/4.0/>)