Critical Factors in Schedule Reliability of Container Shipping Carriers

for MMMse 2011

Cheng-Chi CHUNG
Associate Professor
Shipping and Transportation Management
National Taiwan Ocean University
No. 2, Pei-Ning Road, Keelung
20224 Taiwan, ROC

And

Chao-Hung CHIANG
Ph.D.
Institute of Traffic and Transportation
National Chiao Tung University
3F, 118 Chung Hsiao W. Rd.,
Sec. 1,Taipei, Taiwan, ROC

ABSTRACT

In today's ever-increasing competitive environment, container shipping is a significant part in the supply chain. Schedule reliability of shipping carriers will affect the hinterland transport and customers. Thus, service quality of schedule reliability has a big influence on operational performance of shipping carriers. The main purpose of this study was to analyze and investigate the key influential factors of schedule reliability by using Fuzzy Analytic Hierarchy Process. Results indicated that the important object is 'process management in the shipping lines', and the important criteria were 'well-arranged time window,' 'transship arrangement,' 'planning the suitable ports,' and 'planning the berth and warehouse previously'.

Key words: Container shipping, Schedule reliability, Fuzzy AHP

1. INTRODUCTION

In today's highly competitive environment, container shipping carriers are facing several challenges. Shipping is not only a carrier but also a part of the supply chain; therefore, schedule reliability of container shipping carriers plays a key role in the global supply chain. It is the fact that schedule reliability might affect hinterland transport and logistics costs to the customers.

Although shipping lines operate on fixed-day weekly schedules, the survey of Drewry Shipping Consultants pointed that more than 40% of the vessels deployed on worldwide liner services delayed one or more days (Vernimmen *et al.*, 2007). Drewry (2007-2009) calculated the schedule reliability of global container shipping carriers from 2007 Q3 to 2009 Q2 as shown in Table1. It indicated that most of the carriers can not call the vessels on time.

Table 1 Statistics of global container shipping carriers' schedule reliability

Year /Quarter	No. of Calling Times	No. of Shipping Carriers	On-time Rate (%)	100	90	80	70	60	50	40	30	20	10	0
2007/Q3	2,237	66	No. of Shipping Carriers	0	7	3	2	12	18	8	8	6	1	1
2007/Q4	2,145	65		4	1	0	4	13	16	8	7	6	4	2
2008/Q1	2,130	66		0	1	3	6	11	19	10	8	2	3	3
2008/Q2	1,935	60		1	1	0	6	6	11	9	10	7	4	5
2008/Q3	1,891	58		1	1	2	4	14	11	11	3	6	1	4
2008/Q4	1,641	57		0	4	0	1	5	6	19	7	3	7	5
2009/Q1	1,633	54		0	2	1	3	7	18	4	5	7	2	5
2009/Q2	1,712	61		0	0	6	8	13	10	11	4	3	1	5

Source: Drewry (2007-2009).

This study began with literature reviews, followed by the conduction of the expert questionnaire survey to collect data required for the main purposes of exploring the influential factors on the schedule reliability. It is the fact that fuzziness and vagueness are common characteristics in many decision processes; thus, Fuzzy Delphi Method was used in this study. It was used to rank the critical factors by interviewing the shipping experts. And then, Fuzzy Analytic Hierarchy Process (FAHP) was applied to analyze the importance degree of each criterion to explore the significance of factors which added the concept of weight values. The survey also explored the different two routes, *i.e.*, Asia routes and American routes whether experts have different decisions to determine influential factors of schedule reliability.

The rest of the study was organized as follows: The relevant literature was surveyed in section 2. Section 3 described research design and methods. Section 4 presented empirical results, followed by conclusions and suggestions in section 5.

2. LITERATURE REVIEW

2.1 THE IMPACT OF SCHEDULE RELIABILITY ON SHIPPERS/CUSTOMERS

Due to low-cost trend, the transportation demand of container shipping is getting increasing recently. The system of container transportation is structured under time-tight schedules. Schedule reliability might be the reference for shippers when planning their supply chains with realistic expectations of delivery time and selecting liner carriers. Thus, delays might not only decrease the reliability of the liner service, but also increase logistics costs to the customer, such as additional inventory costs or additional production costs (*e.g.*, a production stop due to a late delivery of materials) (Notteboom, 2006).

2.2 INFLUENTIAL FACTORS ON SCHEDULE RELIABILITY

Carey (1999) claimed that measures of reliability and punctuality of scheduled services are important in planning, management, operating and marketing of the services. Schedule design is a strategic planning problem in shipping lines (Fagerholt, 2004), and it should meet customers' requirements in terms of frequency, transit time and price (Notteboom, 2006). Vernimmen *et al*. (2007) stated that low schedule reliability can be caused by a number of factors, and many of them beyond the control of shipping companies. For instance, vessel delay is the general reason due to bad weather, port congestion, and labor strikes and so on. Besides, two stages of schedule arrangement are port assignments and navigating by sea. Consequently, it divided into four aspects to explore influential factors of schedule reliability in this study.

(1) Operating strategy of shipping carriers

Shipping carriers master the schedule plan in most of time. Shipping lines could improve their efficiency of schedule reliability by performing different strategies, such as avoiding unreliable ports or using the chase strategy and so on. Shippers Today (2007) said that the unwillingness of carriers to make up for lost time by increasing vessel speed also affect schedule reliability. In addition, some shipping companies increase the control in the supply chain, reduce waiting times and guarantee the high vessel productivity by investing in port operating business, such as investing in dedicated facilities (Chiang and Hwang, 2009; Dynamar, 2005).

(2) Staff in shipping lines

Human factor is also the key component on schedule reliability, such as sense of mission in their own duty of every staff. For instance, the ports of Cape Town and Port Elizabeth have been closed on a number of occasions in the past due to employee strikes which caused further schedule unreliability (Vernimmen *et al*., 2007). With good coordination ability of market players (*ex*. port authority and custom) will be helpful to decrease waiting time and to increase efficiency.

(3) Process management in the shipping lines

Planning the berthing windows is an important design in

shipping lines. Wang *et al*. (2010) also claimed that minimum average schedule missed hours of ships between the ship schedule departure time and the actual departure time will enhance the schedule reliability of ships. Well-arranged berthing windows can reduce the loss in customers and shipping lines; moreover, schedule reliability will increase. After one vessel arriving at port on time, it still has to wait in a queue and this will cause missing of berthing window. Drewry ever mentioned that most container carriers do not provide sufficient buffer time of their weekly schedules for contingencies, because some shipping lines think that buffer time is too expensive (Vernimmen *et al*., 2007). In addition, it also needs to take care of the transit time reliability. If a shipping line is behind the scheduled transit time which might shift containers to other vessels/ports, it will abolish the fixed schedule. Thus, the reliability of transit times between two ports also a key factor which will affect the further transport on time or not. Sözer and Dogan (2007) pointed that a good reputation of high schedule reliability also has high transit time reliability.

(4) Ports condition

Notteboom (2006) pointed that port congestion is one of the factors that can disrupt schedules, negatively affect schedule reliability. Thus, the increased port congestion and infrastructure constraints are some of the reasons which will compel the services of shipping lines. Drewry also agreed that the deterioration of liner schedule reliability was caused partly by port congestion (Shippers Today, 2007). Therefore, the characteristic of vessel schedules such as liners' schedule reliability is also an important factor of port selection (Lee et *al.*, 2007; Malchow and Kanafani, 2004). In addition, the schedule reliability also needed for efficient terminal planning, especially in those ports that are non-first port of call (Vernimmen *et al*., 2007). Thus, berth allocation and terminal efficiency are important because these will cause the bad influence on the schedule of next ports.

3. RESEARCH DESIGN AND METHODOLOGY

Expert questionnaire is used to analyze the reliability of schedule. It has two stages to evaluate the importance of the factors in this study. The first stage utilizes Fuzzy Delphi Method to rank the critical factors by interviewing the shipping experts. In the second stage, Fuzzy Analytic Hierarchy Process is applied to analyze importance degree of each criterion to explore the significant of factors.

4. EMPIRICAL STUDY

4.1 HIERARCHY ARCHITECTURE OF THE STUDY

Reviewing relevant literatures about influential factors in schedule reliability of container shipping carriers, it can propose the hierarchy model of influential factors on schedule reliability as Table 3 according to the goal of influential factors on schedule reliability.

4.2 THE RESULTS OF FDM

According to the criteria in Table 3, fuzzy Delphi is applied to investigate the importance of the influence factors on schedule reliability as Table 4. The results show that the ranking of top five criteria from the overall respondents are planning the suitable ports (0.774), well-arranged the time window (0.774), transship arrangement (0.742), terminal efficiency (0.730), and planning the berth and warehouse previously (0.693). In Asia route, ranking of the top five criteria are planning the suitable ports (0.795), well-arranged the time window (0.757), transship arrangement (0.747), terminal efficiency (0.733), chase strategy (0.695) and planning the berth and warehouse previously (0.695). In American route, the top five criteria are well-arranged the time window (0.796), planning the suitable ports (0.748), terminal efficiency (0.725), transship arrangement (0.724), planning the berth and warehouse previously (0.712).

4.3 THE RESULTS OF FAHP

A general consensus among experts can establish a hierarchical structure. Using FAHP to calculate the importance of the influence factors on schedule reliability based on four objects and

12 criteria. The four objects are including operating strategy of shipping carriers, staff in shipping lines, process management in the shipping lines and ports condition. For overall respondents, the results showed that the process management in the shipping lines is the most important object as Table 5.

5. CONCLUSION AND SUGGESTION

(1) Schedule reliability is important for companies when addressing cargo activities. Delays will decrease the reliability of the liner service, cause a knock-on effect on the hinterland supply chain, and also add logistics costs to the customers. Thus, schedule reliability is important for each shipping line while handling cargo by sea.

(2) The result demonstrated that the 'process management in the shipping lines' is the main consideration in the evaluation process by using FAHP. 'Well-arranged time window' is the most important criterion from overall perspectives. Those results might be the direction for shipping companies to improve their reliability.

(3) Compare the Asia routes with American routes; the critical influential factors between them are not significantly different. It also implies that the critical factors of schedule reliability are almost the same, whether in short sea shipping lines or in deep sea shipping lines.

(4) To the shipping lines, it showed that the process management in the shipping lines is the most important, especially well-arranged the time window in the results of study. Thus, liner carriers should plan sufficient buffer time of their weekly schedules for unexpected situations such as bad weather and port congestion. In addition, shippers can also build more buffer time in their supply chains to cover the damage risk of variability in liner schedules.

(5) Service quality of schedule reliability might have a bigger influence on freight rate negotiations between carriers and shippers; meanwhile, it also will influence on performance of shipping lines. Therefore, it suggests that shippers can treat schedule reliability as a key performance indicator in the shipping lines.

Table 3 Influential factors in schedule reliability of container shipping carriers

Goal	Object	Criteria	Statement of Criteria
Influential Factors on Schedule Reliability	O1: Operating Strategy of Shipping Carriers	O11: Planning the suitable ports	Shipping carriers need to choose the suitable ports according to the port condition, cargo volume and so on.
		O12: Chase strategy	Whether shipping carriers execute the chase strategy or not.
		O13: Investing/specializing terminal	Shipping carriers has invested or specialized terminal.
	O2: Staff in Shipping Lines	O21: Staff's sense of mission	Every staff has strong sense of mission in their duty.
		O22: Coordination ability of staff with external relations	Staff should have good coordination ability with market players (ex. port authority and custom) to decrease waiting time and to increase efficiency.
		O23: Control and management staff in the terminal	The shipping carrier should control and manage the staff in the terminal effectively to avoid strike or slowness at works.
	O3: Process Management in the Shipping Lines	O31: Well-arranged the time window	Shipping lines should plan the time window appropriately.
		O32: Planning the berth and warehouse previously	Before arriving to the port, shipping lines should plan the berth and warehouse in advance.
		O33: Transship arrangement	Shipping lines should transship properly to avoid delay.
	O4: Ports Condition	O41: Freely flowing of ports' access roads	Access roads of a port are freely flowing.
		O42: Berth allocation	Berth allocation will influence on the operating time.
		O43: Terminal efficiency	Terminal efficiency will influence on the operating time.

Table 4 Defuzzied scores and ranking of criteria by using FDM

Criteria	Ranking		
	Overall	Asia Route	American Route
Planning the Suitable Ports	0.774(1)	0.795(1)	0.748(2)
Chase Strategy	0.677(8)	0.695(5)	0.642(9)
Invest/ Specialized Terminal	0.645(11)	0.647(11)	0.618(12)
Staff's Sense of Mission	0.661(10)	0.676(9)	0.630(11)
Coordination Ability of Staff with External Relations	0.677(8)	0.666(10)	0.666(7)
Control and Management Staff in the Terminal	0.688(6)	0.695(5)	0.700(6)
Well-arranged the Time Window	0.774(1)	0.757(2)	0.796(1)
Planning the berth and warehouse Previously	0.693(5)	0.695(5)	0.712(5)
Transship Arrangement	0.742(3)	0.747(3)	0.724(4)
Freely Flowing of Ports' Access Roads	0.634(12)	0.609(12)	0.642(9)
Berth Allocation	0.678(7)	0.680(8)	0.651(8)
Terminal Efficiency	0.730(4)	0.733(4)	0.725(3)

Table5 Evaluation criteria weight of experts from different fields

Object	Weights			Criteria	Overall		Asia route		American route	
	Overall	Asia route	American route		Weights of Criteria in Each Object	Global Weight	Weights of Criteria in Each Object	Global Weight	Weights of Criteria in Each Object	Global Weight
O1	0.211 (2)	0.266 (2)	0.112 (2)	O11	0.735 (1)	0.155(3)	0.71 4(1)	0.196 (2)	0.739(1)	0.082(4)
				O12	0.189 (2)	0.040(7)	0.18 4(2)	0.050 (6)	0.164(2)	0.021(9)
				O13	0.075 (3)	0.016(10)	0.10 2(3)	0.020 (9)	0.098(3)	0.008(1 2)
O2	0.138 (3)	0.101 (3)	0.108 (4)	O21	0.174 (3)	0.024(9)	0.30 2(2)	0.018 (10)	0.084(3)	0.019(1 0)
				O22	0.302 (2)	0.042(6)	0.17 4(3)	0.031 (8)	0.327(2)	0.033(7)
				O23	0.524 (1)	0.072(5)	0.52 4(1)	0.053 (5)	0.589(1)	0.057(6)
O3	0.589 (1)	0.563 (1)	0.667 (1)	O31	0.544 (1)	0.320(1)	0.58 7(1)	0.306 (1)	0.650(1)	0.363(1)
				O32	0.126 (3)	0.074(4)	0.10 3(3)	0.071 (4)	0.098(3)	0.084(3)
				O33	0.330 (2)	0.194(2)	0.31 0(2)	0.186 (3)	0.252(2)	0.220(2)
O4	0.061 (4)	0.070 (4)	0.112 (2)	O41	0.144 (3)	0.009(12)	0.09 8(3)	0.010 (12)	0.236(2)	0.016(1 1)
				O42	0.237 (2)	0.014(11)	0.16 4(2)	0.017 (11)	0.116(3)	0.027(8)
				O43	0.619 (1)	0.038(8)	0.73 9(1)	0.043 (7)	0.648(1)	0.069(5)

REFERENCE

1. Carey, M., (1999), "Ex ante Heuristic Measures of Schedule Reliability," **Transportation Research Part B**, Vol. 33, pp. 473-494.

2. Drewry (2007-2009), **Container Shipping Insight**, Drewry Consultant Institution.

3. Fagerholt, K. (2004), Designing Optimal Routes in a Liner Shipping Problem, **Maritime Policy and Management**, Vol. 31, No. 4, pp. 259-268.

4. Lee, S. Y., Chan, Y. T., and Lee, P. T. W. (2007), "Determinants of Port Selection: Heterogeneity among Major Market Players," in *Proc. 2007 International Conference on Logistics, Shipping and Port Management*, Taiwan, pp. 1-13.

5. Malchow, M. B. and Kanafani, A. "A Disaggregate Analysis of Port Selection," **Transportation Research Part E**, Vol. 40, pp. 317-337.

6. Mikhailov, L. and Tsvetinov, P. (2004), "Evaluation of Services Using a Fuzzy Analytic Hierarchy Process," **Applied Soft Computing**, Vol. 5, No. 1, pp. 23-33.

7. Notteboom, T. (2006) "The Time Factor in Liner Shipping Services," **Maritime Economics and Logistics**, Vol. 8, pp. 19-39.

8. Shippers Today (2007), Drewry Survey Shows Liner Schedule Reliability at Record Low, Vol. 30, No. 3, Retrieved on Dec. 5, 2010, from http: //info.hktdc.com/shippers/vol30_3/vol30_3_ocean01.htm.

9. Sözer, C. and Dogan, Y. (2007), "Key performance Indicators for Maritime Transport System: A Feasibility Study on Swedish Maritime System," Master's Thesis, Göteborg University, Logistics and Transport Management.

10. Vernimmen, B., Dullaert, W., and Engelen, S. (2007), "Schedule Unreliability in Liner Shipping: Origins and Consequences for the Hinterland Supply Chain," **Maritime Economics and Logistics**, Vol. 9, pp. 193-213.

11. Wang, L., Li, A., and Wu, D. (2010), "Vessel Schedule Reliability Optimization for Container Terminal Based on Adaptive Differential Evolution," in *Proc. International Conference on Intelligent Control and Information Processing*, Dalian, pp. 475-478.

12. Buckley, J. J. (1985), "Fuzzy Hierarchical Analysis," **Fuzzy Sets and Systems**, Vol. 17, No. 3, pp. 233-247.

13. Chiang, C. H. and Hwang, C. C. (2009), "Competitiveness of Container Ports in a Region with Cooperation and Integration," **Journal of the Society for Transportation and Traffic Studies**, Vol. 1, pp. 77-91.

14. Deng, H. (1999), "Multicriteria Analysis with Fuzzy Pairwise Comparisons," **International Journal of Approximate Reasoning**, Vol. 21, pp. 215-231.

15. Dynamar (2005), *Post-Panamax Terminals in North-West Europe and the Spectre of Congestion*, Alkmaar, p. 181.