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An Analysis of Pilotage Marine Accidents in Korea

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ABSTRACT

Concerns have been raised around pilotage in Korea due to a rise in marine accidents in the 2010s. Since the late 2000s, a debate has been sparked on the most suitable age of retirement for Korean pilots. The debate has focused on the extension of retirement age of pilots from 65 to 68 and whether this will affect the probability of marine accidents. Therefore, it is crucial to calculate the probability of marine accidents in relation to different age groups of pilots. After collecting the data of marine accidents caused by pilot's negligence, the study suggests two measurements of probability of marine accidents during pilotage: on the basis of the number of pilotage services and the hours of pilotage services. The analysis finds that age is not the exclusive cause of pilotage marine accidents by the age group over 65.

1. Introduction

Pilotage, in maritime terms, means the services of a pilot, who gets on board to guide a ship along safe waterways in and around a port or at sea. In Korea, the license of a pilot is issued by the Ministry of Oceans and Fisheries (MOF), after rigorous tests.

There have been several issues and challenges for pilotage in Korea. First of all, pilots and the Korea Maritime Pilot' Association (KMPA) have requested MOF to extend the retirement age of pilots from 65 to 68 since 2009. In 2009, the Korean Government stopped the extension of retirement age. Before this decision Korean pilots could serve additional three years after the age of 65. Second, the average age of pilot applicants rose from 50.0 in 2005 to 52.1 in 2013. Higher revenue of a pilot than that of a captain in Korea lures senior seafarers to apply to a pilot's license. In addition, average age of newly licensed pilots jumped from 43.4 in 2000 to 53.3 in 2013 (KMPA, 2014). The aging of newly licensed pilots is caused by the seniority preference system of license examination, where a senior seafarer can get a higher score in the evaluation of navigation experience. The aging of pilots and applicants raised a concern about pilotage skill from the customers and the shipping companies. Thirdly,

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marine accidents during pilotage in the 2010s, such as oil spills in Yeosu of 1,003 thousand litres in January 2014, heated up the debate on pilotage and marine safety. The pilot and captain in the 2014 oil spill were arrested due to negligence not by the Pilotage Act, but by the Marine Environment Management Act. The Pilotage Act describes a pilot on board as an advisor or an information provider on navigation around a port (Park, 2018).

The MOF drafted and proposed a new Pilotage Act to the National Assembly in November 2016, in order to handle policy issues in service quality and marine accidents. Even with a new amendment of Pilotage Act, major pilots aged 65 and under, and KMPA assert continually that it is necessary for MOF to extend the retirement age in order to better utilize the skills and experience of aged pilots. Hence, an exact analysis on marine accidents during pilotage may lead the MOF, pilots, KMPA, and shipping companies to an agreement on the main causes of the marine accidents and on policy decision of the retirement age of pilots. The debate on the retirement age still exists.

The present paper aims at reviewing marine accidents during pilotage in Korean ports and examining the characteristics of each group of pilots by age and port. Diverse elements of hazards during pilotage come from competency of a pilot, competency of captain, port control, passage plan, navigation aids, and weather (Trbojevic and Carr, 2000). Understanding these elements, the paper focuses on the pilotage marine accidents caused by pilot's negligence. The Korea Maritime Safety Tribunal (KMST) examines and judges the causes of marine accidents in accordance with articles of the Act on Investigation and Inquiry into Marine Accidents. Hence the paper can clarify the causes of marine accidents during pilotage and limit its analysis on the cases of pilot's negligence. The paper is structured as in the following. Section 2 includes literature review on marine accidents and data collection on the pilotage marine accidents in Korea. Section 3 explains the main methodology of the analysis on pilotage marine accidents. Section 4 describes the pilotage marine accidents and analyses them by groups of pilots age and by port. Section 5 discusses the results of Section 4 and presents different views on a higher probability of the aged pilots in the pilotage marine accidents. Section 6 concludes the paper.

2. Literature Review and Data

2.1. *Literature Review*

Studies on pilotage are limited. One of the possible reasons behind this is because the importance of pilotage in marine accidents within a port area is underestimated. Many recent studies on marine accident in ports do not consider pilotage, for example, Yip (2008) and Chauvin et al. (2013). Akten (2004) provides empirical evidence that pilotage is one of the key measures to reduce marine accidents in confined waters.

It is believed that human error is one of the major causal factors in marine accidents. In Korea, the ratio of pilotage marine accidents caused by pilot's negligence records 6.1% of 767 cases of marine accidents within port areas and their sea channels during the period from 2004 to 2013 (KMST, 2014; KMPA, 2014). In a navigation of a vessel within a port area, pilotage is one of hazards, which might cause a harmful consequence such as grounding (Trbojevic and Carr, 2000). Trbojevic and Carr (2000) divide pilotage error into the two different errors by the pilot noticing an inappropriate command and by the ship's crew failing to execute the appropriate command of the pilot. Darbra et al. (2007) attempted to outline the safety culture of pilots by interviewing 77 pilots in Australia and New Zealand. They found that safety was considered as one of the basic tasks of pilotage. A 'blaming culture' exists among pilots and needs to be replaced with more positive thinking in order to improve the pilotage system. Fatigue of pilots is further identified as a matter for concern, especially when poor boarding arrangements occur more and more frequently.

Kunnaala, Lappalainen and Tapaninen (2013) studied how 60 pilotage organisations operate in eight European countries. They presented the basic tasks of pilotage as a process and then benchmarked the pilotage process in the framework of a standard management system ISO 9001. In many pilotage organizations, the number of pilotage accidents is an indicator of organisational effectiveness. Lappalainen, Kunnaala and Tapaninen (2014) found that shipping accidents in Finland are lower than other countries because of the efficient pilotage of vessels in Finland. Nuutinen and Norros (2009) analysed the cognition during pilotage in the framework of core task analysis. They identified nine tensions in the pilotage activity. The nine tensions are caused by increasing demand for safety, bigger ships, and advancing navigation technologies. Chin and Debnath (2009) modelled collision risk in port waters by analysing the pilots' perception of spatial and temporal proximities between ships.

2.2. *Data Collection*

A marine accident in Korea is investigated and determined by KMST. KMST follows the procedures described by the Act on Investigation and Inquiry into Marine Accidents (Ministry of Government Legislation, 2018). The Act defines the causes of marine accidents: intention or negligence of any person; qualifications, skills, work conditions or services of the crew of the vessel; structure, materials and manufacture of the hull or engines, or equipment or performance of the vessel; and others. The Act adopts the international standards and recommendation by the International Maritime Organization (IMO), Resolution MSC. 255 in 2008. The Resolution also describes the contents of investigation report on marine safety, which includes the causal factors such as mechanical, human and organizational factors in Chapter 2 (International Maritime Organization, 2018).

Hence, this study collects the statistics of KMST and selects the cases of marine accidents caused by intention or negligence of a pilot. We select additionally the pilotage marine accidents in port areas and around the sea channels to those ports in Korea. This process enables us to exclude the marine accidents occurred by other factors such as skill and work conditions or services of crews of the ship. Furthermore, the pilotage in Korea for a ship corresponding to the standards of Article 20 (Compulsory Pilotage) of the Pilotage Act is obligatory for the ship. Therefore, KMST can clarify and indicate the marine accidents caused by pilot's negligence.

The number of marine accidents per year grows gradually from 799 in 2001 to 1,070 in 2004 to 1,306 in 2013 in proportion to the increasing ocean going vessel traffic in Korean ports. The ocean going traffic increased from 123 thousand vessels of arrival and departure to 150 thousand vessels and to 166 thousand vessels over the same period (Korea Maritime Institute, 2017). The total number of pilotage marine accidents in the period from 2004 to 2013 was 47 (KMST, 2014; KMPA, 2014).

3. Methodology

A few approaches to analysis of marine accidents have been identified. Chalmers University of Technology adopts a tool for analysing accidents and also pinpointing areas where improvement is needed (Chalmers University of Technology, 2014). General hazard during navigation within

a port can be detailed into the specific hazards such as hazard by pilotage in view of hazard analysis (Trbojevic and Carr, 2000). Although these methodologies give a fruitful information on finding risks at navigation within a port, these do not supply a proper tool in counting probability of pilotage marine accidents by port and by age groups.

The main methodology of this paper is based on the Incidence Rate Ratio Analysis. We are facing a problem in measuring exposure to marine accidents. In pilotage, we can consider two measurements of the exposure: (1) number of pilotage services in a certain period; and (2) pilotage hours, which are similar to aviation pilotage (Civil Aeromedical Institute, 2003). The first measurement is related to the rate of incidences per number of pilotage service; the second is related to an incidence rate per pilotage hour.

The total pilotage hours are composed of hours of land transport before pilotage, pilotage services at sea with pilots on board, movement at sea before and after pilotage, and land transport after pilotage. The present paper chooses hours of pilotage service at sea as a proxy of pilotage hours.

Hence, the paper calculates the probability of marine accidents during pilotage in Korean ports in the following methods. The first probability (Prob 1gp) is based on the number of pilotage services.

$Prob1_{gp}$ = (Number of marine accidents during pilotage of gp pilot group)
/(Total maximum number of pilotage service gp pilot group) (1)

where,
$Prob1_{gp}$: probability of marine accidents of g group during pilotage in p piloting area

The second probability (Prob 2gp) is based on the hours of pilotage.

$Prob2_{gp}$ = (Number of marine accidents during pilotage of gp pilot group)
/(Total maximum hours of pilotage service of gp pilot group) (2)

where,
$Prob2_{gp}$: probability of marine accidents of g group during pilotage in p piloting area

In calculating the probability in Equation 1 and 2, we need to define the maximum number of pilotage services and the maximum hours of pilotage services in each Korean piloting area. Every piloting area has its own characteristics in sea channel, tide, length of approach channel, berth, vessel traffic, water depth of the sea, flows, and weather conditions. Hence, the number and hours of pilotage services in Korea piloting areas are different. In addition, vessel traffic in each year differs in the number and hours of pilotage service. The paper chooses the records of maximum number and maximum pilotage hours in each Korean piloting area from the real records during the period from 2004 to 2013 in order to calculate the probability of marine accidents in Equation 1 and 2. The incidence ratio is calculated the incidence ratio program of STATA.

Another methodology is an interview with staff members of KMPA and Incheon piloting area. The authors visited KMPA and Incheon piloting area in 2016, 2017 and 2018 in order to discuss the marine accidents during pilotage and trace the human factors of marine accidents.

4. Analysis on Pilotage Marine Accidents in Korea

4.1. *Pilotage Services*

The Pilotage Act in Korea in 2018 describes the requirement of pilot licensing: a master of a ship of six thousand tons and more, boarding ships as a captain for five years or longer; the applicant must pass the pilot qualification test and a physical health examination. The requirements imply that the main source of pilots is Korean seafarers, who have enough experience in navigation and on-board work. The Korean government categorized Korean sea into 11 piloting areas, in accordance with the main Korean ports such as Incheon piloting area and Busan piloting area, as listed in Table 1. In 2016, the Korean government also added the Jeju piloting area. The duties of pilots in each piloting area contain the job of pilotage by turns, waiting and preparation for uncertain vessel traffic, piloting, alert, and off-hour as in Appendix 1.

As shown in Table 1, the number of pilots in Korean ports in 2015 was 251, made of 52 pilots in Busan, 42 in Yeosu, 38 in Incheon, and others. The average age of pilots was 59.4. The main age group was the group of 60 to under 65, sharing 41% of pilots. The number of pilots increased from 179 in 2001, to 237 in 2011, to 251 in 2015 (Korea Maritime Pilot' Association, 2016).

Table 1

Piloting areas and number of pilots by age in 2015

Area/Age Group	Under 45	Under 50	Under 55	Under 60	Under 65	65 & Over	Total (Average age)
Busan		1	4	21	22	4	52(59.3)
Incheon			1	11	20	6	38(61.2)
Yeosu	1	2	3	15	15	6	42(59.0)
Ulsan		5	4	5	14	3	31(58.0)
Pyeongtaek		2	3	10	10	4	29(58.9)
Masan		1	1	8	5	1	16(58.3)
Daesan				4	7	5	16(62.3)
Pohang			1	4	4	1	10(59.5)
Gunsan				2	4	1	7(61.3)
Mokpo		1	1	2	1	1	6(57.)0
Donghae			2	1	1		4(55.6)
Total	1	12	20	83	103	32	251(59.4)

Source: KMPA

Table 2

Enlargement of vessels in piloting areas

Area/Year	2004			2013		
	No of pilotage services per pilot	Hours of pilotage per pilot	Average size of vessels (dwt)	No of pilotage services per pilot	Hours of pilotage per pilot	Average size of vessels (dwt)
Busan	793.6	502	17,951	713	562	28,530
Incheon	447.4	736	12,535	389	679	19,763
Yeosu	550.6	763	21,267	499	728	31,129
Ulsan	867.7	575	16,536	838	567	20,639
Pyeongtaek	224.5	416	23,771	410	784	26,216
Masan	428.3	576	15,251	292	405	27,943
Daesan	201.1	264	27,529	448	547	24,857
Pohang	724.3	659	15,278	679	615	16,740
Gunsan	550.7	545	15,071	447	433	19,203
Mokpo	764.8	401	10,718	335	501	30,340
Donghae	605	857	6,181	625	446	13,400
Total	556.8	585	16,957	534	616	24,997

Source: KMPA

The working shifts in each Korean piloting area tends to equalize the

pilotage hours of each pilot. For your reference, Busan port has the work shift of 11 days on working, 13 days off, 5 days on waiting, and 2 days on assisting. Incheon port has different work shift: 7 days on and 7 days off with repeating rotation (Korea Maritime Pilot' Association, 2014). Furthermore, the Pilotage Act regulates that every shipmaster shall, where a pilot gets on board his/her ship, allow the pilot to pilot the ship except where there are justifiable reasons not to do so (Pilotage Act, Article 18 (4)). Hence, the paper can assume that pilots in each piloting area work overall in similar hours under the same shift scheme. Each piloting area has its own peculiarities in the number of pilotage and pilotage hours due to the characteristics of vessel traffic, sea channels, and other environment. We consider the findings of the Chalmers University of Technology in Sweden, showing that the most common causes of the 94 pilotage marine accidents from 2004 to 2014 in Sweden are machinery damage followed by contact with fixed or floating objects (Chalmers University of Technology, 2014). The University defines a significant weather effect contributing to marine accidents, caused by wind and visibility. The rate of marine accidents caused by a significant weather effect was 18.1 % of 94 pilotage marine accidents (Chalmers University of Technology, 2014). Nevertheless, we can assume that all pilots in each piloting area are exposed evenly to weather condition in long term periods such as ten years from 2004 to 2013.

On the demand sides, we can observe the enlargement of vessels, expansion of port facilities such as length of berths and depth of channel, and port development resulting different kinds of vessels in arrival. The average size of vessels with pilotage rose from 16,957 DWT in 2004 to 24,997 DWT in 2013 (Table 2). All piloting areas except Daesan piloting area demonstrated the enlargement of vessels. Number of pilotage per a pilot decreased from 557 in 2004 to 534 in 2013; hours of pilotage per a pilot increased from 585 in 2004 to 616 in 2013.

4.2. *Analysis on Marine Accidents and Probability*

We have collected the data of marine accidents caused by pilot's negligence in Korean ports and the data of KMST on pilotage in Korean ports from 2004 to 2013, as shown in Table 3. Although there could be a debate on the main factors causing marine accidents during pilotage, the paper follows the report by KMST. For improving the quality of data on marine accidents, we necessitate to collect a demographic structure of Korean pilots. Nevertheless, there is not complete data on demographic structure of Korean pilots in each year of the examined period but the demographic data in 2015. Hence, we assume that demographic structure of Korean pilots kept the same age structure from 2004 to 2013 as in the demographic structure in 2015. During the period, the incidence rate calculated from the record of number of pilotage and marine accidents was 0.00004 or 0.004% (KMPA) as shown in Table 3. The incidence rate of 0.004% during pilotage in Korean ports is much lower than the probability of marine accidents of 0.03% during pilotage in Sweden from 1999 to 2009 (Efficiensea.org, 2012).

However, the incidence rate from KMPA does not include the maximum number and hours of pilotage in each piloting area as shown in Equation 1 and 2. The paper calculates the maximum number and the maximum hours of pilotage by selecting maximum records of each piloting area from 2004 to 2013 as listed in Table 4. In addition, when selecting the maximum records, our analysis divides the period into two periods: from 2004 to 2008 and from 2009 to 2013. In 2008, the world maritime industry showed a sudden depression.

Table 3

Marine accidents during pilotage and number of pilotage from 2004 to 2013

Year/Item	Marine accidents	Number of pilotage services	Incidence rate (%)
2004	2	113,026	0.002
2005	4	117,279	0.003
2006	5	117,688	0.004
2007	4	123,238	0.003
2008	3	125,677	0.002
2009	5	118,073	0.004
2010	4	129,894	0.003
2011	6	135,095	0.004
2012	10	135,196	0.007
2013	4	129,893	0.003
Total	47	1,245,059	0.004

Source: KMPA

Table 4

Maximum number and maximum hours of pilotage services per year and pilot from 2004 to 2013

Area/item	2004 ~ 2008		2009 ~ 2013	
	Maximum Number	Maximum Hours	Maximum Number	Maximum Hours
Busan	833	594	877	674
Incheon	450	736	389	679
Yeosu	551	763	527	766
Ulsan	868	575	891	613
Pyeongtaek	398	528	448	573
Masan	520	739	378	523
Daesan	374	689	527	1001
Pohang	853	764	747	863
Gunsan	611	602	481	472
Mokpo	605	900	464	613
Donghae	875	529	838	551

Source: Author's elaboration on the data of KMPA

The paper estimates the maximum number and the hours of pilotage services from Korean piloting areas: 1,374 thousand vessels and 1,531 thousand hours as shown in Table 5. With the estimated maximum number of pilotage services in Korean piloting areas, 1,374 thousand vessels are more than the real record, 1,245 thousand vessels. The incidence rates are 0.000034 and 0.000031, respectively, as shown in Table 6. The incidence rates by estimated maximum number and hours are lower than 0.00004 calculated by KMPA as shown in Table 3.

Table 5

Estimated total maximum number and maximum hours of pilotage services in Korea piloting areas from 2004 to 2013

Age Group	Number of pilotage services				
	Real records			Estimated number	Estimated hours
	2004-2008	2009-2013	Total	Total	Total
65 & under	546,967 (17)	593,923 (24)	1,140,891 (41)	1,259,464	1,494,451
Over 65	49,941 (1)	54,228 (5)	104,168 (6)	114,994	136,450
Total	596,908 (22)	648,151 (25)	1,245,059 (47)	1,374,458	1,530,901

Note: The figures in parenthesis denote marine accidents during pilotage

Source: Author's elaboration on the data of KMPA

Since the main policy issue in Korean pilotage is the extension of retirement age, the paper focuses on the difference in probabilities of two age groups: a group of 65 and under, and another group over 65. We acknowledge a higher incidence rate in the group of over 65 during the period from 2004 to 2013 compared to the group of 65 and under, as illustrated in Table 6. The incidence rates of the group over 65 during the period show respectively 5.8E-05 in real records of pilotage, 5.2E-05 in estimated total maximum number, and 4.4E-05 in estimated total maximum hours.

If we divide the period into two: the first period from 2004 to 2008 and the second period from 2009 to 2013, the group of age over 65 demonstrates a lower incidence rate during the first period than the group of age 65 and under. During the first period, the incidence rates of group over 65 are respectively 2.0E-05 in real records of pilotage, 1.8E-05 in estimated maximum number, and 1.6 E-05 in estimated maximum hours, which are lower than those of age group of 65 and under, 3.1 E-05, 2.8 E-05 and 2.5 E-05.

The incidences rate of the age group of over 65 increased during the second period. Although this study does not address the cause of marine accidents, we hypothesize that the age group over 65 is exposed to different environment in vessels, ports, vessel manoeuvering skills, vessel traffic, and pilotage process from the environment which the aged pilots were accustomed in the first period.

Table 6

Incidence rate by estimated total maximum number and hours of pilotage services

Age Group	Real records of pilotage services			Estimated total maximum number			Estimated total maximum hours		
	Prob1 (number of services)			Prob1 (number of services)			Prob2 (hours of services)		
	2004-2008	2009-2013	Total	2004-2008	2009-2013	Total	2004-2008	2009-2013	Total
65 & Under	3.1 E-05	4.0 E-05	3.6 E-05	2.8 E-05	3.7 E-05	3.3 E-05	2.5 E-05	2.9 E-05	2.7 E-05
Over 65	2.0 E-05	9.2 E-05	5.8 E-05	1.8 E-05	8.4 E-05	5.2 E-05	1.6 E-05	6.7E-05	4.4 E-05
Total	3.0 E-05	4.5 E-05	3.8 E-05	2.7 E-05	4.1 E-05	3.4 E-05	2.5 E-05	3.2 E-05	3.1 E-05

Source: Author's elaboration on the data of KMPA

We explore further into each piloting area in order to find a major cause of higher incidences rate in the age group of over 65 during the second period. On average, the age group over 65 experienced six marine accidents during the whole period: one in the first period and five in the second period. Four marine accidents among five in the second period occurred in Incheon and one in Donghae area as listed in Table 7. When considering the average age in each piloting area, we find that Daesan area records the highest, 62.3 as shown in Table 1. But Daesan had no marine accidents from 2004 to 2013. Incheon ranks the third on average age, 61.1 following Gunsan, 61.3.

Table 7

Marine accident during pilotage by age group and by port

Area /Age Group	2004-2008		2009-2013		Total
	65 or under	Over 65	65 or under	Over 65	
Busan	5	1	3		9
Incheon	4		8	4	16
Yeosu			8		8
Ulsan	3		1		4
Pyeongtek	1		2		3
Masan	1		2		3
Daesan					0
Pohang					0
Gunsan	1				1
Mokpo					0
Donghae	2			1	3
Total	17	1	24	5	47

Source: KMST

Therefore, age may not be the exclusive cause of marine accidents during pilotage by the age group over 65. Aging and the characteristics of Incheon piloting area seems to bring more marine accidents. We can observe that the incidence rates of the group of 65 and under in Incheon also increased during the second period.

5. Discussion

While excluding the pilotage marine accidents at Incheon piloting area, the paper finds that the incidence rate of the group over 65 is lower that of the group of 65 and under as shown in Table 8. This result brings an argument against the extension of retirement age of Korean pilots. However, the incidence rate of the group over 65 in all piloting areas are higher than that of the group 65 and under during the second period as shown in Table 6. From this, we can argue that the extension of retirement age might bring higher incidence rate. Since we have two contradictory results of incidence rate for the two groups over 65 age, we need to trace the cause of higher incidence rate in Incheon port during the second period.

Table 8

Incidence rate by estimated maximum number and hours of pilotage services

Age Group	Estimated maximum number except Incheon			Estimated maximum hours except Incheon		
	Prob1 (number of services)			Prob2 (hours of services)		
	2004-2008	2009-2013	Total	2004-2008	2009-2013	Total
65 & Under	2.57E-05	2.82E-05	2.70E-05	1.94E-05	1.94E-05	1.94E-05
Over 65	2.16E-05	1.92E-05	2.03E-05	1.63E-05	1.33E-05	1.47E-05
Total	2.54E-05	2.74E-05	2.65E-05	1.91E-05	1.89E-05	2.02E-05

Source: Author's elaboration on the data of KMPA

We examine further into the cases of pilotage marine accidents in Incheon piloting area by interviewing staff members in the port. The interviewees point some characteristics of Incheon piloting. First, the basic geographic structure of Incheon port is pretty long ranging from North and South areas of Incheon city adjacent to the sea which made many different types of ships and pilotage services concentrated on narrow maritime routes. The routes are mostly located around the Pal-Mi Island as depicted in Figure 1. Second, there exists night works and thick fogs at Incheon port, and the difference of the rise and fall of the tide is pretty large, which makes it difficult to work on pilotage in the area. Third, the average age of pilots in Incheon is a bit higher than those of other ports because of the lack of influx of young pilots into the area.

Nevertheless, the first and the second element of pilotage marine accidents in Incheon piloting area are found the same in the first period and the second period. Hence, the first and the second element are not a main cause of a higher incidence rate of the group over 65 in Incheon piloting area during the second period. The third element pointed by the interviewees seems to be a rational factor.

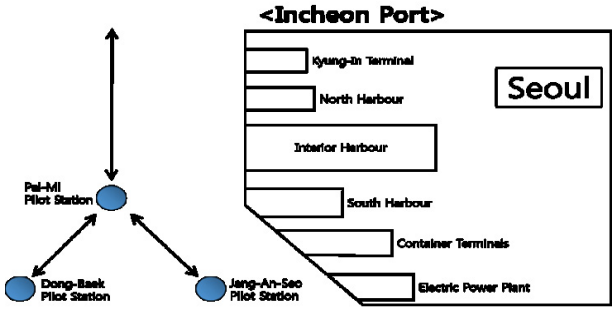

Fig. 1. Pilot Service of Incheon Port

Source: Author's elaboration on the data of Pilot Area (2017)

KMPA and the staff in Incheon piloting area assert that the development and expansion of Incheon port after the mid of 2010s enforced the pilots in Incheon to serve new types of ships such as very large container vessels and cruise ships. In particular, Incheon Container Terminal which can handle 20 thousand tonnage vessels commenced its

operation in 2004; SICT container terminal in 2005; and EICT container terminal in 2009 (Yeosu and Gwangyang Port Authority, 2016). In addition, two international passenger terminals in Incheon started their services respectively in 2000 and 2002. The number of arriving cruise ships in Incheon soared from two in 2007 to 15 in 2009 (MOF, 2010).

This might be the main reason why there are more accidents in Incheon port in the older age group compared to other pilots in different ports and why the younger pilot group in Incheon port also illustrates more marine accidents during the second period. The younger pilot group in Incheon port records eight marine accidents during the second period as shown in Table 7, four more accidents compared to the number of marine accidents during the first period. Nevertheless, the younger pilot group in Yeosu piloting area records eight marine accidents during the second period, eight more accidents compared to the number of marine accidents during the first period. Hence there might be other causes of pilotage marine accidents in Incheon and Yeosu.

6. Conclusions

The tendency of aging pilots in Korea raises several issues and challenges of pilotage. Although pilots and KMPA have requested MOF to extend the retirement age of pilots, we find that the incidence rate of group over 65 soars up during the second period from 2009 to 2013. Therefore, the decision of MOF not to extend the retirement age is reasonable and seems to reduce possible marine accidents during pilotage which may occur in the case of extension of retirement age. Nevertheless, Incheon piloting area brings mainly a higher incidence rate of age group over 65 in all piloting areas during the second period. Hence, a survey on Incheon piloting area in the future and comparison of pilotage system of all piloting areas would heighten our understanding of pilotage marine accidents in Korea.

The present paper has a few policy implications. First, it is important for the MOF to lower the age of applicants and pilots. The policy on age limitation of applicants may have positive effect in lowering the average age of Korean pilots. Taiwan, Japan and France set age limitation to pilot applicants: 50 in Taiwan, 35 in Japan and 35 in France. Second, the present retirement age of pilots, 65, is reasonable when considering a higher incidence rate of group over 65. The discussion on extension of retirement age necessitates the records of lower incidence rate of group over 65, compared to the group of 65 and under. Furthermore, we also find a contradictory result of incidence rate of group over 65 when excluding pilotage marine accidents in Incheon. The senior group without Incheon pilots show a lower incidence rate than that of the younger pilots. Hence, an additional survey of each piloting area would hint us an accurate cause of higher incidence rate of group over 65 in Incheon. Third, some measures to reduce the pilotage marine accidents of the age group over 65 are necessary. Improvement of work shift would be one of effective measures. A work shift, which allots pilotage service of day time more to the senior group, would reduce the fatigue of the senior group during pilotage.

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<Appendix 1> Work shift in Daesan piloting area (July 2014)

Day/shift	2	4	6	…	2	1	Alert	Off
1	A	B	C	…	Q	R	Z,Y	**X**
2	R	A	B	…	P	Q	Z,Y	**X**
…	…	…	…	…	…	…	…	**…**
31	G	H	I	…	E	F	X	Z,Y

Note: The initials in the table mean the abbreviation of names of pilots.
Source: Daesan Pilot Area Office (2015).