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Developing Parameters of Forecasting Models in the Field of Distribution Science to Forecast Vietnamese Seafarer Resources

Dinh-Chien DANG[1,*], Thai-Duong NGUYEN[2], Nhu-Ty NGUYEN[3]

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Abstract

Purpose: Maritime sector is fundamental to international trade; there is no doubt that seafarers have played an essential role in maritime shipping and distribution science industry. Thus, this study uses Grey models to predict the number of seafarers in Vietnam expecting to provide a range of future seafarers. **Research design, data and methodology:** Statistics data are adopted for numbers of seafarers by Vietnam Maritime Administration categorizing into three types: Officers at Management level, Officers at Operational level and Navigation - Engine officer cadet. **Results:** The results have showed that a lack of qualified seafarers in the distribution industry, which has become a global issue and Vietnam is facing challenges of providing enough supply of seafarers in the next few years. Since there has been a concern of the unbalance between demand and supply of seafarers, researches in maritime sector needs a high accuracy in forecasting the number of available qualified seafarers in Vietnam. **Conclusion:** This method can be applied to predict numbers of other human resources in transportation, distribution and/or logistics industries when the information is poor and insufficient. The next few years are predicted to witness a downtrend in sailors - oilers which leads to the fact that the total number of available seafarers is decreased.

Keywords : Distribution; Grey models; seafarers; logistics; prediction; accuracy

JEL Classification Code: L11, L91; M12, D3

1. Introduction

Maritime sector is fundamental to international trade and there is no doubt that seafarers have play an essential role in maritime distribution industry. A seafarer is defined as a person who is employed on board a ship, according to the Maritime Labour Convention, 2006. The unavailability of qualified seafarers and supply shortage become the barriers for global economy since the nature of this occupation is a high-risk career and distinct from others, particularly in working environment. There is a huge demand of suitably qualified seafarers for global trade, which is estimated that about 147,500 seafarers (18.3%) are still in need for 2025 according to BIMCO/ICS in 2015. The global market forces countries to seek a sustainable number of seafarers for such global demand according to BIMCO/ICS in 2015; 1 out of 10 officer trainees fails to complete the training. Therefore, a shift to recruit seafarers from developed countries to emerging countries occurs for lower crewing cost (Lobrigo, & Pawlik, 2015).

In Vietnam, the demand of seafarers is relatively high due to the supply and demand imbalance according to BIMCO/ICS in 2015. According to UNCTAD (2020), Vietnam is recognized as the most beneficial country which attracts more manufacturing facilities moving in such as Intel and Samsung as a result of trade tensions between US and China. Moreover, the number of vessels in

* Corresponding Author
1 Dinh-Chien Dang. Faculty of Navigation, Vietnam Maritime University, 484 Lach Tray Str., Haiphong City, Vietnam. Email: dangdinhchien@vimaru.edu.vn
2 Thai-Duong Nguyen, Faculty of Navigation, Vietnam Maritime University, 484 Lach Tray Str., Haiphong City, Vietnam. Email: nguyenthaiduong@vimaru.edu.vn
3 Nhu-Ty Nguyen. [3a]School of Business, International University. Vietnam National University HCMC, Vietnam. Email: nhutynguyen@gmail.com

Vietnam is in top 4 among ASEAN countries and top 30 of world fleet, contributing to 0.52% of total global vessels and 2.54% of seafarers supply. However, Vietnam Maritime Administration (2010) reported that there is a lack of seafarers that 43% of human resources decide to leave their career path, even though the annual graduation level is about 4,000 ship crews. The current challenges of Vietnamese seafarers supply happen in both recruitment and retentions (Nguyen, Ghaderi, Caesar, and Cahoon, 2014). Therefore, it is essential to conduct an analysis in order to forecast the number of available Vietnamese seafarers in the upcoming years. Compared to other maritime studies, there has been little research on establishing a model to predict the trend of seafarer labor for adopting adequate strategies in recruitment and management (Lim, 2019; Park, Chaffar, Kim, & Ko, 2017; Indahingwati, Launtu, Tamsah, Firman, Putra, & Aswari, 2019; Valipour, Salehi, & Bahrami, 2013). In addition, maritime sector still needs more researches to investigate on forecasting the supply and demand as energy, airline, tourism industries research which/that have been done.

The Grey System theory is one of the prominent forecasting tools which was proposed by Deng (1989) and gains its popularity for its high quality of prediction with incomplete and poor information system (Nguyen, 2019; Nguyen & Nguyen, 2019; Nguyen & Tran, 2015; Nguyen & Tran, 2016). By leveraging the small sample, the grey system theory helps to extract the next future data from it in an uncertain system. In grey system theory, there are three colors: “black”, “white” and “grey” used to represent the degree of information certainty. “Black” color refers to the unknown information, while “white” color indicates clearly known information. The information which has both partially unknown and partially known is “grey” information. There exist various types of models developed from grey system theory and Grey Model First Order One Variable GM (1, 1) is one of the most frequently used time-series models, so as to forecast nonlinear time series data and prove its high computational efficiency. In literature, Grey model GM (1,1) is widely applied in many fields such as energy, tourism, airline, etc and demonstrates good study results for high accuracy. The power of GM (1,1) is that it can be used for short-term forecasting with just only 4 historical data. With the context of maritime seafarer supply, historical data can be understood as the number of available seafarers each year. Since maritime sector is strongly depends on international trade where uncertain events occur in short time and demands for trading are different from the past, the high accuracy in forecasting supply for seafarers needs to be investigated more in research study (Pham, Nguyen, & Tran, 2019; Nguyen & Tran, 2018a; Jeong, 2017; Trinh, Nguyen, & Tran, 2020; Nam, 2019; Firman, Putra, Mustapa, Ilyas, & Karim, 2020). Hence, the present study uses Grey model GM (1,1) to predict the number of seafarers in Vietnam, which expects to provide a range of future seafarers supply.

2. Literature Review

In 1982, Julong Deng initiated and established the grey systems theory Deng (1989). Currently, grey systems theory has been widely applied in areas like social sciences, economics, agriculture, meteorology, military sciences, etc., providing solutions to a large number of practical problems and challenges met in daily lives and day-to-day tasks (Wang, Nguyen, & Tran, 2014a). To this end, various versions of grey systems modeling software have played a very important role in such large-scale practical applications of grey systems theory, for example, distribution, logistics, wholesale and so on. Along with the rapid development of information technology, high level programming languages have gradually matured, the applications of computing packages have become daily routines, and grey systems modeling programs are also becoming sophisticated.

In a variety of single forecast methods, grey forecasting model has several advantages (Chia-Nan & Ty, 2013): First, low requirements of sample, distribution regularity of the sample is not needed. Furthermore, the large number of samples is not necessary; generally, four or more samples can be used to figure out a precision-desired result. Second, it can be used in recent, short-term and long-term forecasting (Wang & Tran, 2014; and Wang et al., 2014b). Third, the forecast accuracy is of a high level. Thanks to many advantages, grey system has made considerable progress in the recent thirty years Wang et al. (2014c).

Most of the users of grey systems theory have been scientists and practitioners. Their purposes of applying the software system were mostly for their scholarly works (Liu, Lin, & Forrest, 2010). So, other than the computational outcomes, they are also very interested in knowing the specific procedural details. However, the original software package could only provide the results of computation and was unable to reveal the relevant computational details.

After spending a lot of time implementing quality improvement programs for financial modeling and decision processes across a large number of industrial sectors, including companies and universities organizations, we have noticed some high-level observations. Firstly, Excel - Microsoft Excel, which is a spreadsheet application developed by Microsoft for Microsoft Windows and Mac OS, has been used by the vast majority of these organizations to have financial models for forecasting (Day, 2013). These models are generally and often developed by junior staff but used by management. Finally, the lack of understanding of the needs of different stakeholders (including senior decision makers) causes widespread frustration.

Grey system theory, developed originally in early 1980s by Deng in 1982 (Deng, 1989), is an interdisciplinary scientific area. This theory has become a very popular method to deal with uncertainty problems under discrete data and incomplete information. As the superiority to conventional statistical models, grey models require only a limited amount of data to estimate the behavior of unknown systems (Deng, 1989).

It can be seen that grey system theory has aroused the interest of the scientists and scholars. The spread of this new theory has taken place as follows: in early 1990s, some universities located in Australia, China, Japan, Taiwan, and USA have started offering courses on grey system theory. Chinese Grey System Theory Association (CGSA) was established in 1996. A conference on grey system theory and applications is held by CGSA every year. For the dissemination of research results, academic periodical "the Journal of Grey System" starts to be published in England in 1989. Additionally, more than 300 different academic periodicals accept and publish the grey system-related articles in the world (Liu & Lin, 2011).

Deng (1989) in "Introduction to Grey System Theory" introduces some following essential contents and topics of Grey system.

In 1986, Xuemeng Wang and Jiangjun Luo created their grey systems modeling software using BASIC language and published Programs of Grey Systems' Prediction, Decision-Making, and Modeling (Liu & Lin, 2011 and Xuemeng & Jianjun, 1986). In 1991, Xiuli Li and Ling Yang respectively developed grey modeling software using GWBASIC and Turbo C (Liu & Lin, 2011). In 2001, Xuemeng Wang, Jizhong Zhang, and Rong Wang published the book, titled "Computer Procedures for Grey Systems Analysis and Applications," in which they listed the structure and procedure codes established for grey modeling. All of these computer software packages were developed on the DOS platform and have become obsolete in the more user-friendly Windows framework. Bo et al. (2011) created the modeling system of Grey Theory 6.0 Based on Visual C# and XML (Bo et al., 2011 and Liu & Lin, 2011).

In 2003, Bing Liu developed the first grey systems modeling software for the Windows using VisualBasic 6.0. As soon as this package was available, it was most welcomed in the community of scholars and practitioners of the grey systems research, and became the first choice of application in the field of grey systems modeling (Liu & Lin, 2011). With the time as the technology of software development evolves and continued progress in the research of the grey theory, the habit of computer operation changes, and some of the weaknesses of the package were found, including mainly the following: Data entry was tedious; the classification of the modules was not scientifically sound; the software system could not show the relevant computational procedures; the system's capability was disconnected from the most recent research progress; and there are some problems with the choice of the package development (Liu & Lin, 2011).

Besides that, many other papers, books and works have been published by applying grey system theory, especially GM (1,1) based on Matlab (Wen & Chang, 2005; Wen et al., 2006; You et al., 2006; Wen, 2008; Wang et al., 2013)

3. Research Methods and Materials

3.1. Establishment of GM (1,1)

The GM (1,1) model is established based on the first-order differential equation. The algorithmic sequences of forming GM (1,1) is presented step by step below (Nguyen & Tran, 2018b; Nguyen & Tran, 2019; Nguyen et al., 2015; Nguyen, 2019; Wang et al., 2015; Nguyen & Nguyen, 2020; Nguyen, 2021; Nguyen et al., 2021).

1. Establish original non-negative time series sequence $x^{(0)}$ with sample size n:

$$x^{(0)} = (x^{(0)}(1), x^{(0)}(2), \ldots, x^{(0)}(n)),\ n \geq 4$$

Since the condition of data sample size in GM(1,1) must be equal or larger than 4, then $n \geq 4$.

2. Generate new sequence $x^{(1)}$ from original data by $x^{(0)}$ using the Accumulating Generation Operator (AGO) to weaken the volatility of $x^{(0)}$, which is monotonically increasing.

$$x^{(1)} = (x^{(1)}(1), x^{(1)}(2), \ldots, x^{(1)}(n)),\ n \geq 4$$

, where each value of new sequence is defined as

$$x^{(1)}(k) = \sum_{i=1}^{k} x^{(0)}(i), \quad k = 1,2,3, \ldots, n$$

3. Build the first-order differential equation of grey model GM (1,1), which is given as

$$\frac{dx^1(t)}{dt} + ax^{(1)}(t) = b$$

And establish the grey difference equation: $x^{(0)}(k) + az^{(1)}(k) = b$

The background sequence of GM(1,1) $z^{(1)} = (z^{(1)}(1), z^{(1)}(2), \ldots, z^{(1)}(n))$ is the generated mean sequence of $x^{(1)}$, where the mean of adjacent data

$$z^{(1)}(k) = \frac{1}{2}\left(x^{(1)}(k) + x^{(1)}(k-1)\right),\ k = 2,3, \ldots n$$

a and b in grey system theory are the development coefficient and the driving coefficient respectively.

In the formula above, the sequence of parameters $[a, b]^T$ can be computed by using least mean square estimation technique coefficients, which is defined as $[a, b]^T = (B^T B)^{-1} B^T Y$ with

$Y = [x^{(0)}(2), x^{(0)}(3), \ldots, x^{(0)}(n)]^T$ and $B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \ldots\ldots & \ldots & \vdots \\ \ldots\ldots & \ldots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix}$

4. After obtaining the estimated parameters a and b, the solution of predicted value $x^{(1)}(t)$ at the time k is

$$x_p^{(1)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-ak} + \frac{b}{a}$$

5. With the Inverse Accumulating Generation Operator (IAGO), calculate the predicted value of the primitive data at time (k + 1) and at time (k + H):

$$x_p^{(0)}(k+1) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-ak}(1 - e^{a})$$

$$x_p^{(0)}(k+H) = \left[x^{(0)}(1) - \frac{b}{a}\right] e^{-a(k+H-1)}(1 - e^{a})$$

3.2. Data source

The present paper adopts statistics data for numbers of seafarers in the distribution industry by Vietnam Maritime Administration. According to the standards of the Convention STCW78, the data is categorized into three types: Officers at Management level, Officers at Operational level and Navigation - Engine officer cadet, which is from high to low level certificates. Seafarers in Vietnam need to be qualified by the standards in competency, English language and medical fitness to serve on board (see Table 1).

Table 1: Total seafarers in recent years

Year	Officers at Management level	Officers at Operational level	Sailors - Oilers	Total
2011	7,613	8,911	23,546	40,070
2012	8,421	8,892	25,665	42,978
2013	8,023	8,303	25,305	41,631
2014	9,828	9,555	25,738	45,121
2015	10,578	9,673	24,469	44,720
2016	11,163	9,977	21,997	43,137
2017	11,060	9,527	20,718	41,305
2018	11,241	9,143	19,001	39,385

3.3. Sample forecasting of grey model and evaluation metric

Adopting the GM (1,1) formula, the data from the years 2011 to 2018 is $x^{(0)}$ calculated by Matlab software to deliver the final result. Data in each type of seafarers is used as input for each original time series sequence from step 1 of GM (1,1) calculation. Then, the data continues to process by following the above next steps in model and calculating means of relative errors for predicted results evaluation. As can be observed in table 3, although the number of officers at management level increased from 7613 in year 2011 to 11241 in year 2018, the number of navigation-engine officer cadets tends to decrease and the number of officers in operational level has been going up and down in the past 8 years.

For testing accuracy, Mean Absolute Percentage Error (MAPE) is adopted as one of the widely used measures for evaluating forecasting accuracy. The smaller MAPE shows the better prediction results. The formula of MAPE is the sum of absolute percentage errors in each period divided by the number of observed values or

$MAPE = \frac{1}{n}\sum\frac{|Actual - Forecast|}{Actual} \times 100$, where n is the number of observed values

The evaluation of forecasting ability is performed with MAPE criterion (Table 2).

Table 2: Total seafarers in recent years

MAPE (%)	Evaluation
<10%	Excellent
10%~20%	Good
20%~50%	Reasonable
>50%	Poor

Table 3 shows the series of Actual value, Forecast value by GM (1,1), Accumulated Generating Operation (AGO), Absolute error (actual – forecast) and Absolute percentage error from 2011 to 2018. MAPE for forecasting the numbers of seafarers of the distribution is presented in the last column to evaluate. As observed, the total of MAPE values is 3.03 which indicates excellent grey prediction method. Moreover, MAPE test for the accuracy forecast ability for officers at Management level (4.07), officers at operational level (12.23) and navigation – engine officers (2.90) also shows results from good to excellent.

3.4. Results

Based on the data from Vietnam Maritime Administration, the numbers of seafarers in recent years from 2011 to 2018 are analyzed in this section. Moreover, GM (1,1) calculation continues to provide the predicted values in the next 7 years from 2019 to 2025 in table 4. It should pay attention to the current total number of seafarers in Vietnam, which tends to experience a decrease. The errors between actual and predicted values in 2011 – 2018 are so small with excellent MAPE score 3.03% for the whole; and 4.07%, 12.23% and 2.90% for each types of seafarers based on professional level including officers at management level, officers at operational level and sailors - oilers respectively.

Table 3: Total seafarers in recent years

Types of Officer	Year	Actual	GM(1,1)	AGO	|Error|	$\frac{\|Error\|}{Actual}$ x 100	MAPE
Officers at Management level	2011	7,613	7,613	7,613	0	0.00	**4.07**
	2012	8,421	8,470	16,083	49	0.59	
	2013	8,023	8,948	25,031	925	11.53	
	2014	9,828	9,453	34,484	375	3.82	
	2015	10,578	9,986	44,470	592	5.60	
	2016	11,163	10,549	55,020	614	5.50	
	2017	11,060	11,144	66,164	84	0.76	
	2018	11,241	11,773	77,937	532	4.73	
Officers at Operational level	2011	8,911	8,911	8,911	0	0.00	**12.23**
	2012	8,892	8,922	17,833	30	0.34	
	2013	8,303	9,044	26,878	741	8.93	
	2014	9,555	9,167	36,045	388	4.06	
	2015	9,673	9,292	45,337	381	3.94	
	2016	9,977	9,419	54,756	558	5.59	
	2017	9,527	9,547	64,304	20	0.21	
	2018	9,143	9,678	73,981	535	5.85	
Sailors - Oilers	2011	23,546	23,546	23,546	0	0.00	**2.90**
	2012	25,665	26,832	50,378	1,167	4.55	
	2013	25,305	25,548	75,926	243	0.96	
	2014	25,738	24,325	100,251	1,413	5.49	
	2015	24,469	23,161	123,412	1,308	5.35	
	2016	21,997	22,052	145,465	55	0.25	
	2017	20,718	20,997	166,462	279	1.35	
	2018	19,001	19,992	186,453	991	5.21	
Total	2011	40,070	40,070	40,070	0	0.00	**3.03**
	2012	42,978	44,023	84,093	1,045	2.43	
	2013	41,631	43,544	127,637	1,913	4.59	
	2014	45,121	43,070	170,707	2,051	4.55	
	2015	44,720	42,601	213,308	2,119	4.74	
	2016	43,137	42,137	255,445	1,000	2.32	
	2017	41,305	41,678	297,123	373	0.90	
	2018	39,385	41,225	338,348	1,840	4.67	

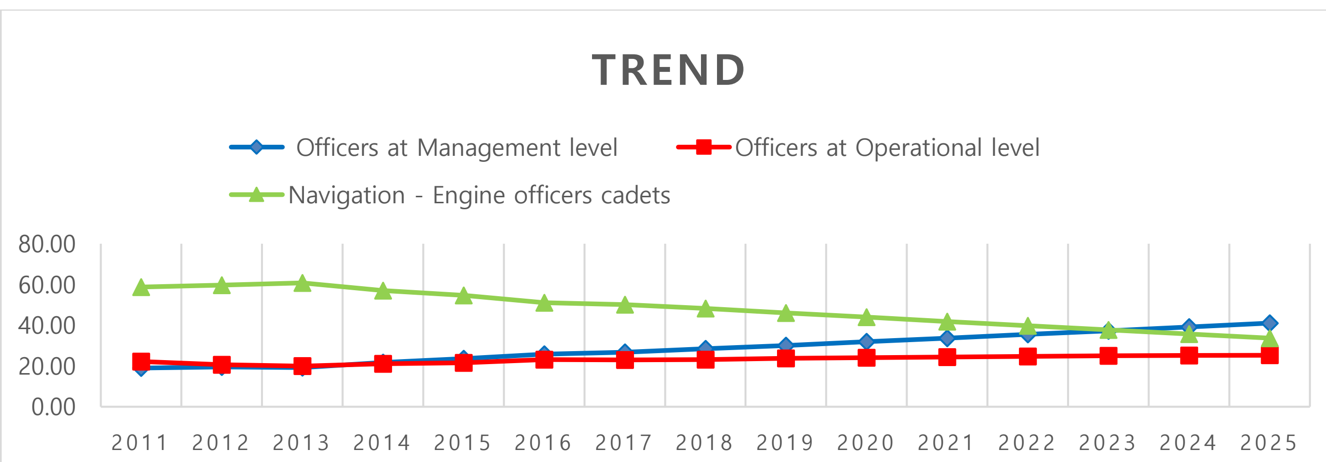
*AGO (Accumulated Generating Operation)

4. Trending for development

The grey model GM(1,1) predicts the next numbers of seafarers in future periods from 2019 to 2025, which are presented in Table 4, as this model gives high accuracy with small errors. Furthermore, the data is also illustrated by a line graph to demonstrate the trend of seafarers supply in recent years and the next eight years. In the graph, although both the number of officers at management level and that of operational level have slightly increased, Sailors - Oilers, accounting for the largest proportion in the total number of seafarers, have been dropping dramatically over the past 8 years. This explains that the predicted total numbers of seafarers tend to observe a decrease in the future. To be specific, the number of officers at management level is increasing from 19.00% to 41.05%. Officers at operational level line also shows their growth in the numbers but the growth pace is slow, which does not demonstrate too much of a difference in time series from 22.24% in 2011 to 25.27% in 2025. The line of sailors - oilers which also presents the future of new entrants tend to fall with the big gap of difference between 58.76% to 33.68% in 2025. In a big picture, the supply of seafarers in Vietnam will go down in the future (see Figure 1)

Table 4: The forecasted data results

Year	Officers at Management level	Officers at Operational level	Sailors - Oilers	Total
2019	12,437.175	9,809.523	19,035.025	40,775.684
2020	13,138.736	9,943.250	18,123.953	40,331.729
2021	13,879.871	10,078.800	17,256.488	39,892.608
2022	14,662.812	10,216.198	16,430.542	39,458.268
2023	15,489.918	10,355.469	15,644.128	39,028.657
2024	16,363.679	10,496.638	14,895.354	38,603.723
2025	17,286.728	10,639.732	14,182.419	38,183.416



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Management Officers	19.00	19.59	19.27	21.78	23.65	25.88	26.78	28.54	30.13	31.89	33.68	35.49	37.33	39.19	41.05
Operational Officers	22.24	20.69	19.94	21.18	21.63	23.13	23.07	23.21	23.76	24.13	24.45	24.73	24.96	25.14	25.27
Sailors–Oilers	58.76	59.72	60.78	57.04	54.72	50.99	50.16	48.24	46.11	43.98	41.87	39.77	37.71	35.67	33.68

Figure 1: The general trend of Vietnamese seafarers in recent years and next eight years

5. The gap ratio

From the bottom to top level of officers, there will be a gap between generations based on officers on board experience. The gap is shown by the ratio (1) between officers at management level and navigation – engine officer cadets and ratio (2) between officers at operational level and navigation – engine officer cadets.

$$ratio(1) = \frac{Officers\ at\ management\ level}{Navigation - Engine\ officer\ cadets}$$

$$ratio(2) = \frac{Officers\ at\ operational\ level}{Navigation - Engine\ officer\ cadets}$$

As can be observed in the table 6, at present (2011 – 2018), the ratio (1) and ratio (2) are less than 1, which means that the number of navigations – engine officer cadets is higher than that of high-level officers. Forecasting by GM (1,1) indicates that the trend presents a big gap among these types of officers as both ratio (1) and ratio (2) tends to be greater than 1. This shows the future generations have fewer interests in becoming seafarers since the forecast number of navigation – engine officer cadets is less than both numbers of higher level officers. This issue is not just only for the Vietnamese maritime sector, but it becomes a global ongoing issue among international countries.

Table 5: The gap ratio among generations in each year from 2011 to 2025

Years	Officers at Management level	Officers at Operational level	Sailors - Oilers	Ratio(1)	Ratio (2)
2011	7,613	8,911	23,546	0.32	0.38
2012	8,421	8,892	25,665	0.33	0.35
2013	8,023	8,303	25,305	0.32	0.33
2014	9,828	9,555	25,738	0.38	0.37
2015	10,578	9,673	24,469	0.43	0.40
2016	11,163	9,977	21,997	0.51	0.45
2017	11,060	9,527	20,718	0.53	0.46
2018	11,241	9,143	19,001	0.59	0.48
2019	12,437	9,810	19,035	0.65	0.52
2020	13,139	9,943	18,124	0.72	0.55
2021	13,880	10,079	17,256	0.80	0.58
2022	14,663	10,216	16,431	0.89	0.62
2023	15,490	10,355	15,644	0.99	0.66
2024	16,364	10,497	14,895	1.10	0.70
2025	17,287	10,640	14,182	1.22	0.75

The nature of seafarers is different from other ashore jobs, which requires separation from family, working in the on-board environment, and acceptance of risks on the sea. Therefore, some reasons are researched to explain the difficulties of recruitment and retentions in this industry. The challenges in Vietnam are found in the research of (Nguyen et al, 2014) and some of the top reasons are low salary, poor working conditions, the lack of work experience and training time, which leads to poor English and on-board skills, high attrition and high level of fatigue. In the research on Chinese student's perception, high wage is the important factor that affects Chinse students (Fei, 2014). Moreover, Chinese students also consider the trade-off between working on-board a ship and conditions of being separated from their families, landside job opportunities and raising children. Thus, there should be more investment to attract more young generation so as to not only offer high wages but provide a clear potential career path for new entrants. Investment on working environment on ship and human resource management can optimize the quality of retention. Sleep quality is also a factor affecting seafarer's fatigue, which is a highlighted concern in the research of Härmä et al (2008). Another considerable factor is personal interest motivation that pushes seafarers to continue to work with 54,6% among factors, compared to the highest score in salary and benefits (81.5%) in the research on South African cadets (Ruggunan & Kanengoni, 2017). Meanwhile, Taiwanese students are more motivated by intrinsic factors rather than external ones (Guo, Liang, & Ye 2006).

6. Discussion

According to the statistics of the Vietnam Maritime Administration, by the end of 2019, the total number of valid certificates of professional ability (GCCNCM) is over 41 thousand, with the number of ships flying the Vietnamese flag at about 1,500. If calculated simply arithmetically, the number of these officers and crew members can still meet the demand (including the number of over 2,000 seafarers of distribution going to work for the fleet with foreign flags).

In fact, it is increasingly difficult for ship owners to recruit crew members, especially experienced and skilled people. Some ship owners must use foreign crew members, including low-ranking titles such as AB, OS, with not much seafaring experience to maintain the operation of the fleet. This fact shows that many seafarers have quit their jobs and switched to other jobs ashore. Young people are less and less interested in studying at seafarer training institutions. In other words, the maritime industry in general and the profession of working in overseas ships are no longer attractive to workers. There are many reasons leading to this situation, but some of the main reasons are summarized as follows:

Firstly, along with the development of the national economy, people's material and spiritual life has been improved. Workers (especially young people) have many suitable job choices, while seafaring is still considered as a heavy and strenuous job, often away from home, floating on the sea... However, income cannot compete with jobs on shore.

Secondly, Vietnamese families have fewer and fewer children, and the general mentality is that they don't want their children to study and work hard at sea, often away from home.

Thirdly, the situation of salary debt, salary burst, fragmented and unprofessional management methods of some ship owners leads to employees being discouraged, discontented, and losing the confidence of society in the sailing profession. the sea (recently, this phenomenon has been greatly reduced, but the after-effects cannot end on one day or two).

Fourth, the mechanisms and policies of the State currently do not have any special incentives to attract workers to this very important but disadvantageous working environment.

We also obtained the results from this research that the number of deck and engine management officers ~~is~~ would be higher in 2024 and 2025. On December 3, 2019, the State President signed the Order to promulgate the Labor Code (amended), which was approved by the XIV National Assembly at the 8th session, on November 20, 2019. Accordingly, employees working in the maritime sector are classified in the group of special occupations (including: arts, sports, maritime, aviation), and are entitled to a number of appropriate regimes on training and retraining to improve qualifications, labor contract, salary, bonus, working time, rest, etc., according to the Government's regulations (Article 166 - Labor Code).

At the same time, this is also a premise for State management agencies, enterprises, training institutions and so on to coordinate, research, and propose solutions to the Government and competent authorities. Appropriate regulations and policies (such as: recruitment, training, internship on ships; working regimes, wages, bonuses, etc.) to contribute to solving existing difficulties and creating motivation attract back maritime human resources in general, and seafarers working on ships in particular.

7. Conclusions

The demand of international trade calls for a need of seafarers in the maritime sector. A lack of qualified seafarers becomes a global issue and Vietnam is facing challenges of providing sufficient supply of seafarers in the next few years. Since there has been a concern of the unbalance between demand and supply of seafarers, research in maritime sector needs a high accuracy in forecasting the number of available qualified seafarers in Vietnam. Therefore, grey model GM (1,1) proposed by Deng (1989) is applied to forecast it with a small data sample from Vietnam Maritime Administration. GM (1,1). The predicted results help to observe the trend of development in Vietnamese seafarers that the generation gap of supply is bigger in the future. Next few years are predicted to witness a downtrend in sailors – oilers, which leads to the total number of available seafarers being decreased. The application of GM (1,1) in the context of Vietnamese seafarer~~s~~ supply proved its power in prediction as MAPE errors are from good to excellent in total and each level of officers. This method can be applied to predict the number of other human resources in transportation industry when the information is poor and insufficient.

8. Limitations and Future Research

Due to the weak regularity of related data about this industry in Vietnam, the results of this study probably contain some errors compared with the facts. Therefore, how to improve the reliability of application Grey Forecasting in the field of research on seafarers will become a focus of further research. Moreover, with the attained results from this research, this method can be applied for further maritime resources planning, for example, more kinds of jobs or maybe the turnover rates. Therefore, it is so important to have good strategies to make good development for Vietnamese maritime system.

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