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A Study on the Safety Effect of Leadership & Teamwork Education by Application to the Coastal Passenger Seafarers in Korea

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연안여객선 종사자에게 리더십 및 팀웍 교육 적용에 따른 안전효과에 관한 연구

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Abstract

The Purpose of this study is to supplement the present educational contents of Leadership & Teamwork training systems currently being introduced in the coastal seafarers, whereby it found that in particular, applying the educational contents such as organizational management, onboard leadership, and emergency decision making, etc. are most effective factors to reduce the casualties. In addition, the factors of workload, old age and chemical & alcoholic intake are required to be prior task for improvement. It has also the political implication of necessities to improve customized education in consideration of the operation route area & distance, ship's size & type and seafarers' quality, etc. for more efficient educational effect.

Key words : Coastal passenger seafarers, Leadership, Teamwork, Casualties

Ⅰ. Introduction

Quality shipping can generally be referred to a ship or ship operation that is in accordance with the applicable international standards of the day. such international standards, in turn, can be broadly divided into three categories: economic, social, and safety and environment.

Economic standards are mainly concerned with good commercial practices, social standards are basically concerned with well-being and treatment of seafarers, while safety and environment standards deal primarily with the technical and operational aspects of ships. It is on this last aspect, concerning safety and environment standards that the discussion in this study will concentrate.

Safety and environment standards in maritime transport, as well as in other sectors, are normally subject to specific rules and regulations. In addition these rules and regulation are mostly made by the industries themselves or any other professional bodies. The economic of maritime safety and environment specializes in studying the relationship between the economic system and the maritime

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safety and environment system and the way the two systems interact. Such a way aims at achieving a balance between the objectives of the two systems.

In the maritime sectors, safety, risk-free transportation does not exist. In any given technical and operational setting, the number of accidents threatening the safety to people or property is proportional to the scale of production. As a environment or safety system and economic system are ‘conflicting’ systems, one cannot optimize simultaneously the objectives of both systems. The gain of one is the loss of the other. The environment system interacts with the economic system and the whole issue becomes a matter of choice:

The principles of safety and environment economics apply certainly in maritime transport. Due to the international nature of sea transportation, safety and environment problems in relation to maritime transport have for a long time been a major preoccupation of the international community. Subsequently, a good number of a specialized international rules and regulations have been introduced since 1948 when the IMO(International Maritime Organization) established.

The leadership and teamwork management is one of the international convention created as above procedures. This IMO regulation is aiming at the reduction of an accident of the vessel. According to the 2010 STCW Manila Revision Convention, the leadership & teamwork management regulations should be applied to the ocean-going vessel above 500 gross tonnage from the year of 2012 to 2017 for the coastal ships.

As widely known, the coastal ships’ casualties are also never diminishing in the number which showed more than 2,582 cases in 2017 on the statistics of national maritime safety court in Korea. Especially the passenger ship is recognized as the most important to secure the safety for the preservation of lives and properties.

This study is, therefore, focused on the safety effectiveness on application of the above leadership and teamwork regulations on the costal passenger ship in Korea since lots of coastal passenger ship-owners are not aware of the necessity of this convention as well as the coastal seafarers too on the effect of accident mitigation.

For the purpose of achieving the researching goal, various previous literature studies and documentary evidences with field interviews, etc. have been carried out, then upon extraction of relevant factors, the questionnaires could be prepared for the empirical analysis accompanied by survey.

Ⅱ. Literature Review

Chang et al.(2009) conducted a survey for sailors and carriers to classify the human factors of marine accidents into the categories of each rank (captain, first, second, third, etc.) in which the causes of marine casualties found to be high due to negligence of work and safety consciousness in general.

Jang and Kim(2010) pointed out that it would be desirable to introduce an ERM system that accommodates the requirements of the 1995 STCW Convention, and aimed at establishing specific procedures for efficient construction, implementation and maintenance of ERM.

Kim et al.(2011) suggested that the "Manuscript on the Analysis of Human Accident Error" should be developed to effectively identify the human error

in the process of domestic marine accident investigation.

Kim(2016) classified 25 factors out of total 1417 marine accidents which occurred in the waters around Korea in the recent 5 years (2010 ~ 2014) through careful review of the Central Maritime Safety Tribunal cases. As a result, the main causes of marine accidents are confirmed to be caused by human factors related to engine room and wheel room, such as bad handling of machinery facilities, poor handling of firearms, poor navigational law, Collision and stranding occupy a large proportion, and the types of accidents caused by human factors related to engine room are mainly caused by engine damage or fire explosion.

Kim(2006) studied the general procedure for investigating the root cause of human factors, which is the main cause of marine accidents, and the cause of ship's collision. respectively.

Hwang et al.(2015) tried to develop public transportation systems based on the importance of transporting 16 million passengers per year, and pointed out the employing conditions of seafarers is much poor than ocean-going vessel.

Ⅲ. Status of Coastal Passenger Routes & Analysis of Marine Accidents

1. Status of Coastal Passenger Routes

As of December 31, 2017, the total number of 108 routes(general routes: 81, subsidiary routes: 27, etc.) have been operating around the country in Busan, Incheon, Yeosu, Masan, Donghae, Gunsan, Mokpo, Wando, Pohang, & Daesan, etc. with 168 vessels(141 ordinary vessels, 27 subsidiary vessels).

<Table 1> Status of Routes, Vessels and Firms

Nbr of Routes			Nbr of Vsl			Firms
Ttl	Gen.	Sub.	Ttl	Gen.	Sub.	
108	81	27	167	141	27	68

Source: Statistics of Korea Shipping Association, 2018.

According to the analysis of the passenger transportation performance by year and route, it reached 16.06 million people in 2013, but decreased by 10% or more to 14.27 million in 2014 when the RoRo ship 'Sewol' accident occurred, then it has gradually recovered to 15.42 million in 2016, and 16.9 million people in 2017 respectively.

<Table 2> Status of Coastal Passenger Transport

2011	2012	2013	2014	2015	2016	2017
14,537	16,537	16,062	14,271	15,381	15,423	16,910

Source: Statistics of Korea Shipping Association, 2018.

<Table 3> Status of Coastal Vehicle Transport

2011	2013	2014	2015	2016	2017
2,033,722	2,716,113	2,533,801	2,640,459	2,747,747	2,991,832

Source: Statistics of Korea Shipping Association, 2018.

The number of transporting vehicles are also getting increased year by year showing about 3 million units in 2017, which means the coastal passenger routes are great contributing the national sea logistics.

The number of companies with capital of more than 1 billion won in 2017 is 26, which is nearly half of the total number of companies. In particular, the number of companies with less than 100 million won shows 10 in 2014 and 9 in 2015, but it was 0 in 2017, which means most of the coastal passenger firms are getting improved in terms of financial status.

<Table 4> Capital Status of the Passenger Firms

Size of Capital	Nbr of Firms		
	2017	2016	2015
Total(Mill. won)	58	60	62
Bellow 1	-	9	10
2~3	8	9	10
3~5	13	10	8
5~10	11	10	13
Above 10	26	22	21

Source: Statistics of Korea Shipping Association, 2018.

However, most of the domestic passenger firms are still in inferior condition in light of the capital level since the statistics show more than half of the companies holds the capital size between 2 and 10 millions won only.

As shown on the <Table 4>, most of the coastal passenger firms are operating the vessel within bellow 10 in terms of number, and more than 50% out of them are operating between 1 and 2 vessels only.

<Table 5> The Number of Vessel owned by the Firms

Number of Vessel	Nbr of Firms owned		
	2017	2016	2014
Total	59	60	61
1	17	18	21
2	15	18	14
3	10	5	9
4	13	11	9
5	1	5	4
6	1	-	2
Above 7	2	3	2

Source: Statistics of Korea Shipping Association, 2018.

<Table 5> shows total number of seafarer being employed in the coastal shipping in Korea, about 800 out of them are calculated as employers of the coastal passenger routes.

<Table 6> Seafarer Status in Coastal Shipping

2009	2010	2011	2012	2013	2014	2015	2016	2017
7,702	7,926	8,155	8,155	8,099	7,749	7,743	7,776	7,939

Source: Statistics of Korea Shipping Association, 2018.

2. Analysis of Marine Accidents

The number of marine accidents occurring in Korea has been increasing every year. In particular, in 2016 & 2017, it showed an increase of nearly 60% compared with the previous year. most of the accidents are happening at the area of the coastal area. <Table 7> explains the type of casualties happening in the coastal area and shows the number of accident cases are getting increased year by year. According to the statistics in 2017, an institutional damage accounted for 75% of the total with 520 cases(20.5%) of other injuries. Then, safety and operational obstacles were shown by 442 cases(16.9%), collisions 258 cases(9.1%) and grounding 149 cases(5.9%).

<Table 7> Type of Coastal Sea Casualties

Kind & Year	2013	2014	2015	2016	2017
Collision	196	175	180	235	258
Contact	33	23	19	28	25
Grounding	113	91	96	84	149
Capsizing	39	32	35	32	65
Fire & Expl.	105	79	97	100	96
Sinking	41	21	19	31	29
Engine	489	290	339	703	838
Human death	60	45	113	144	160
Safety Restriction.	227	191	205	331	442
Others	270	146	227	413	520
Total	1,573	1,093	1,330	2,307	2,582

ource: Korea Maritime Safety Tribunal, 2018.

Meantime, the marine casualties happen in various kind of ships with total 2,882 ships in 2017. The accidents have happened in relatively

small ships of less than 500 tons as of 2017, showing average more than 60 cases on the passenger ship over recent past.

The marine accidents are caused by one or several factors. Looking at the case of marine casualties surveyed by the marine safety tribunal in 2017, a number of marine casualties have been caused by operational malpractice with the case of 1,170 and malfunctions & ship's defects with 175 cases, and 1,345 cases were resulted in the course of reorganization.

The causes of operational errors and malfunctions are mainly led by human errors. It can be said that marine accidents should solve the problems of human error as priority solution.

<Table 8> Ships' Type of Coastal Sea Casualties

Year	Pass.	Cgo	Tank	Tug	Othr	Fish	Total
2013	29	107	52	78	201	467	839
2014	51	111	51	102	221	1,029	1,565
2015	66	115	65	94	401	1,621	2,362
2016	65	116	67	77	430	1,794	2,549
2017	46	127	73	91	606	1,939	2,882

Source: Korea Maritime Safety Tribunal, 2018.

Otherwise, the number of marine accidents that have been steadily increasing since 2013 is unlikely to decline significantly in the future.

Ⅳ. Introduction of Leadership & Teamwork

This training course was originated to comply with the requirements set by International Maritime Organization(IMO)´s STCW 2010 convention and applies to the bridge and engine room officers of the merchant vessels.

The course focuses on issues concerning effective communication and management of bridge and engine room resources in conjunction with situational awareness and workload management. The course also covers the topics: National and international rules and regulations, mission planning, safe navigational watch keeping, engine room watch keeping for safe operation, emergency procedures, crisis management, risk handling, vessel traffic service(VTS) and pilotage.

The main objective is to improve the operational efficiency and safety while navigating the ship, including to reduce the risk of accidents and undesired events that have an impact on health or property.

Further, focus is on creating an awareness about the different areas of responsibility and working conditions with regard to the bridge, deck, engine room and the maritime environment. A key point is to ensure that the participants keep a high standard of competence within the CRM(Cockpit Resource Management)/BRM(Bridge Resource Management) principles.

Curriculums are as follows.

-Introduction to BRM and Engine room Resource Management(ERM)
-Error chain analysis, situational awareness including case studies
-Master - team - pilot interaction
-Bridge - engine room - team
-Leadership, organization on the bridge, in the engine room and teamwork
-Communication
-Emergency response & Crisis management
-Voyage planning
-Safe operation of engines
-Stress and Fatigue
-Suitable For
-Navigators and engineers seeking to comply with IMO-STCW requirements or outright

improve their team and human performance skills.

Examination: No written or oral examination.

The Leadership and Teamwork(Ex. BRM/ERM) training is further defined as follows. "Education to cultivate the ability to utilize and coordinate both the skills, knowledge, experience and available resources of missions(engine room) working teams to achieve or achieve the goals set for safe and efficient navigation".

Leadership and Teamwork Education is not a program to train ship's navigation technology but an education program to change human attitude to use navigation knowledge that they know well according to navigation procedure. It is not limited to missions(engine room). It is an education that can be applied to all parties in ship operation.

Generally, when a ship is operated in a normal condition, it is only necessary to follow standardized operating procedures. However, there are some situations in which unexpected variables may arise in a special situation of a ship, and in some cases, it may not be possible to settle the situation with only the knowledge and experience that he has known so far. In this situation, synergy can be achieved when the crew cooperates to solve the problem together. Leadership and Teamwork training is an education that helps the ship crew learn how to get synergy from each other in solving a problem.

The development of BRM education comes from CRM, which was conducted for aircraft pilots. The aircraft cockpit was replaced with the mission of the vessel, and the same training module was applied to the environment of the missions that controlled the ship.

In accordance with the 2010 STCW Manila Revision Convention, the ocean-going vessel above 500 gross tonnage should be applied in this regulations. It is for those operating class engineers and management class officers serving on the ocean-going merchant ships.

This regulation have been also in force on the officers and engineers serving on the coastal ships from 1st Jan., 2017. However, most of the ship-owners and seafarers engaging in the coastal shipping are not aware of this regulation. This study is, therefore, focused on the demonstration of the safety effect on the coastal passenger ships for the purpose of understanding the importance of this international convention.

Ⅴ. Questionnaire & Empirical Study

1. Questionnaires

In this study, a questionnaire survey for 54 Seafarers was carried out with the 7 point scale on local passenger ships and statistical analysis was conducted on the results. The survey was executed from July to September, 2017, based in Mokpo Harbor, which has the largest number of coastal passenger ships in Korea. The general characteristics of respondents to the questionnaire are as follows.

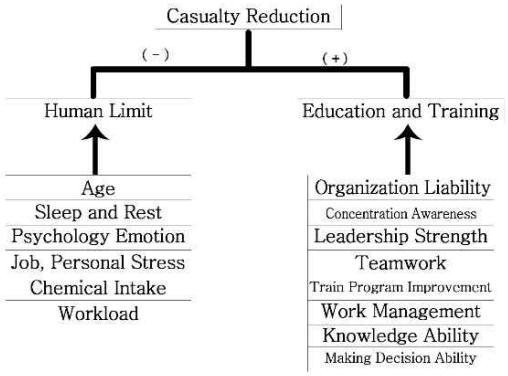
First, the operation route distance are mostly 20 miles or longer, and the number of employees were mainly with more than 20. Secondly, Most of the respondents are the coastal passenger ships' employees with the experience of 5 to 10 years or more, and their positions were an officers or engineers including captain, sailors and shore managers, etc. Thirdly, the majority education levels were graduation of high school, which shows somewhat low grade of academic backgrounds. Half of the respondents received the leadership and

teamwork education, and they were in a positive position on the necessity of the leadership and teamwork education for the sake of ship's safety operation.

2. Empirical Analysis

1) Analysis Model & Hypotheses

This study is aiming to demonstrate an safety effectiveness on the coastal passenger ships through analysing the factors affecting to the leadership & teamwork on the coastal passenger ships. Therefore, the researching goal is setting up to verify casualty reduction.



[Fig. 1] Hypotheses & Analysis Model

As a independent variable factors affecting to the negative(-) were selected as old age, insufficient sleep & rest, psychology emotion, job & personal stress, chemical intake like alcohol and workload, etc. which are all in relation to human limitation. Meanwhile the study classified the factors affecting to the positive(+) as organization liability, concentration & awareness, leadership strength, teamwork, train program improvement, work management, knowledge ability and decision making ability, etc., which are all in conjunction with the improvement possibility in accordance with education and training procedures.

2) Methodology & Results

The analysis tool was used by PASW Statistics 18 in order to analyse the value of mean and standard deviation, etc., and the questionnaire survey result.

Amos 18.0 was also utilized for the analysis of above hypotheses model together with corelation matrix for the measuring factors, and maximum likelihood method was used for the parameter estimation method.

Meantime, in order to verify a suitability of hypotheses model, the chi-square value, root mean square error approximate(RMSEA), goodness of fit index(GFI), adjusted goodness of fit index(AGFI), normed of fit index(NFI), comparative fit index(CFI), incremental fit index(IFI) and parsimony adjusted index, etc. were introduced.

According to the empirical analysis as shown on the <Table 9>, the technical statistics of the corelation matrix on the factors of human limitation were calculated at relatively high value with average 4.9～6.8. In view of the related scale, the specific factor values of age & workload, sleep & rest and chemical intake are showing much high while the psychology & emotion factor values are low, which means these kinds of factors are influenced negatively in securing the safety operation of the coastal passenger ship.

In the case of educational training factors, the descriptive statistics of the variables are distributed in the range of 5.3 to 6.5, which is also higher than the average. Among these variables, there is a relatively low level of knowledge on the improvement of shipboard training programs and efficient resource management, but relatively high level of 6 or more in terms of shipboard

organization, structure, authorization and responsibility, etc., which means more intensive training and education in these areas are very necessary. In other words, it suggests the policy implication that education and training are needed in the part of decision making in emergency, organization management and onboard leadership, etc.

<Table 9> Technical Statistics of Analysis Items by Variables

	Def.	Q Items	Av	Stan. Dev.	Reliables
Human Limit	H1	Age	6.7	0.59	α=0.8243
	H2	Sleep, Rest	5.1	0.60	
	H3	Psychology, Emotion	4.9	0.43	
	H4	Job, Personal Stress	5.3	0.63	
	H5	Chemical Intake	6.2	0.48	
	H6	Workload	6.8	0.62	
	Average		5.8		
Edu & Train	E1	Organization, Liability	6.5	0.62	α=0.7254
	E2	Concentration, Awareness	6.1	0.52	
	E3	Leadership Strength	6.3	0.54	
	E4	Teamwork	6.2	0.61	
	E5	Train Program Improvement	5.3	0.41	
	E6	Work Management	6.1	0.45	
	E7	Knowledge Ability	5.9	0.63	
	E8	Making Decision Ability	6.3	0.58	
	Average		6.1		

The results of the correlation matrix and normality test between the variables set as the measurement variables are shown in the <Table 10>. In the case of correlation, the coefficient was 0.177～0.660, and all significance levels were statistically suitable in the meaningful at 0.01.

In order to determine the normality of the data, the degree of skewness and kurtosis is calculated for each of the measurement variables. In general, if the absolute value of skewness & kurtosis is greater than 3.0 & 8.0 respectively, it is judged that the value regarded as extreme does not have regularity.. In this study, however, it is verified that the maximum value of skewness and kurtosis is 1.01 and 0.911 respectively based on the absolute value. The normality is, therefore, confirmed to be secured.

<Table 10> Corelation and Normality Analysis

Var.		Human Limit						Education & Training							
		H1	H2	H3	H4	H5	H6	E1	E2	E3	E4	E5	E6	E7	E8
H Limit	H1	-													
	H2	.571	-												
	H3	.635	.409	-											
	H4	.511	.560	.464	-										
	H5	.672	.498	.445	.463	-									
	H6	.660	.560	.511	.501	.489	-								
	E1	.397	.354	.305	.289	.287	.222	-							
Edu Train	E2	.299	.302	.308	.255	.266	.179	.567	-						
	E3	.288	.265	.265	.191	.233	.201	.453	.577	-					
	E4	.270	.234	.310	.205	.177	.232	.544	.447	.538	-				
	E5	.301	.305	.204	.188	.206	.256	.533	.543	.551	.449	-			
	E6	.309	.277	.236	.301	.207	.198	.447	.551	.533	.509	.409	-		
	E7	.282	.198	.292	.299	.255	.306	.564	.477	.422	.556	.511	.505	-	
	E8	.256	.208	.275	.272	.188	.285	.499	.508	.419	.495	.539	.559	.523	-
Per. (-)		.708	.732	.982	.499	.810	.609	.432	.354	.387	.423	1.01	.449	.508	.537
Kur.		.237	.019	.453	.911	.263	.523	.287	.159	.034	.125	.015	.007	.033	.172

Note: All corelation coefficients are omitted for $p < 0.01$ **

The main purpose of this study is to analyze the hypothesis of independent variables for the dependent variable of marine accident reduction. From the analysis the chi-square value is 1247.623, indicating that the model is inadequate. However, since the Chi square value tends to be very sensitive to sample size, there is a need to consider other alternative fitness indexes.

As a result, it was verified that the RMSEA 0.056, GFI 0.894, and AGFI 0.899 were suitable as absolute fitness indices. In addition, the NFI, the CFI, and the incremental fit index(FFI) were 0.912, 0.911, and 0.922 respectively, and the Relevance Standard Compliance Index(PNFI) was 0.811 as shown on the <Table 11>.

Therefore, other indices except for the Chi-square value, which responds sensitively to the sample size, were found to be appropriate and statistically significant. Thus, the model was finally adopted without modification.

<Table 11> Fit Analysis of Hypothetical

Division	Criteria	Measures	Fit or Not
Absolute fit index			
χ^2	> .05	1247.623	Not Fit
RMSEA	< .04 - .07	.056	Fit
GFUI	> .88	.894	Fit
AGFI	> .79	.899	Fit
Incremental fit index			
NFI	> .92	.912	Fit
CFI	> .92	.911	Fit
IFI	> .92	.922	Fit
Simplicity Suitability Index PNFI	> .59	.811	Fit

Ⅵ. Conclusions

As the data of statistics is shown on the previous chapter, the coastal ships' casualties are getting increased year by year in Korea. In terms of protecting the people's lives and their properties at sea, the safety operation of passenger ships is especially recognized as the most important and prior political issues.

On the above background, this study focused on identifying the safety effect of the present leadership & teamwork education and training systems which were in force on the costal seafarers from the 1st Jan., 2017 as a way of reducing the maritime accidents mostly caused by human errors.

According to the empirical study, it has researching implications that the trains are needed more intensively & elaborately on organization techniques, use of authorization, structuring, responsibility, strengthening leadership, ability to apply decision-making technology and teamwork. In other words, marine accidents could be reduced through supplementing and applying the above contents to the present leadership and teamwork education system.

In addition, the analysis suggested that the factors of work load, old age and chemical & alcoholic intake, etc. which are affecting negatively to the ship's safety operation should be seriously recognized as the improvement task priority in coastal seafarers. It has also political implication that more customized education according to the situation of coastal passenger ship such as consideration of route distance, operation area and crew qualities, etc. should be taken into account for more efficient educational effect.

This study, however, has a researching limitation in that the analysis of the questionnaires was carried out only on the employees of the coastal passenger routes in Mokpo area.. Therefore, the further and widen scale of analysis are needed for more obvious objectivity.

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