The study on the window time of Large Cruise's Berthing Based on Pearson Correlation Analysis——Take Shanghai Wusongkou International Cruise Terminal as an Example

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Abstract

For Shanghai Wusongkou International Cruise Terminal, the main risks is encountering the peak of the vessel traffic flow in Baoshan secondary channel and other waters when Large cruise ship's Approaching and Leaving Docks. The Pearson correlation analysis method is used to analyze the observation of dataset. It is found that has significant negative correlation between the number of small ships in Baoshan subway and the tidal changes. It is suggest that large cruise ships arrive at or depart harbors to avoid low tide period for the purpose of removing or reducing risks.

Keywords

Ship traffic flow, Tide, Pearson correlation analysis.

1. Introduction

Shanghai Wusongkou International Cruise Terminal (hereafter referred to as "SWIC Dock") is an important part of the construction of Shanghai International Shipping Center. It is the largest professional cruise in the Asia-Pacific region. Since the operation of the SWIC Dock, the number of cruise ships and the number of passengers have doubled every year. There are 4 large cruise ship berths, a total length of 774 meters, the design berthing capacity of 200,000 gross tonnage, for two 100,000 GT cruises and two 200,000 GT cruises berthing at the same time.

Large cruise ships are scheduled when ships' Approaching and Leaving Docks because of the operating characteristics. It is very important to protect the safety of life at sea and reduce the loss of property that choice time reasonable of large cruise ship's berthing.

2. Berthing analysis

Figure 1 is a simulation of a large cruise ship berthing in SWIC Dock, the large cruise ship model information as Table 1:

Table 1. The large cruise ship model

Length overall (m)	Molded breadth (m)	Gross tonnage (t)	Average draught (m)
347.1	41.4	168666	14.5

After three simulations, the average size of the whirling waters is 589m * 533m, the average time is 1h12'58 ".

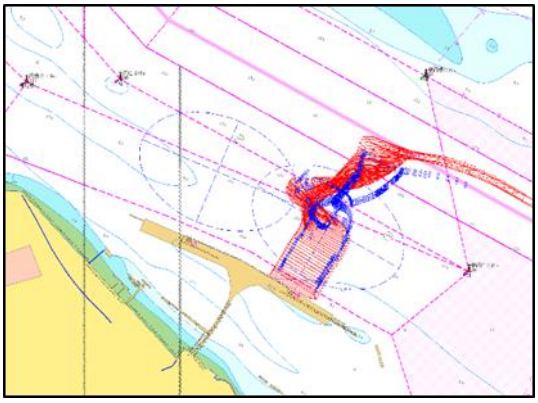

Figure 1 Large cruise ship Berthing in SWIC Dock

It can be seen from the figure, in the process of berthing, large cruise across four channels. So there exists some potential danger that has increased the probability of ships' encountering each other near the SWIC Dock.

The analysis shows that large-scale cruise ship berthing has a large turning basin, slow speed, time-consuming and so on. And large cruise's turning basin is in the Baoshan secondary channel, so it is the focus on the safety of Baoshan secondary channel.

It is the Small-sized ships sailing within Baoshan secondary channel. Those small ships are many and mixed, and there are still a few vessel do not comply with ship's routing, which brought a high risk to ships' (especially large ships') berthing. It is a preliminary understanding that these small vessels are mostly fishing vessel, sailing on certain times. Taking into account the fact that most of the vessel have the habit of navigating with the help of the tide, the number of the vessel are likely to be associated with tides. Therefore, this paper conducted a one-week observation of the ship's traffic flow to analyze the relationship between the ship's traffic flow and the tide in the Baoshan secondary channel and other waters, to find out the regularity.

In this paper, the dataset comes from AIS, radar and on-site observation. It carried out a seven-day observation of the ship traffic flow near the Baoshan Maritime Safety Administration from June 9, 2017 to June 15, 2017. As shown in Figure 2, this paper set up two observation lines: the observation line 1 and observation line 2, to observe the ship entrance channel and out the channel. In Figure 2, channel 1 is the Yangtze River deep water channel extension section, channel 2 is the Baoshan channel, and channel 3 is the Baoshan secondary channel. In order to facilitate the study and analysis, for the Yangtze River deep water channel extension section and Baoshan channel, this article called channel 1, channel 2 for short.

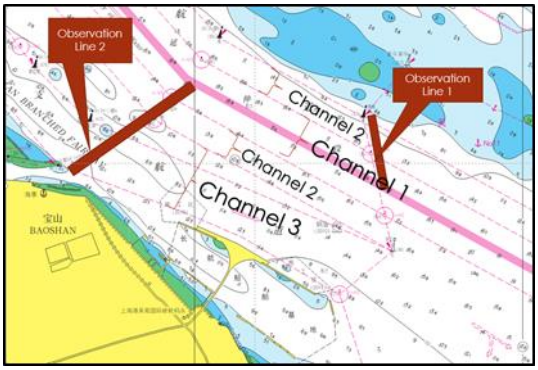

Figure 2 Ship traffic flow observation

3. Ship traffic flow

In the seven days of observation, the total number of ships is 5347 in the Channel 1, channel 2, and Baoshan secondary channel, including 1416 in the Baoshan secondary channel, accounting for 26.48%. As shown in Figure 3, during the observation period, 134 – 329 ships appeared at Baoshan

secondary channel a day. As can be seen in Figure 4, the daily average number of ships in the Channel 2 is most, as 1.75 times as the channel 1, as 1.77 times as Baoshan secondary channel.

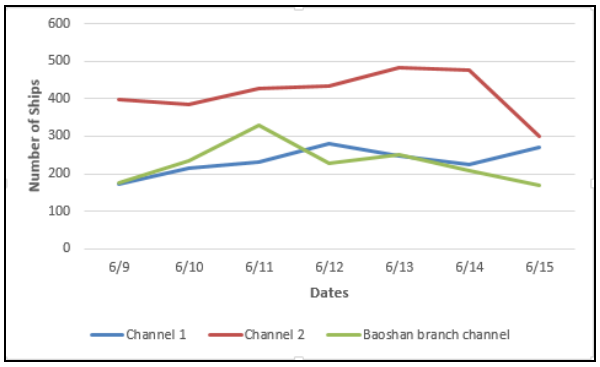

Figure 3 Daily number of ship in different channels

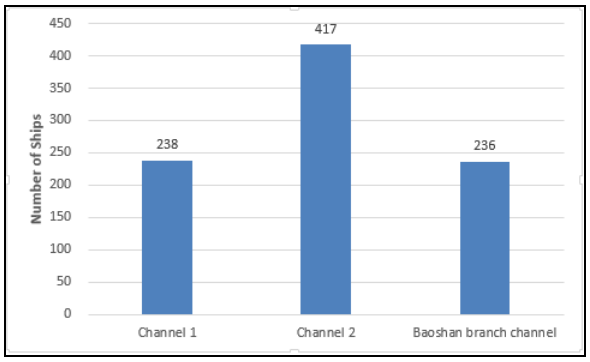

Figure 4 Average number of ship in different channels

As shown in Figure 5, the number of vessels with a length of 50-100 m is 2587, accounting for 48.38% of the total number of vessels, followed by 1508 vessels with length of 25-50 m, accounting for 28.20%. In Baoshan secondary channel, there are 714 vessels (50.42%) with a length of 25-50m, followed by 50-100m (37.92%). It shows that the vessels sailing in the Baoshan secondary channel is smaller than that in the Channel 1 or channel 2.

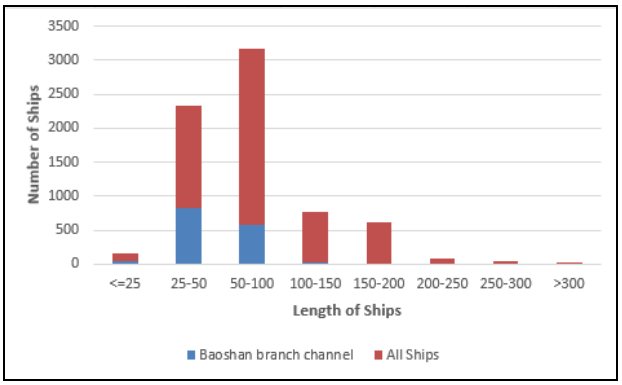

Figure 5 the length of ships Between Baoshan secondary channel and all the waterway

4. Correlation between ship traffic flow and tide

As shown in Figure 6 to Figure 12, it find out the common regularity during the flow observation period by comparing the daily tide and the number of ships of different channels:

(1) The number of ships in the Baoshan secondary channel reaches the peak of the day when 0-1 hours before and after the first low tide in the day;

(2) Meanwhile the number of ships in the Channel 2 has also increased;

(3) However, the number of ships in the Channel 1 is not obvious changed with the tide.

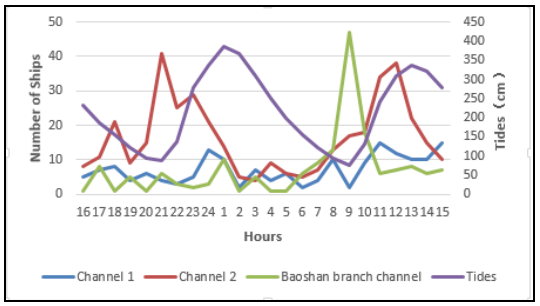

Figure 6 June 9, 2017, Tides and the number of ships changed hour by hour

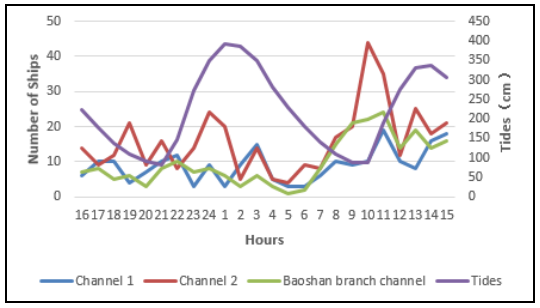

Figure 7 June 10, 2017, Tides and the number of ships changed hour by hour

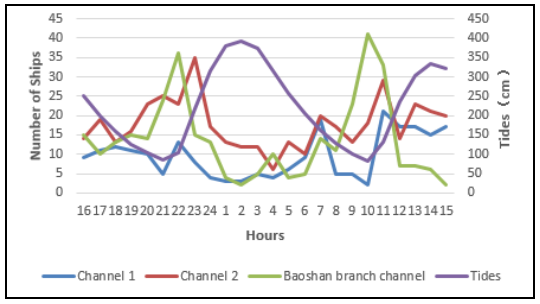

Figure 8 June 11, 2017, Tides and the number of ships changed hour by hour

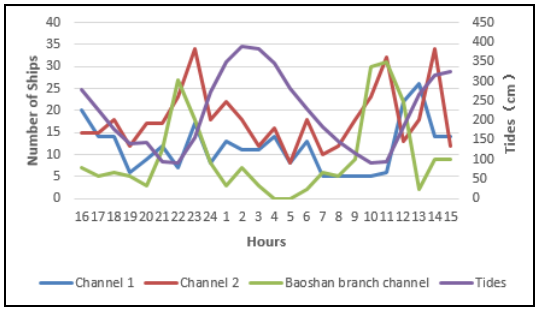

Figure 9 June 12, 2017, Tides and the number of ships changed hour by hour

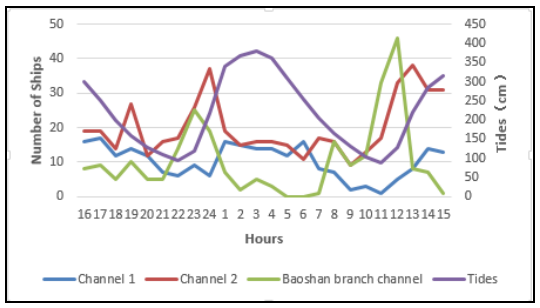

Figure 10 June 13, 2017, Tides and the number of ships changed hour by hour

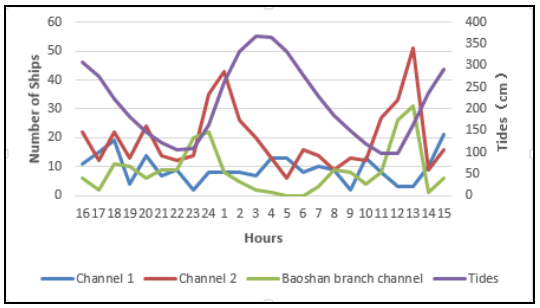

Figure 11 June 14, 2017, Tides and the number of ships changed hour by hour

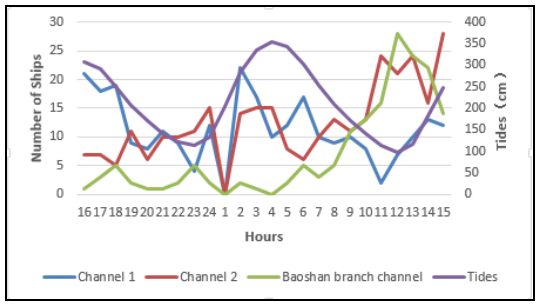

Figure 12 June 15, 2017, Tides and the number of ships changed hour by hour

It is clear that the number of ships most likely to be related to the tide in the Baoshan secondary channel.

Table 2 Correlation between tidal variation and ship number in Baoshan secondary channel

		Tide	Number of ships
Tide	Pearson correlation	1	-0.587
	Significant (bilateral)		0.000
	N	192	191
Number of ships	Pearson correlation	0.587	1
	Significant (bilateral)	0.000	
	N	191	191

5. Pearson correlation analysis

Pearson correlation analysis is generally used to analyze the relationship between two continuity variables, the formula is as follows:

$$r=\frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2\sum_{i=1}^{n}(y_i-\bar{y})^2}} \quad (1)$$

Where the correlation coefficient r ranges: $-1 \le r \le 1$:

$r > 0$ is positive correlation, $r < 0$ is negative correlation;

$|r| = 0$ indicates that there is no linear relationship;

$|r| = 1$ indicates that there is no linear relationship;

$0 < |r| < 1$ indicates that there are different degrees of linear correlation:

$|r| \le 0.3$ is no linear correlation;

$0.3 < |r| \le 0.5$ is no linear correlation;

$0.5 < |r| \le 0.8$ is high linear correlation;

$|r| > 0.8$ is significant linear correlation.

Using the SPSS software to analyze the correlation between the tidal change data and the number of ships in the Baoshan secondary channel, the results are as follows:

Pearson correlation corresponds to the correlation coefficient r, which reflects whether the two are positive or negative correlation, are close or not close.

Significant (bilateral) Sig is to determine the correlation significance. If Sig <0.05 indicates that this correlation is statistically significant, i.e. that the two are really relevant. If it is> 0.05, the correlation is not significant, that is, the two are not related.

In the above table, the correlation coefficient between tide and ship number is -0.587, Sig = 0.00 <0.05, indicating significant correlation between tide and ship number, or rather negative correlation between tide and ship number.

Model test with ANOVA, the results are as follows:

Table 3 Model test with ANOVA

Anova[a]

Model	Quadratic sum	df	mean square	F	Sig.
Regression	3425.609	1	3425.609	66.590	.000[b]
Residuum	10031.510	195	51.444		
Gross	13457.119	196			

A. Dependent variable: number of ships

B. Predictor: tide.

The statistics of F are: 66.590, the P value is 0.000, and the model is proved to be significant.

Similarly, the data of channel 2 and channel 1 are analyzed, and conclusions that are no significant negative correlation and irrelevant are obtained respectively. It is consistent with our previous analysis.

6. Conclusion

There is a significant negative correlation between the number of small ships in Baoshan secondary channel and the daily tidal change. In order to saving fuel and other costs, the small ships sail with the help of tide frequently. So they choose sailing time at low tide, along the next high tide to Wusong alert area or Huangpu River.

Considering the safety of Large cruise ship's Approaching and Leaving Docks near the Baoshan secondary channel, it is suggest that the large cruise ships' berthing to avoid the low tide.

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References

[1] Feng Hongxiang, "Study of Vessel Traffic Forecasting ModelBased on Support Vector Machine", Navigation of China, Year. 2011, No.4, pp. 62-66.

[2] Zhang YUlei, "Quantitative Analysis of the Relationship of Biology Species Using Pearson Correlation Coefficient", Computer engineering and application, Period. 5, pp. 83-86.

[3] JIN Xingfu, "Research on vessel traffic flow at Chengshantou water area based on AIS Data", Journal of Dalian Maritime University, Period. 01, pp. 33-36.

[4] LIU Jing-xian , “Research on Combination Forecasting Method for Ship Traffic Flow”, Navigation of China, Period. 03, pp. 80-84.