AMSE JOURNALS-AMSE IIETA publication-2017-Series: Modelling D; Vol. 38; N°1; pp 26-35
Submitted Dec. 2017; Revised Jan 15, 2018, Accepted Jan. 30, 2017

The Analysis of the Sharing of Bicycles

*C. Feng, *X. Li, *,**J. Liang

*Guangdong University of Science and Technology, Dongguan 523083, China
(57079540@qq.com)
**School of Applied Mathematics, Guangdong University of Technology,
Guangdong 510080, China

Abstract

This paper, based on the ecology of Shared bicycle supply equation, using three kinds of methods, analysis of Shared bicycle quantity statistics, obtained the reasonable quantity, to reduce the operating cost sharing bike, reduce occupied city public area, and reduce the urban traffic crowded. It has very important significance .The first method: according to the ecology of Shared bicycle supply equation, under the condition of the damping parameters k, used quantity of Shared bicycle supply x are constant, to calculate the Shared bicycle supply y,which is an ideal and identified as sharing bicycle supply which is as the mathematical expectation. And then sharing a small part of the bicycle quantity was collected, and it is assumed that in the test sample, which is as a subsample, to determine whether the quantity of the bicycle is acceptable.

The second method: based on the ecological equation of the Shared bicycle to obtained a series $y_i(i = 1,2,3\cdots)$, It is assumed that in the test sample, as a subsample, and it is used to comparison between the actual and the observed actual volume of the operation is made to estimate whether the actual volume is reasonable in which the damping parameters k, is constant.

The third method: obtained a series $y_i(i = 1,2,3\cdots)$, based on the ecology of shared bicycle supply equation to comparison between the actual and the observed actual volume of the operation, but the damping parameters k is various.

Key words

Ecological equation, limit cycle, hypothesis test.

1. Introduction

With the rapid expansion of urban population, the problem of urban transportation lies before us: that too much traffic jams, and urban noise harms and air pollution, in which restricts the development of cities. The population is too large to make the vehicle seem inadequate. To solve these problems, people have come up with many methods :

1) propose to enlarge the effective use of the road [1-10].

2) propose to reduce the number of vehicles on the road [11−12] and so on. These have played a big role in reducing urban traffic pressure. At present, the sharing of bicycles in China has received a warm welcome. He does not use oil resources, does not pollute the air, solves the last mile of people's commutes. The merchants seized the opportunity and launched a large number of Shared bikes for the public to use.

But here is no corresponding increase in the amount of use. There are plenty of unused bikes parked in and around the station: too much spending and too much public space. It creates another blockage. This is the problem to be solved in this paper.

Article [13] simulation of the unused bicycle parking lot y, the relationship between the application of the bicycle and the relationship between x, and the ecological equation of the Shared bicycle:

$$\frac{dx}{dt} = y - (x_2 -)$$

$$\frac{dy}{dx} = - x \qquad (1)$$

It has following lemma:

Lemma 1.

For equation (1), if $k > 0$ there is a unique limit cycle, and is a stable limit cycle, and its corresponding the example:

Example:

At a certain subway exit in Guangzhou of China, the actual usage of the Shared bicycle.is $x = 50$, and usage speed of bicycle is $\frac{dx}{dt} = 10$. It is to be considered the following damping works, which are to cases, and its parameter of damping work $k = 2480$ **:**

1) $F(x) = x(x^2 - k) = x(x^2 - 2480)$ (2)

2) $F(x) = kx = 248x$ (3)

Firstly, case 1), and from the first form in equation (1), we have

$$y = \frac{dx}{dt} + x(x^2 - k) \tag{4}$$

the share dropping y, which is the reasonable amount of release is computed;

$$y = \frac{dx}{dt} + x(x^2 - k)\Bigg|_{\substack{\frac{dx}{dt}=10 \\ x=50 \\ k=2480}} = 1100 \,. \tag{5}$$

and the reasonable amount is $y = 110$. It means that the will tend to a limit cycle. This ordinate y =110 of the sharing of bicycle quantity is reasonable. For a long time in the future, only the smaller wave will swing, not overinflated and out of control. The diagram is as follows:

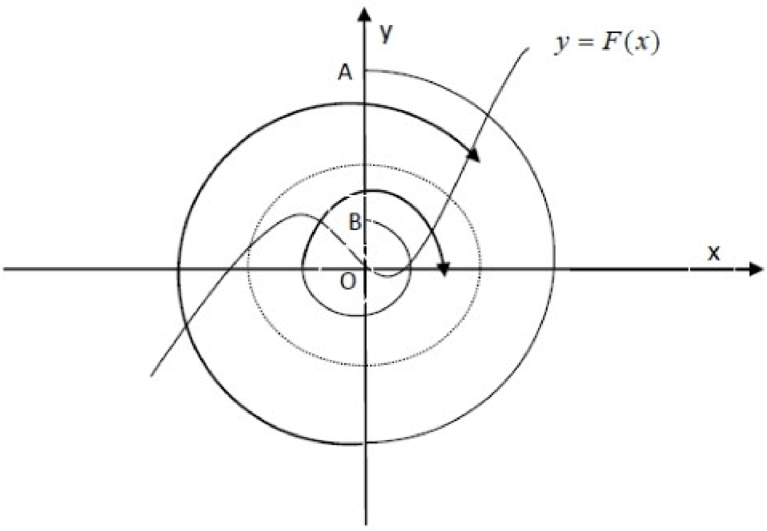

Fig 1 Trajectory Map

In fact, at a certain time, we can count the number of Shared bikes in a certain location, but how to determine whether they are reasonable or not? This is the problem to be solved in this article.

2. Main Result

The main result is following methods:

1) The first method: The reasonable amount $y = 110$ in form (4) used to be a mathematical expectation compares with the observed a series $y_i (i = 1,2,3,\cdots,14)$, which is the data of a Shared bicycle unconsumed.in Guangzhou, China, for a period of time ,and these, x represents the number of used .That tabulate statistics the observed a series $y_i (i = 1,2,3,\cdots,14)$

Tab 1. Obsened a Series $y_i (i = 1,2,...,14)$

y_1	y_2	y_3	y_4	y_5	y_6	y_7	y_8	y_9	y_{10}	y_{11}	y_{12}	y_{13}	y_{14}
100	105	108	104	110	120	121	118	116	114	112	116	109	104

We compute the average $\bar{y}$

$$\bar{y} = \frac{1}{14}\sum_{i=1}^{14} y_i$$

$$= \frac{1}{14}(100 + 105 + 108 + 104 + 110 + 120 + 121 + 118 + 116 + 114 + 112 + 116 + 109 + 104)$$

$$= 111.21$$

And calculate their variance:

$$S^2 = \frac{1}{13}[(100 \quad 111.21)^2 \quad (105 \quad 111.21)^2 \quad (108 \quad 111.21)^2 \quad (104 \quad 111.21)^2 \quad (110 \quad 111.21)^2 -$$

$$+(120 - 111.21)^2 + (121 - 111.21)^2 + (118 - 111.21)^2 + (116 - 111.21)^2 + (114 - 111.21)^2$$

$$+(112 - 111.21)^2 + (116 - 111.21)^2 + (109 - 111.21)^2 + (104 - 111.21^2)] \qquad (6)$$

$$\approx \frac{1}{13}(125.67 + 38.6 + 10.30 + 52.00 + 14.60 + 77.27 + 95.84 + 46.10 + 22.94 + 7.78$$

$$+0.63 + 22.94 + 4.88 + 51.98)$$

$$= 43.96$$

obeys the distribution; the reliability $\alpha = 0.05$ is given

As a statistic

$$T = \frac{\bar{y} - Y}{\frac{S}{\sqrt{n}}}$$

$$= \frac{111.21 - 110}{\frac{\sqrt{43.96}}{\sqrt{14}}} \approx \frac{1.21}{\frac{6.63}{3.74}} \approx \frac{1.21}{1.77} \approx 0.68 \qquad (7)$$

Establish the test hypothesis:

$H_0: \ \mu = \bar{y}$

where μ is the population mathematical expectation.

$$p\left\{ \left| \frac{\bar{y} - Y}{\frac{S}{\sqrt{14}}} \right| > 1.96 \right\} = 0.05$$

According to mathematical statistics hypothesis test method, the series $y_i \, (i = 1,2,3,\cdots,14)$ observed, are from the mathematical expectation .that means :The tracks of equation go through point $A(50,y_i)$, $y_i \, (i = 1,2,3,\cdots,14)$ will approach a limit cycle and the series $y_i \, (i = 1,2,3,\cdots,14)$ can be accepted to be the reasonable quantity sharing of bicycle.

2) $k = 2480$ is considered and x_i, $\frac{dx}{dt}_i$ are various.

In form (4)is replaced by the $x_i = 25, \ 26, \ 27, \ 28 \ 29 \ 31$ and $\frac{dx}{dt}_i = 8 \ 6 \ 7 \ 6 \ 8 \ 10$, $k = 624 \ 675 \ 728 \ 783 \ 840 \ 960$ .Then following $Y_i \, (i = 1,2,3,4,5,6.)$ have been obtained :

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=8 \\ x=25 \\ k=624}} = 33 \qquad (8)$$

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=6 \\ x=26 \\ k=675}} = 32 \tag{9}$$

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=7 \\ x=27 \\ k=728}} = 34 \tag{10}$$

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=6 \\ x=28 \\ k=783}} = 34 \tag{11}$$

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=8 \\ x=29 \\ k=840}} = 37 \tag{12}$$

$$y = \frac{dx}{dt} + x(x^2 - k)\Big|_{\substack{\frac{dx}{dt}=10 \\ x=31 \\ k=960}} = 41 \tag{13}$$

The result of the above listed in the table below:

Tab.2. The Values of Variables in Equation

x_i	25	26	27	28	29	31
$\frac{dx_i}{dt}$	8	6	7	6	8	10
k_i	624	675	728	783	840	960
y_i	33	32	34	34	37	41

Because the curve of the equation (2) is going to go to the limit cycle, $y_i\,(i = 1,2,\cdots,6)$ of the above are reasonable quantity, and their average quantity and variance are computed:

$$\bar{y} = \frac{1}{6}\sum_{i=1}^{6} y_i = \frac{33+32+34+34+37+41}{6} \approx 35.17 \tag{14}$$

$$\begin{aligned} s &= \sqrt{\frac{(33-35.17)^2+(32-35.17)^2+(34-35.17)^2+(34-35.17)^2+(37-35.17)^2+(41-35.17)^2}{6-1}} \\ &= \sqrt{\frac{4.7089+10.0489+1.3689+10.0489+3.3489+33.9889}{5}} \\ &\approx 2.73 \end{aligned} \tag{15}$$

Now following is the actual stopping amount of a Shared bicycle:

$$Y_1 = 38\,,\quad Y_2 = \quad,\quad Y_3 = \quad,\quad Y_4 = 38 \quad Y_5 = \quad,\quad Y_6 = 42 \tag{16}$$

And If the reliability $\alpha = 0.05$ is given. Calculate their mean and variance:

$$\bar{Y} = \frac{1}{6}\sum_{i=1}^{6} Y_i = \frac{38+39+41+38+40+41}{6} \approx 39.5 \tag{17}$$

$$\begin{aligned} S &= \sqrt{\frac{(38-39.5)^2+(39-39.5)^2+(41-39.5)^2+(38-39,5)^2+(40-39.5)^2+(41-39.5)^2}{6-1}} \\ &= \sqrt{\frac{(38-39.5)^2+(39-39.5)^2+(41-39.5)^2+(38-39,5)^2+(40-39.5)^2+(41-39.5)^2}{6-1}} \\ &= \sqrt{\frac{2.25+0.25+2.25+2.25+0.25+2.25}{5}} \\ &= 1.9 \end{aligned} \tag{18}$$

Current statistic

$$F = \frac{s^2}{S^2} \tag{19}$$

First, establish the test hypothesis

$$H_0: \sigma_1 = \sigma_2 \tag{20}$$

where σ_1, σ_2 are the variances of Y, y.

When H_0 is established, F obeys distribution F, which is of two degrees of freedom $6-1$.

If the reliability $\alpha = 0.05$ is given, and lookup table can confirm

$$P\left\{\frac{s^2}{S^2} < F_a\right\} = P\left\{\frac{s^2}{S^2} > F_b\right\} = \frac{\alpha}{2} = 0.025$$

where $F_b = F_{0.025}(6-1, 6-1) = 5.05$, and

$$P\left\{\frac{s^2}{S^2} < F_a\right\} = P\left\{\frac{S^2}{s^2} > \frac{1}{F_a}\right\} = 0.025$$

$$\frac{1}{F_a} = F_{0.025}(6-1, 6-1) = 7.15$$

$$F_a = \frac{1}{F_{0.025}(6-1, 6-1)} = \frac{1}{7.15} \approx 0.14$$

$$F = \frac{s^2}{S^2} = \frac{2.73^2}{1.9^2} = \frac{7.4529}{3.61} \approx 2.07$$

$$0.14 < 2.07 < 5.05$$

So H_0: can't be refused , and $Y_1 = 38$, $Y_2 =$, $Y_3 =$, $Y_4 = 38$ $Y_5 =$, $Y_6 = 42$ in form (15) can be thought they are not different with the reasonable values $y_i\,(i = 1,2,\ldots,6.)$ in table (2) .because they can approach the limit cycles corresponding with $k_i\,(i = 1,2,\ldots,6.)$ in table (2). The values $Y_1 = 38$, $Y_2 =$, $Y_3 =$, $Y_4 = 38$ $Y_5 =$, $Y_6 = 42$ can be seen to be acceptable values , and build another hypothesis $\mu_1 = \mu_2$, which are two general mathematical expectations . Because

$$T = \frac{\bar{Y} - y}{\sqrt{\frac{S^2 + s^2}{n}}} = \frac{39.5 - 35.17}{\sqrt{\frac{3.61 + 7.4592}{12}}} \approx \frac{4.33}{3.46} \approx 1.25$$

Obey the t distribution with two degrees of freedom $2n - 2$,which is on the hypothesis H'_0 : $\mu_1 = \mu_2$,and , $\alpha = 0.05, n = 6$ and look table:

$$t_\alpha = t_{0.05}(10) = 2.228 > 1.25 = T$$

There is no obvious difference between the ideal sharing bicycle and the actual observed value.

Conclusion

This paper provides an ideal comparison method of the shared bicycle parking and the actual observation value, which provides the basis for the parking management of the shared bicycle. Make the businessman press the method of this article, consciously carry on the release. Also, the traffic management department shall supervise the inspection methods of this paper. It's very practical.

References

1. Y. Duan, T. Gao, Based on the fuzzy comprehensive evaluation method of urban road congestion evaluation method research, 2013, Logistics Technology, pp. 15-33.
2. X. Cong, Research to the influential factors of urban road traffic capacity, 2016, College Students Paper Joint Than in the Library.
3. J. Li, Based on the influence of road network logistics cost research, 2009, Master Thesis, Hefei University of Technology, pp. 6-48.
4. C. Yu, Thinking on some issues of traffic management, 2016, Digital Communication World, pp. 1-38.
5. Y. Wang, Rail transit network changes and the response of the urban space development strategy research, 2013, Tianjin University Doctoral Dissertation, pp. 1-117.

6. Y. Duan, Optimization design of the single processor scheduling algorithm in real-time system research, 2013, Journal of Operational Research, vol. 17, no. 1, pp. 27-34.
7. L. Lin, W. Cheng, Petri network application in uncontrolled intersection conflict analysis, 20019, Forest Engineering, pp. 60-63.
8. Y. Duan, Comparative study of different genetic operator combination to solve TSP proble, 2012, Science and Technology, vol. 28, no. 5, pp. 27-31.
9. Z. Wang, Road traffic capacity analysis (new)[DB/OL], Baidu library, September 2013. https://wenku.baidu.com/view/0cc8620dbd64783e09122b8b.html
10. G. Sansone, Sopra lequazione di A. Lienard delle ocillaxionidi rilassamento, 1949, Ann. Mat Pure End Appl., Vol, 4, pp. 153-181.
11. C. Feng, J. Liang, Solve the more general travelling salesman problem2014, AMSE Journals Series: Modelling D, vol. 35, no. 1, pp. 9-23.
12. C. Feng, J. Liang, The solution of the more general traveling salesman, 2014, AMSE Journals Series: Advances A, vol. 51, no. 1, pp. 27-40.