Journal of Navigation and Port Research International Edition
Vol.33, No.4 pp. 277~282, 2009 (ISSN-1598-5725)

Estimation on the Port Container Volume in Incheon Port

† *Jung-Hoon Kim*

† *Research Institute of Maritime Industry, Korea Maritime University, Busan 606-791, Korea*

Abstract : *This paper estimated the container volumes for the Incheon port with univariate time series. As best suited models Winters' additive model, ARIMA model,and Winters' additive model were selected by import-export, coastal, and transshipment volume respectively, based on the data of monthly volume by October 2008 since January 2001. This study supposed the import-export container volumes would be decreased by 14% against that in 2008 and would have been recovered to the increasing trend of the volumes beyond the fourth quarter of 2010. The future import-export and transshipment volumes showed the increasing trend beyond 2011, while the coastal volumes would be on the stagnation. The yearly container volumes were finally forecasted as 1,705, 2,432, and 3,341 thousand TEU in 2011, 2015, and 2020 respectively.*

Key words : *Container volume, Incheon port, Import-export volume, Transshipment volume, Coastal volume, Time series model*

1. Introduction

Container traffic has been regularly servicing inland ports since 1980. In 2007, the total number of container cargos loaded/unloaded in inland ports recorded about 29 times of that in 1980. But, this rapid increase rate has weakened in recent years. Due to the various factors, such as the change of industry structure, domestic manufacturers relocating to China, and the increase rate of import-export cargos was falling (Jun et al., 2006)

In the case of Incheon port the container volume 1,664 thousand TEU was handled in 2007. This showed a 20.8 % increase from 2006. In fact, 6 additional regular lines had inaugurated for Incheon port to have 35 regular lines in 2007 since 2005. The number of fleet to Incheon port increased from 18 fleets in 2005 to 27 ones in 2007 (Lee, 2008). There are also several studies to develop the logistics system on Incheon port (Chung and Choi, 2007; Yeo, 2008; Kim et al., 2008).

In the year to June, the container volume, however, just grew by a slower 10.0%. This decline phenomenon of the increase rate is forecast to continue for the second fiscal semester and in the next years with the slowdown in the economy. Slower economic growth in China as well as high crude oil prices and weakening global economies threaten Korea's export outlook.

In this situation, this study estimated the container volume in Incheon port after classifying into import-export, coastal, and transshipment volume. Time series forecasting was used to model the container volumes until 2020. The estimates of the constructed models were also compared with existing estimated one the government reported for Incheon port.This study was to review the future container volume in Incheon port.

2. The current situation on container volume

2.1 Import-export volume

It has showed continuous increase trend of monthly import-export container volume since 2001, as shown in Fig. 1. The monthly average volume increased from 45 thousand TEU in 2001 to 136 thousand TEU in 2007. From Table 1, the yearly import-export volume was on the increase from 537 thousand TEU in 2001 to 1,628 thousand TEU in 2007 by annual growth rates of 9.1~27.5%.

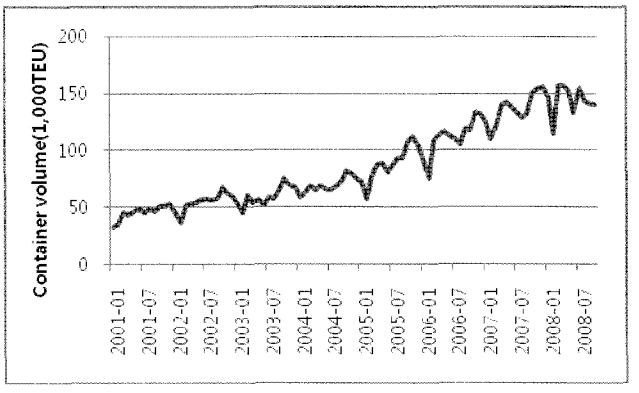

Fig. 1 The current situation of import-export volume

† Corresponding Author : Jung-Hoon Kim, jf1999@empal.com 051)410-4102

2.2 Coastal volume

It has showed the trend to bemaintained low since monthly coastal container volume reduced in 2006, based on Fig. 2. It was not by chance that the volume was suddenly decreased. The major shipping line Hanjin stopped the coastal transport service in May 2006 because of the lower profitability. The monthly average volume decreased from 10 thousand TEU in 2001 to 2 thousand TEU in 2007. From Table 1, the yearly import-export volume reduced from 125 thousand TEU in 2001 to 18 thousand TEU in 2007 by annual decline rates of 5.9~62.0%. Consequently, the coastal volume in 2007 shrank to barely 15% of the amount in 2001.

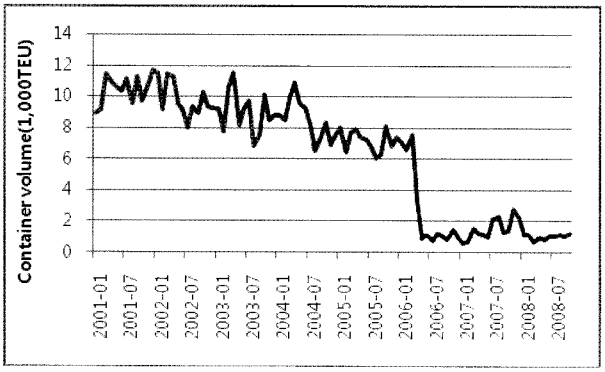

Fig. 2 The current situation of coastal volume

2.3 Transshipment volume

As shown in Fig. 3, it has showed the trend to be greatly increased for monthly transshipment volume since 2001. Particularly, the annual growth rate almost doubled in 2006 although the volume was not sizable enough to influence total container volume. The monthly average volume increased from 96 TEU in 2001 to 1,499 TEU in 2007. From Table 1, the yearly transshipment volume was on the increase from about 1 thousand TEU in 2001 to 18 thousand TEU in 2007 by annual increase rates of 36.0~99.0%.

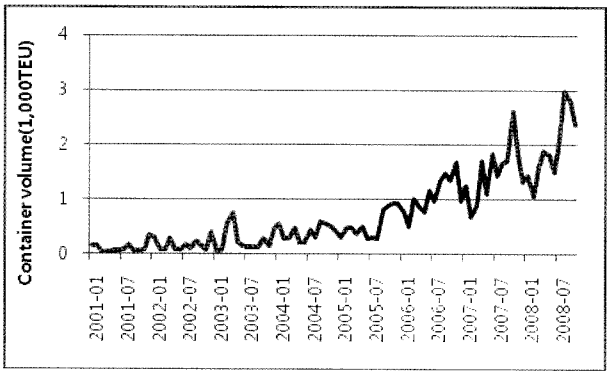

Fig. 3 The current situation of transshipment volume

2.4 Total container volume

It has showed the growing trend of total container volume as a whole and is similar with Fig. 1. The monthly average volume increased from 55 thousand TEU in 2001 to 139 thousand TEU in 2007. The yearly volume increased from 663 thousand TEU in 2001 to 1,664 thousand TEU in 2007 by annual growth rates of 6.7~22.9% with the result in Table 1.

2.5 Existing forecasted result

Table 1 The current of total container volume in Incheon port

(Unit: TEU)

Year	Total	Import-export	Coastal	Transship-ment
2001	663,042 -	536,631 -	125,256 -	1,155 -
2002	769,791 (16.1)	650,505 (21.2)	117,328 (-6.3)	1,958 (69.5)
2003	821,071 (6.7)	709,932 (9.1)	108,135 (-7.8)	3,004 (53.4)
2004	934,954 (13.9)	828,404 (16.7)	101,786 (-5.9)	4,764 (58.6)
2005	1,148,666 (22.9)	1,056,054 (27.5)	86,133 (-15.4)	6,479 (36.0)
2006	1,377,050 (19.9)	1,331,440 (26.1)	32,720 (-62.0)	12,890 (99.0)
2007	1,663,800 (20.8)	1,627,640 (22.2)	18,174 (-44.5)	17,986 (39.5)

( ): average annual growth rate (%)
Source : http://www.spdic.go.kr(2008)

The Ministry of Land, Transport and Maritime Affairs (MLTM) reported that the container volume of Incheon port would be 3,055 thousand TEU in 2011, 3,871 thousand TEU in 2015, and 5,346 thousand TEU in 2020. It was 2.66 times in 2011, 3.37 times in 2015, and 4.65 times in 2020 that of the previous container volume in 2005, respectively.

Table 2 Existing forecasted result on the container volume of Incheon port

(Unit: 1,000TEU)

	2005	2011	2015	2020
Container volume	1,149 -	3,055 (2.66)	3,871 (3.37)	5,346 (4.65)

( ): multiple of specific year's volume, compared to that in 2005
Source: The planned revision of Korea ports basic plan(2006)

3. Estimation for container volume

In this paper time series models were constructed after classifying into three groups; import-export, coastal, and transshipment volume, which forecasted the container volume in Incheon port. A time series is a sequence of data points, measured typically at successive times, spaced at (often uniform) time intervals. Time series analysis comprises methods that attempt to understand such time series, often eitherto understand the underlying context of the data points, or to make forecasts. Time series forecasting is the use of a model to forecast future events based on known past events: to forecast future data points before they are measured.

In this study univariate time series was applied to predict future container volume based on the data of monthly volume in Incheon port by October 2008 since January 2001. This study supposed that the import-export container volumes would be decreased by 14% against that in 2008 and would have been recovered to the increasing trend of volumes beyond the fourth quarter of 2010.

Univariate time series refers to a time series that consists of single observations that are the container volume, recorded sequentially over equal time increments. Exponential smoothing models and autoregressive integrated moving average (ARIMA) models were considered to set a best suited model through the procedure of time series analysis. The final models were selected with repeating continuously three stages: model identification, model estimation, and model diagnostic checking (George, 2008).

3.1 Import-export volume

As the best suited model Winters' additive model was selected for the time series model of import-export container volume in Incheon port. After accomplishing model match repeatedly through trial and error, the setting subject and statistics of a model which were set ultimately were as follows: First, there were the test of variable transform, evidence of seasonal variation, and the autocorrelation and partial autocorrelation functions to choice tentative models. These chosen models were diagnosed by overfitting diagnostics and residual analysis. A most suitable model was selected among candidate models according to model selection criterion such as stationary R-square, R-square, mean absolute percentage error (MAPE), and normalized BIC. Winters' additive model was finally adapted and the estimate values of its parameters are shown in Table 3.

Table 3 Winters' additive model parameters on the import-export container volume

	Estimate	SE	t	Sig.
Alpha (Level)	0.386	0.091	4.262	0
Gamma (Trend)	1.324E-05	0.007	0.002	0.999
Delta (Season)	0.001	0.087	0.011	0.991

The P-value of Ljung-box Q was 0.067 and normalized BIC was 17.591 in the diagnosis result of constructed model. It was confirmed to be satisfied with the independence, normality and homoscedasticity of residual.

The future monthly import-export container volumes showed the trend to increase continuously through the model as shown in Fig. 4. The import-export container volumes were forecasted as yearly volumes of 1,655, 2,370, and 3,263 thousand TEU with increasing rates of 1.7%, 45.6%, and 100.4% respectively in 2011, 2015, and 2020 with that in 2007, based on Fig. 4. The import-export container volume showed the largest one in November and the smallest in February.

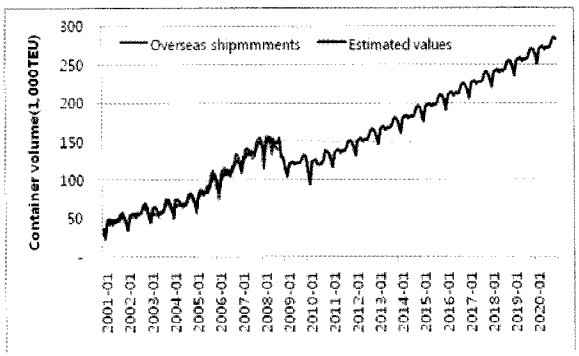

Fig. 4 Developments of import-export volume by model

Table 4 Predicted outcome of import-export volume

(Unit: TEU)

Year / Month	2011	2015	2020
1	127,140	186,670	261,070
2	116,290	175,810	250,220
3	135,620	195,140	269,550
4	138,450	197,970	272,380
5	139,770	199,300	273,700
6	135,370	194,900	269,300
7	137,870	197,400	271,800
8	136,940	196,460	270,870
9	139,800	199,320	273,730
10	147,890	207,420	281,820
11	151,270	210,800	285,200
12	148,930	208,450	282,860
Total	1,655,340 (1.7)	2,369,640 (45.6)	3,262,500 (100.4)

( ): Growth rate(%) compared to that in 2007

3.2 Coastal volume

An ARIMA model was selected for the time series model of coastal container volume in Incheon port as the best suited model. Like the procedure of model construction for import-export container volume that the best model for future coastal container volume was selected through trial and error. The ARIMA(2,1,0)(1,0,0)$_{12}$ model without a constant was finally adapted and the estimated values of its parameters are shown in Table 5.

Table 5 ARIMA Model Parameters on the coastal container volume

		Estimate	SE	t	Sig.
AR	Lag 1	-0.561	0.106	-5.284	0.000
Difference		1			
MA	Lag 2	0.456	0.111	4.097	0.000
AR, Seasonal	Lag 1	0.494	0.096	5.136	0.000

The coastal container volumes were forecasted as yearly container volumes of 12,600TEU respectively in 2011, 2015, and 2020. They mean decreasing rates of 30.7% with that in 2007.

It will be difficult to increase the coastal container volume if there are not special change factors on coastal shipping transport: reorganization of a coastal container transport system, construction and operation of the multi-purpose quays for coastal container, and participation in the coastal shipping transport service by foreign-flag vessel (Hee et al., 2008).

3.3 Transshipment volume

As the best suited model Winters' additive model was selected for the time series model of transshipment container volume in Incheon port. Like the procedure of model construction for other volumes that the final model for future transshipment container volume was selected. The Winters' additive model was adapted and the estimate values of its parameters are shown in Table 7.

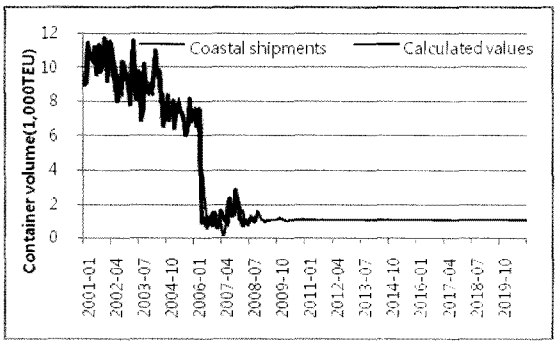

Fig. 5 Developments of coastal volume by model

Table 6 Predicted outcome of coastal volume

(Unit: TEU)

Year Month	2011	2015	2020
1	1,050	1,050	1,050
2	1,050	1,050	1,050
3	1,040	1,050	1,050
4	1,050	1,050	1,050
5	1,040	1,050	1,050
6	1,050	1,050	1,050
7	1,050	1,050	1,050
8	1,050	1,050	1,050
9	1,050	1,050	1,050
10	1,050	1,050	1,050
11	1,060	1,050	1,050
12	1,060	1,050	1,050
Total	12,600 (-30.7)	12,600 (-30.7)	12,600 (-30.7)

( ): Growth rate(%) compared to that in 2007

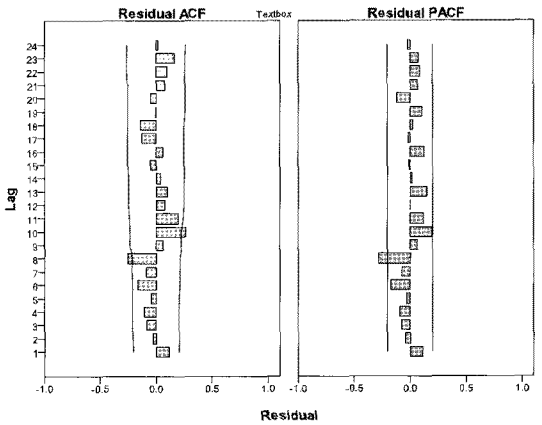

Fig. 6 Residual ACF/PACF chart

As shown in Fig. 6, the future transshipment container volumes showed the trend to increase continuously through the model. Table 8showed the transshipment volumes were forecasted as yearly volumes of 36,820, 49,460, and 65,230 TEU with increasing rates of 104.7%, 175.0%, and 262.7% respectively in 2011, 2015, and 2020 with that in 2007. The transshipment container volumes were estimated the largest one in October and the smallest in February.

Table 7 Winters' additive model on the transshipment container volume

	Estimate	SE	t	Sig.
Alpha (Level)	0.309	0.079	3.916	0.000
Gamma (Trend)	6.761E-06	0.011	0.001	1.000
Delta (Season)	1.516E-05	0.089	0.000	1.000

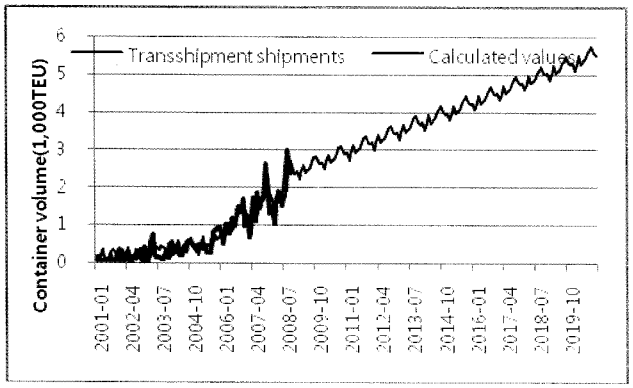

Fig. 7 Developments of transshipment volume by model

Table 8 Predicted outcome of transshipment volume

(Unit: TEU)

Year Month	2011	2015	2020
1	2,920	3,970	5,290
2	2,730	3,790	5,100
3	2,930	3,990	5,300
4	3,120	4,170	5,490
5	2,920	3,970	5,280
6	2,990	4,040	5,350
7	3,020	4,070	5,390
8	3,190	4,250	5,560
9	3,300	4,350	5,670
10	3,360	4,410	5,720
11	3,200	4,250	5,570
12	3,140	4,200	5,510
Total	36,820 (104.7)	49,460 (175.0)	65,230 (262.7)

( ): Growth rate(%) compared to that in 2007

3.4 Total container volume

There was an overall tendency for future total container volumes to increase. Table 9 showed the yearly container volume were forecasted as 1,705, 2,432, and 3,341thousand TEU with increasing rates of 2.5%, 46.2%, and 100.8% respectively in 2011, 2015, and 2020 with that in 2007. Although the estimated container volume would increase continually, its growth rate would have decrease from 15.7% in 2011 to around 5.8% in 2020 according to the models constructed respectively.

As shown in Fig. 7, the estimated container volumes were 50~60% mark of existing estimated ones MLTM reported for Incheon port. This means future container volumes in Incheon port have to be reassessed on the government level.

Table 9 Predicted outcome of total container volume

(Unit: 1,000TEU)

Year	Total		Import-export volume	Coastal Volume	Transshipment
	Volume	Growth rate (%)			
2011	1,705	15.7	1,655	13	37
2012	1,887	10.7	1,834	13	40
2013	2,069	9.6	2,013	13	43
2014	2,250	8.7	2,191	13	46
2015	2,432	8.1	2,370	13	49
2016	2,614	7.5	2,548	13	53
2017	2,796	7.0	2,727	13	56
2018	2,977	6.5	2,905	13	59
2019	3,159	6.1	3,084	13	62
2020	3,341	5.8	3,263	13	65

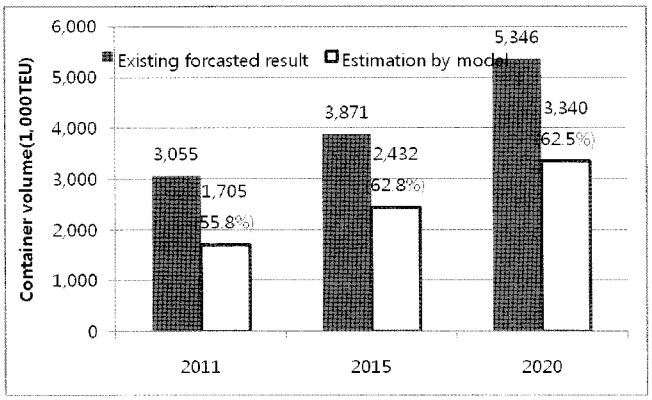

Fig. 8 Comparison of estimated container volumes

4. Conclusion

In this paper the container volumes were estimated for the Incheon port through the quantitative models of time series procedure. The container volumes were classified into import-export, coastal, and transshipment volume. Univariate time series was applied to predict future container volume based on the data of monthly volume in Incheon port by June 2008 since January 2001. This study supposed that the import-export container volumes would be decreased by 14% against that in 2008 and would have been recovered to the increasing trend for volumes beyond the fourth quarter of 2010.

Exponential smoothing models and ARIMA models were considered to set a best suited model through the procedure of time series analysis. As best suited models Winters' additive model, ARIMA(2,1,0)$(1,0,0)_{12}$, and Winters' additive model were selected by import-export, coastal, and transshipment volume respectively.

The import-export volumes were forecasted as yearly volumes of 1,655, 2,370, and 3,263 thousand TEU with increasing rates of 1.7%, 45.6%, and 100.4% respectively in 2011, 2015, and 2020 with that in 2007. The coastal volumes were forecasted as yearly volumes of 12,600 TEU respectively in 2011, 2015, and 2020. They mean decreasing rates of 30.7% with that in 2007. The transshipment volumes were forecasted as yearly volumes of 36,820, 49,460, and 65,230 TEU with increasing rates of 104.7%, 175.0%, and 262.7% respectively in 2011, 2015, and 2020 with that in 2007.

The yearly container volumes in Incheon port were finally forecasted as 1,705, 2,432, and 3,341 thousand TEU. They would be increasing rates of 2.5%, 46.2%, and 100.8% respectively in 2011, 2015, and 2020 with that in 2007. The estimated container volume was 50~60% mark of existing estimated one the government reported in 2006.

There's a considerable difference between the estimated result of this study and that of previous government reports. If there is no consideration about the issue, it may cause excessive investment for the port facility. A close review will be necessary to avoid the problem.

This study has the following limits. First, it is hard to predict how long the slump of domestic port container volume will last for international prolonged economic slowdown. Second, logistics change of Incheon port was not included as the impact of Kyungin canal. These topics should be dealt with as research projects in the future.

Acknowledgements

This work was supported by Korea Research Foundation - Grant funded by the Korean Government (KRF-2006-353-F00014)

References

[1] Chai, H.J., Ahn, K.M., and Kim, K.H.(2008), "A Study for Coastal T/S Transport Activation of Busan Port Container Cargoes", Journal of Navigation and Port Research, Vol.32, No.3, pp. 159~165.

[2] Chung, T.W. and Choi, S.K.(2007), "A Study on Marketing Analysis of Incheon Container Ports", Journal of Navigation and Port Research, Vol.31, No., pp. 179~186.

[3] George, E.P., Gwilym, M.J., and Gregory, C.R.(2008), "Time Series Analysis", John Wiley & Sons.

[4] Hu, M.H.(2008), "Spss Time Series Analysis And Missing Value Analysis", SPSS Korea.

[5] Jeong, D.B. and Won, T.Y.(2001), "Simplicity of Analysis for Time Series data", SPSS Korea.

[6] Jun, C.Y.(2006), "Analysis of Factors Affecting Recent Variation of Container Traffic Volume", Korea maritime institute.

[7] Kim, S.C., Ryoo, D.K., and Lee, D.H.(2008), "A Strategic Development of Incheon Port Authority Using SWOT/AHP Method", Journal of Navigation and Port Research, Vol.32, No.2, pp. 193~198.

[8] Lee, I.A.(2008), "Incheon port, What was changed?", Maritime Korea, No.419, pp. 34~38.

[9] MLTM(2006), "The planned revision of Korea ports basic plan", The Ministry of Land, Transport and Maritime Affairs, pp. 29~48.

[10] Yeo, G.T.(2008), "A Study on the Evaluation on the Logistics Performance of Incheon Port", Journal of Navigation and Port Research, Vol.32, No.3, pp. 179~184.

[11] http://en.wikipedia.org/wiki/Time_series

Received 2 September 2008
Revised 10 June 2009
Accepted 26 June 2009